REPORT

FOR

Storm and Sanitary Sewer Study
Volume 2 – Storm Sewer Study

FOR
City of Midland

August 2018

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Midland Stormwater Study

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Midland Stormwater Study

A. Introduction – Need for Project

The flooding that occurred in the City of Midland in late June 2017 revealed that the City's stormwater and wastewater systems needed to be evaluated based on their ability to provide a reasonable Level of Service (LOS) to the residents and businesses of Midland. The flooding that occurred on and around June 23, 2017 (an 82-year recurrence interval event) was the result of backups in both the stormwater and wastewater collection systems, as well as high river levels observed along the Tittabawassee River; this impacted basements, street/yard flooding, and caused significant property damage.

The City hired OHM Advisors and HRC to evaluate the City's stormwater and wastewater collection systems. This report focuses on the stormwater collection system.

Although the stormwater and wastewater collection systems are separate ***by design***, they can be connected via unanticipated connections above and below the surface. This is often referred to as Rainfall-Dependent Inflow & Infiltration (RDII). When a stormwater system is unable to provide quick and efficient drainage, water can temporarily flood the surface (i.e. roadways, yards, etc.); this flooded water can enter a sanitary sewer through manhole covers (see Figure 1) and directly-connected footing drains, thereby increasing the flow in the sanitary sewer and increasing the threat of basement backups.

Figure 1 – Submerged Manhole
Even an inch or two of water above a sanitary manhole can cause significant inflow

Maintaining an efficient stormwater collection system is an important first step in reducing RDII in a wastewater system. Flood control from rainfall helps to reduce the number of connections between the storm and sanitary sewers. As such, the recommendations in this report go hand-in-hand with those in the Sanitary Sewer Study.

Additionally, stormwater collection systems can be designed to reduce the likelihood of surface flooding, which can cause property damage and disrupt the local economy (see Figure 2). This study includes an analysis of various rainfall events and introduces a recommended Level of Service for the City to consider when making future capital improvements to its storm sewer system.

Figure 2 – Flooding Along Joe Mann Boulevard, June 2017 (Mall Area)
Source: Eye in the Sky Productions, YouTube video

The hydrologic/hydraulic modeling program XP-SWMM 2017 was used to estimate peak flow rates and determine the hydraulic capacity of the key components of the City of Midland's stormwater collection system during the 10-year / 24-hour design event, including storm sewers sized 24-inch diameter and larger and selected reaches of open drainage channels.

The XP-SWMM model is compatible with EPA SWMM with some minor modifications to the hydrologic model to ensure that peak flows are equivalent to those calculated in the XP-SWMM model. The City can, at its discretion, use EPA SWMM to model the storm sewer system in the future.

The findings from this modeling effort, as well as the recommended improvements, are covered in the following sections of this report.

B. Key Findings and Recommendations

There are two primary causes of flooding in the City of Midland:

1. **Floodplain inundation from the Tittabawassee River and Sturgeon Creek**. During the June 2017 rainfall, the Tittabawassee River crested about two feet below the historical high water level. Based on our review of USGS river gage data (USGS Gage # 04156000) and the FEMA Flood Insurance Study for Midland County (updated in January 2013), the peak river level observed on June 24, 2017 (elevation 612.2 feet) was approximately equivalent to a 50-year recurrence interval flood level. The 1986 event (historical high water level of 614.1 feet) was just above the 100-year recurrence interval flood level.

   The City of Midland is near the downstream end of the Tittabawassee River watershed, which is approximately 2,400 square miles (see Figure 3). The water levels in the river are impacted by rainfall patterns many miles north and west of Midland.

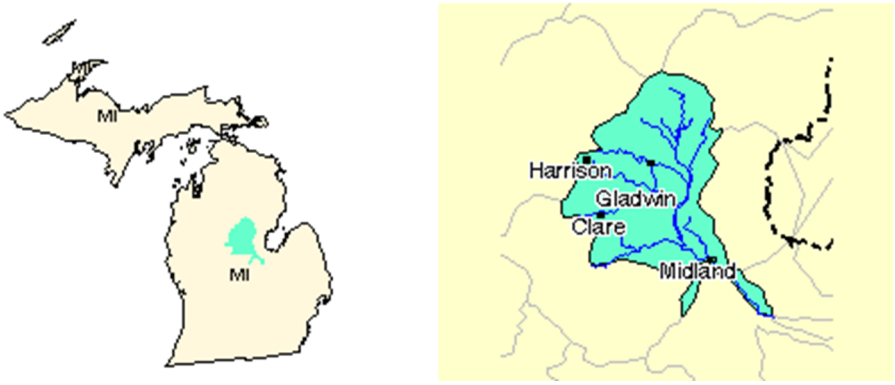


Figure 3 – Tittabawassee River Watershed
Source: U.S. EPA

   Furthermore, Sturgeon Creek, which flows from the north to the south along the City's west side, is also directly impacted by the Tittabawassee. Neighborhoods along the Sturgeon Creek, primarily south of Highway 10, are impacted by the water levels in the Tittabawassee. Furthermore, public comment received indicated that blockages at bridges and culverts along the Sturgeon Creek exacerbated flooding for properties near the creek. Other local drainage channels, such as Snake Creek, Jacobs Drain, Engle Drain, and Dingman Drain, are higher and/or do not drain directly to the Tittabawassee and were therefore not impacted in the same way.

   The Sturgeon Creek experienced additional hydraulic surcharge, primarily north (upstream) of Saginaw Road; this is based on public comments received during the draft report review and aerial flooding videos provided by the Michigan State Police. According to the aerial flooding videos, the June 23 flooding of the Sturgeon Creek resulted in a peak flood elevation of ~620 feet north of Highway 10, in the vicinity of the airport. This flood elevation exceeds the 500-year flood profile of the Sturgeon Creek, according to the 2013 FEMA Flood Insurance Study.

The Sturgeon Creek flood profile does not appear to reflect observed conditions. This may be due to the absence of modeled bridges/culverts from Sugnet Road north to the airport (see Figure 4). The aerial videos indicated that the Highway 10 culverts (as well as the service roads north and south of the highway) created significant headwater during the cresting on June 23, 2017. As such, it is likely that the flood risk along the Sturgeon Creek is not adequately represented in the FEMA study.

The Sturgeon Creek watershed is 64 square miles, and it is impacted by precipitation patterns and hydrologic characteristics well outside the City of Midland. Given that there was an existing FEMA study for the Sturgeon Creek, the flood profiles in that study were used in lieu of a separate detailed hydraulic analysis. This was done as a measure to keep the costs within budget and focus efforts on other key drainage channels which impact many of the City's storm sewer systems, and where many of the most concentrated flooding problem areas were reported. Also, the FEMA study suggested that the Sturgeon Creek was wholly under the influence of the Tittabawassee River levels, which precluded the creek to be targeted for extensive study.

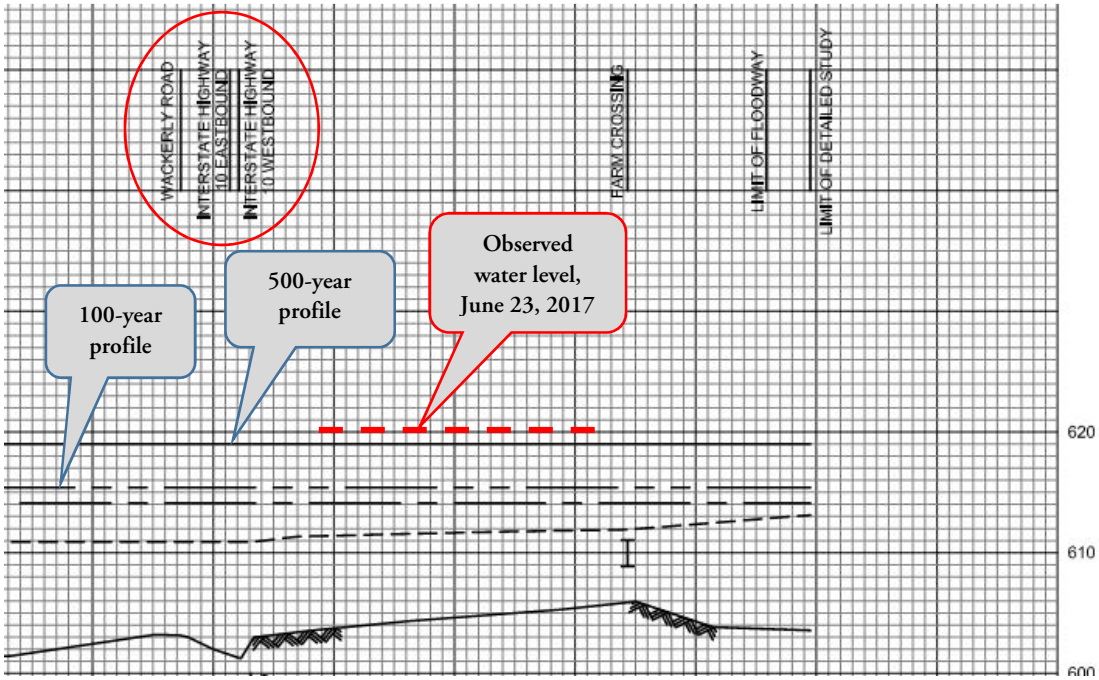


Figure 4 – Sturgeon Creek Flood Profiles
FEMA Flood Insurance Study (January 2013)

Many homes and businesses within the Tittabawassee floodplain were impacted by the high water levels (See Figure 5). This flooding was not due to the City's stormwater infrastructure, but instead was the result of high waters in the Tittabawassee / Sturgeon that backed up (either through storm sewers or overland) onto properties and into homes. As Figure 6 shows, some low-lying areas exist well beyond the river location. The locations depicted in Figure 6 illustrate

areas where the high river level (as observed in June 2017) would surcharge the sewer system and flood surrounding areas.

Figure 5 – Downtown Flooding along the Tittabawassee
Source: Midland Daily News, June 25, 2017

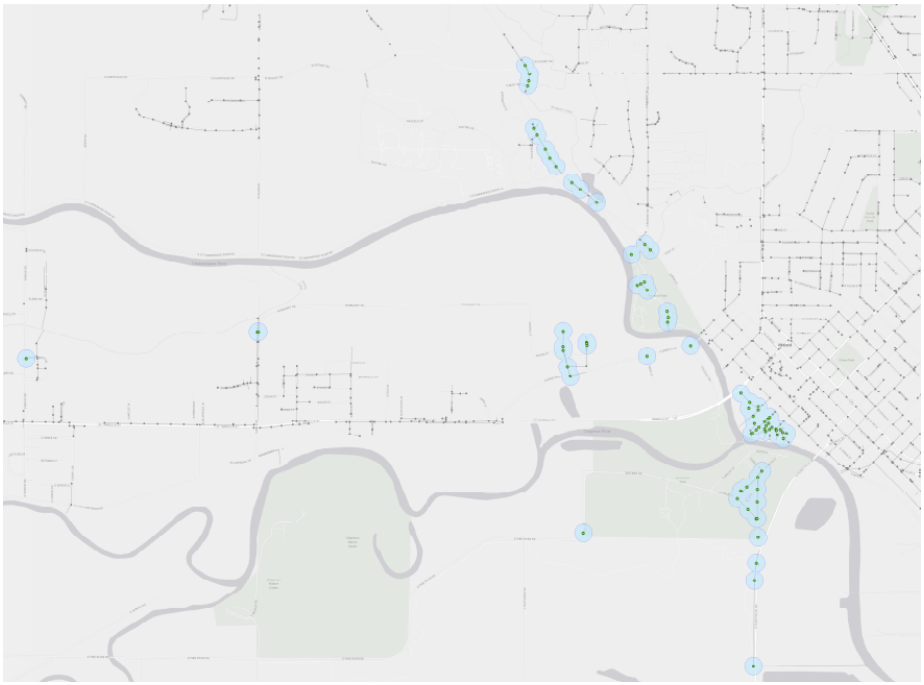


Figure 6 – Storm Sewer Manholes Below June 2017 Tittabawassee Crest Elevation
June 24, 2017 (crest elevation = 612.23)

2. **Undersized Storm Sewers and Culverts.** The City of Midland's stormwater collection system has hydraulic deficiencies that result in increased risk of surface flooding relative to typical municipal standards for LOS. When this type of flooding occurs, water levels generally rise quickly and then subside within 30-60 minutes of a storm (unlike floodplain inundation caused by the river that can last hours or more than a day).

   The type of damage that can be caused by undersized storm sewers is still very significant and shouldn't be discounted relative to floodplain inundation. When storm sewers are unable to convey the runoff generated from nearby roads and other impervious surfaces, it can cause the following:

   - Impassable roadways
   - Flow onto private property and into homes through windows and/or doors
   - Increased flows in the sanitary sewer system, due to inflow into sanitary manholes, caused by standing water on the roadway surface

   The total cost for Priority 1 flood control projects is $30.0 million.

   The amount of flow a stormwater system should handle varies by community, and is not directly regulated (as it is for the City's wastewater system). However, most cities design their stormwater systems to safely convey flow resulting from a 10-year storm, which has a 10% chance of being exceeded in any given year (see the discussion on Level of Service in the following section).

   Section J includes additional detail on the key findings from the Existing Conditions hydraulic model. Section K includes a list of proposed improvements to achieve the recommended LOS.

Some types of flooding are unpreventable. Homes and businesses that are close to a floodplain will be subject to occasional overland/surface flooding regardless of the size or physical condition of the City's stormwater infrastructure.

The recommended Capital Improvement Program to address the desired LOS discussed with the City includes over 50 individual sewer segments, four culvert replacements, 15 offline stormwater detention storage areas, and an initial allowance for high priority sewer inspection, cleaning, and emergency repairs. These projects are separated into Priority 1 and Priority 2 projects.

- Priority 1 projects are defined as those that will have the most significant impact on reducing flood potential in the City. In many cases, these projects represent the downstream component of other (Priority 2) projects that are not feasible until the Priority 1 projects are fully-implemented. Included with Priority 1 is an update of the City's stormwater GIS geodatabase (see Section D for additional information on the need for this activity).
- Priority 2 projects are either projects that only marginally fail the current LOS or they depend upon Priority 1 (downstream) projects to be constructed first before they are feasible.

The total planning-level cost to implement Priority 1 projects is $30.0 million. The total planning-level cost to implement all recommended projects is $79.7 million.

The entire CIP is not practical to implement in a 5-year (or even a 10-year) time frame, as a result of the predicted cost magnitude. This is due to the fact that the City of Midland, which is typical of most cities in Michigan, has no dedicated funding source for stormwater infrastructure. In order to implement this Stormwater Master Plan, it is suggested that the City take the following steps to improve its stormwater system:

1. Focus on the Priority 1 projects (see Section K for a list of Priority 1 projects).
2. Align recommended storm sewer improvements with upcoming road projects. As older road surfaces are replaced, it is significantly less expensive to replace storm sewer as a marginal cost on a road project than as a stand-alone project. This strategy will likely result in a long-term implementation of the entire CIP, likely ranging between 30-40 years.
3. Implement projects from downstream to upstream. This may require some deviation from Item 2 above, as some road replacement projects are upstream of future recommended storm sewer improvements. In those cases, it may be necessary to plan ahead and implement downstream projects as stand-alone projects in order to accommodate upstream improvements.
4. Review alternative revenue options, including a Stormwater Utility (enterprise fund) or a special tax millage for stormwater projects.

C. Level of Service

The Level of Service (LOS) for a stormwater system is traditionally defined as the storm magnitude (i.e. annual exceedance interval) that the collection system can convey without causing surface flooding that may negatively impact residents, businesses, and institutions. This is often referred to in terms of inches of rainfall or annual recurrence interval, such as the 10-year storm (also known as the 10% storm, as it has a one-in-ten chance of being exceeded in any given year). For this analysis, we analyzed the City's collection system against the 1-year, 2-year, 5-year, and 10-year events as they provide a wide range of LOS that can be used to evaluate different parts of the City's collection system.

The reason for analyzing the City's system under lower magnitude (i.e. more frequent) storms like the 1-, 2-, and 5-year recurrence interval is that it was necessary to determine what level of service is actually provided under current hydraulic conditions. This also allows the magnitude of the June 2017 event to be evaluated in the context of a recurrence interval. ***Based on our analysis of the City's stormwater collection system, the LOS varies between different neighborhoods; however, in general, the system can adequately convey a 2-year storm (50% chance of being exceeded in any given year) without excessive surcharge (greater than five inches) above the surface elevation.***

The City's current stormwater ordinance, Chapter 29 Stormwater Runoff Regulations and Control, states for new developments, "*where storm sewers are required they shall be of such size as will provide sufficient capacity to receive the flow generated by a ten-year storm from upland area*."

Upon discussion with City staff, it was determined that a 10-year storm (10% chance of being exceeded in any given year) should be used as the basis for evaluating the storm sewer system. This event is defined as a rainfall occurring uniformly across the City and directly impacting the City's storm sewer system. More specifically, stormwater infrastructure components were considered as not achieving the desired LOS if:

- SEWERS: The sewer causes a hydraulic surcharge that exceeds 5 inches (0.42 feet) above the surface elevation at the peak flow generated from a 10-year, 24-hour duration storm (SCS Type II rainfall distribution)
- CULVERTS/BRIDGES: A culvert or bridge that results in roadway overtopping at the peak flow generated from a 10-year, 24-hour duration storm (SCS Type II rainfall distribution)

D. Modeling Methodology: Hydraulics

XP-SWMM is a physically-based storm event simulation program capable of simulating runoff from various land uses and soil types, combining sub-basin hydrographs, and routing flow through storage (detention ponds, floodplains, and/or street/surface flooding) and conveyance elements (sewers, open drainage channels, and roadway flow that occurs when the sewer system is surcharged).

XP-SWMM integrates the hydrologic analysis with the hydraulic analysis, so stormwater storage resulting from detention ponds or surface flooding/ponding is taken into account in peak flow computations. Peak flows from the hydrologic analysis (see Section E) are used to compute a hydraulic grade line (HGL) for each component of the collection system (pipes, culverts, open channels).

An *Existing Conditions* XP-SWMM model was developed to simulate the hydraulic characteristics of the collection system under existing land use conditions. The key findings of the Existing Conditions XP-SWMM model are discussed in Section J. A *Proposed Conditions* XP-SWMM model was developed to simulate the impacts of recommended hydraulic improvements (see Section K).

Channel cross sections of the Snake Creek and parts of Dingman Drain and Jacobs Drain were modeled, as these drainage channels represent a major component of the City's drainage system and they impact storm sewers that discharge to these channels. Sections of the creek or drains were modeled only when not impacted by the 100-year backwater from the Tittabawassee River.

The Sturgeon Creek watershed is 64 square miles (Sturgeon Creek Watershed Management Plan, 2003). Given the size of the watershed and the additional complexities involving channel hydraulics, modeling the channel was beyond the scope of this study. Furthermore, the Sturgeon Creek floodplain, as currently reflected in the FEMA Flood Insurance Study, does not appear to be accurate, especially in the vicinity of Highway 10 (See Section K for recommendations on how to remedy this). As such, the Sturgeon Creek was not modeled as part of this project. As the influence of water levels from the Tittabawassee River control the water levels through the majority of Sturgeon Creek within the City, the observed water levels in June 2017 were used as a basis for establishing downstream boundary conditions for sewers draining into Sturgeon Creek.

Bridge and culvert dimensions were based on as-built drawings or field survey.

Hydraulic characteristics for the stormwater collection system were based on existing GIS data and supplemented with field survey to confirm rim and invert elevations. Storm sewers 24-inch diameter and larger were included in the hydraulic model. The base assumption is that every storm sewer is structurally sound and clear of sediment or other debris. Given that the City regularly cleans their storm sewer system, the model assumptions should generally hold true to the physical conditions of the collection system.

There are some discrepancies on sewer size and elevation in City's GIS stormwater geodatabase. Where obvious discrepancies were noted, field survey was used to verify actual sewer pipe size.

1. Existing GIS Geodatabase: Ground Surface Elevations

The rim and invert elevations in the storm sewer system were based on the values currently populated in the City's GIS stormwater geodatabase. During the modeling effort, it was discovered that a vertical discrepancy exists in some areas in which the rim (surface) elevation varied from the elevation in Midland County's Digital Elevation Model (DEM) that was used to create the contours in the City's GIS.

As the LOS determination is completely dependent on the depth of surcharge above the surface elevation, having an accurate rim/surface elevation is critical. During the analysis of CIP projects, areas showing significant surcharge were reviewed to see if a vertical discrepancy exists. In some cases, the ground surface profile (per the DEM) was higher than that defined by the rim elevation in the stormwater geodatabase. Based on conversations with City staff, this is due to the City-specific datum used on as-built drawings, which is offset approximately 1.9' relative to the NAVD88 vertical datum used to generate the County's DEM and contours.

Given the vertical datum shift between the surface elevations and the GIS stormwater manhole rim elevations, in addition to pipe size discrepancies noted above, we recommend that future modeling efforts for preliminary design include a vertical datum shift of the storm sewer system to the NAVD88 datum. This will be an important step to optimize the stormwater model and increase confidence in the sizes and locations of the sewer improvements.

2. Open Channels / Cross Sections

Surveyed cross sections of the waterways were collected and spaced roughly between 50 to 100 feet. Additional cross sections were collected near bridges and culverts. The cross sections include low-lying or flat areas outside of the defined channel. This was done in order to more accurately model the floodplain during low-probability storms, allowing the flow which overtops the banks of the channel to spread over adjacent areas.

The channel roughness factor (Manning's n), was estimated based on the 2011 Flood Insurance Study for Snake Creek as listed in the following table:

Stream	Channel n	Overbank n
Snake Creek	0.03-0.12	0.031-0.055

Given that Snake Creek is heavily wooded along its banks, the Manning's n value used for the channel is 0.06. The overbank generally consists of less heavy (woody) vegetation and was assigned a Manning's n value of 0.043.

Bridge and culvert dimensions were based on field survey. Entrance and exit loss coefficients were estimated based on hydraulic charts for bridges and culverts available from the Federal Highway Administration (FHWA).

3. Boundary Conditions / Coincidental Probabilities

The hydraulic characteristics of each drainage area, as represented in the XP-SWMM model, reflect downstream boundary conditions for each modeled storm sewer that discharges to the respective creek/drain. For the smaller (modeled) creeks, the boundary condition is calculated in the model. For the larger creeks (Sturgeon and Tittabawassee) the boundary conditions were selected based on HEC-22, Urban Drainage Design Manual (Federal Highway Administration, 2009). According to this manual:

> *If the outfall channel is a river or stream, it may be necessary to consider the joint or coincidental probability of two hydrologic events occurring at the same time to adequately determine the elevation of the tailwater in the receiving stream. The relative independence of the discharge from the storm drainage system can be qualitatively evaluated by a comparison of the drainage area of the receiving stream to the area of the storm drainage system. For example, if the storm drainage system has a drainage area much smaller than that of the receiving stream, the peak discharge from the storm drainage system may be out of phase with the peak discharge from the receiving watershed.*

In other words, it is not appropriate to use the 100-year high water elevation (or even the 10-year elevation) of the Tittabawassee or Sturgeon Creek as the downstream boundary condition for a 10-year event on the local collection system, as the probability the peak flows coinciding are extremely small. Based on guidance in the FHWA document, the tailwater elevation for the receiving stream should be based on a more frequent event when evaluating the storm sewer system discharging into it if the receiving stream has a drainage area that is much larger than that discharging into it.

Table 7-3 (Frequencies for Coincidental Occurrence) from the FWHA document provides the following guidance, which was used in establishing boundary conditions for the City's stormwater system under the design storm event. Based on the relative differences between the smaller urban subcatchments in this study's model and the much larger watersheds they drain to, we recommend the following boundary conditions:

- Systems discharging to Sturgeon Creek: 10-year storm (local system) vs. 2-year peak water level (Sturgeon Creek). This tailwater condition should be re-evaluated given the discrepancy between official and observed flood profiles, as noted previously.
- Systems discharging to Tittabawassee River: 10-year storm (local system) vs. 2-year storm (Tittabawassee River)

On average, the drainage systems discharging into the Tittabawassee River and Sturgeon Creek are about 1/1,000th to 1/500th the size of the watersheds of the receiving streams.

E. Modeling Methodology: Hydrology

The 40-square-mile study area for the City's stormwater collection system, which includes some areas along the perimeter of the City (such as the Jacobs Drain, much of which lies beyond City limits), was limited to areas draining to City-owned storm sewers. The hydrologic model consists of 270 individual subcatchments to quantify the stormwater runoff contribution from individual portions of the studied watershed. Figure 7 shows the subcatchments created by the existing delineated drainage districts. Subcatchment delineation was confirmed using 2-foot contours provided by the City of Midland. The City currently has ten primary drainage districts. The drainage districts were subdivided into smaller sub-basins to quantify the stormwater runoff contribution from individual portions of each watershed.

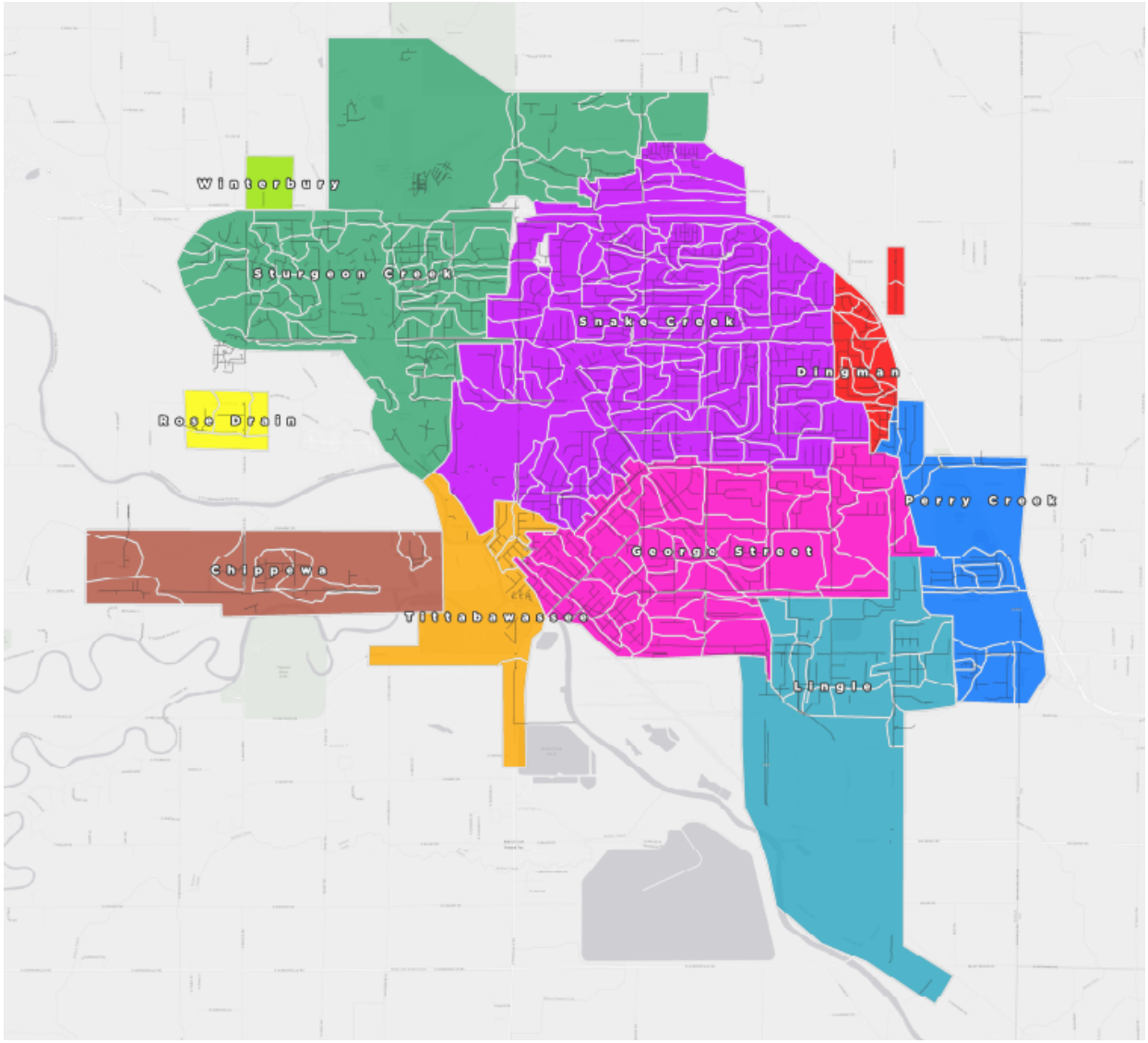


Figure 7 – Modeled Subcatchments

The majority of the City has soils classified as Type B, confirmed by our analysis of the USDA/NRCS online soils map. Type B soils are generally classified as moderately-drained soils and usually consist of sandy/loamy mixtures. All subcatchments were assigned a saturated soil conductivity (infiltration, k_{sat}) rate reflective of sandy loam soils in an urban environment (compacted topsoil, k_{sat} = 0.15 inch/hour).

The Green Ampt methodology was used to model infiltration for pervious areas. This is a standard tool to

The City uses SCS Soil Types C & D for planning, which are appropriate for a conservative design; this study is based on Type B soils, which results in lower peak flows but reflects the predominant soils in the City.

model the impacts of infiltration and depends on multiple variables to define the pervious surface and how quickly rainfall can soak into the soil so it does not become runoff. Variables used in the City of Midland model are as follows for sandy loam conditions.

- Average Capillary Suction: 8 inches (typical for sandy loam)
- Initial Moisture Deficit: 0.33 (typical for sandy loam)
- Saturated Hydraulic Conductivity: 0.15 inch/hour (typical for Type B soils in an urban environment)

A key variable in urban stormwater models is ***percent impervious***, as the hard (impervious) surfaces in each drainage area create the majority of runoff and therefore place a greater demand on the stormwater system. The percent impervious value was estimated for residential subcatchments based on actual measurements of impervious areas (using the City's aerial photography) for lower and higher density development areas. These percentages were applied to other areas of equivalent land use. Residential areas were assigned lower (30%-35%) impervious area percentages, while commercial/industrial districts were assigned higher (70%-80%) impervious area percentages.

The Jacobs Drain was also modeled, although this drain is part of the Sturgeon Creek watershed illustrated on Figure 7. A significant portion of the Jacobs Drain watershed is north of the current city limits and much of this area is undeveloped. However, it was necessary to define this drainage area, as it contributes flow to the large-diameter corrugated metal pipe (CMP) that runs under the County Fairgrounds site and is a key outlet for the Midland Mall area.

Stormwater detention can impact peak flows and it is useful to model it where specific data (i.e. storage volume and outlet characteristics) are available. Our modeling effort focused on the larger detention ponds in the vicinity of the Midland Mall (north of Highway 10), as the information on these ponds was readily available.

Future development scenarios were not modeled in this study for the following reasons:

- Most watersheds in this analysis are completely built out with no anticipated additional development impacting flows in the modeled sewers.
- Those watersheds that are not completely developed, such as Jacobs Drain, will include future developments that are required to meet the City's stormwater detention and peak flow requirements. Assuming land development meets these standards, we do not anticipate that peak flows will increase for the design event.

F. Modeling Methodology: Design Storms

Design storms were used to predict peak flows throughout the watershed under existing conditions and to model proposed improvements. Peak flow rates were evaluated using the 1-, 2-, 5-, 10-, and 100-year recurrence interval events. The rainfall depths are based on the National Oceanic and Atmospheric Administration's (NOAA) Precipitation Frequency Data Server (PFDS), also known as NOAA Atlas 14. These values supersede previous rainfall depth/frequency tables, TP-40 and Bulletin 71, both of which are based on older rainfall statistics. Two types of rainfall distribution were used, SCS Type II and Huff 1st Quartile, which are both commonly used rainfall distribution in the Midwest to estimate peak flows for design events. Although the Huff rainfall distribution was used to provide a comparison set of peak flows, the SCS Type II rainfall was selected for all LOS determinations used in this study, as it is the most common rainfall distribution used in Michigan and is generally considered to be the standard by the MDEQ for design purposes.

The 25-year storm event, which is used by the MDEQ for sanitary sewer system design, is not completely relevant for stormwater systems, which are often based on different criteria (in this case, the 10-year recurrence interval event).

Table 1 lists the total rainfall depths for the different recurrence intervals. Another way to interpret recurrence interval is by percent chance of exceedance; this helps when communicating risks to the public. For instance, a 5-year storm has a 20% chance of being exceeded in any given year. A 50-year storm as a 2% chance of being exceeded in any given year. That said, it is important to understand that a 10-year storm *can* occur multiple times during a 10-year period. ***For instance, the chance of a 10-year storm being exceeded during any 5-year period is 41%.***

Table 1: Design Storm Rainfall Depths in the City of Midland (NOAA Atlas 14)

Recurrence Interval	24-hour Rainfall (inches)	2-hour Rainfall (inches)
1-year	2.05	1.15
2-year	2.31	1.37
5-year	2.83	1.75
10-year	3.36	2.08
50-year	5.01	2.97
100-year	5.89	3.39

The rainfall depths for smaller storm events from TP-40 (USDA/SCS, 1961) are slightly below the rainfall depths compared to NOAA Atlas 14. However, for the 100-year recurrence interval storm event, the NOAA Atlas 14 24-hour rainfall depth is approximately 30 percent higher than that listed in TP-40.

The 10-year / 24-hour storm event of 3.36 inches was used to evaluate the LOS of the City's existing stormwater collection system. The analysis used in this study is based on the assumption that the design storm occurs uniformly across the entire city. This is a conservative approach, as many intense storms usually vary by intensity and total rainfall. Using a single uniform rainfall ensures that all system components are being stressed to their design capacity.

In addition to using design storms (which are based on a synthetic rainfall distribution), OHM modeled the June 17-23, 2017 storm event using XP-SWMM. Although the overall 7-day rainfall total reflected an 82-year recurrence interval storm, the most intense part of this storm, which occurred during the middle of the night, was a relatively low intensity (0.9 inches per hour) and well below the typical design storm threshold. Since this storm is recent and reflects an actual storm in the City of Midland, it was a useful benchmark against which to measure the effectiveness of the storm sewer system. This served as a calibration event; the modeling results from this storm were compared to observed conditions in the City and necessary adjustments were made to achieve a good match between predicted (modeled) conditions and observed conditions.

1. June 2017 Storm Event

Over a seven-day period in late June 2017 (June 17-24), it rained over 7.5 inches in Midland, with the majority of precipitation occurring on June 22 and 23. The total amount of rainfall over a 24-hour period on June 22-23 was 4.7 inches. The Tittabawasse River reached a stage height of 612.23 feet (gage height of 32.2 feet, which was about 1.7 feet below the record river level in 1986, when the river crested at 33.9 feet). This storm event caused significant flooding along the Tittabawasee River and widespread damage to homes, businesses and public infrastructure.

The wastewater and stormwater collection systems responded differently to this rainfall event. A wastewater system is generally more responsive to long, soaking rainfall events, such as the 7.5 inches of rain that fell over a 7-day period. During this period, soils saturated by the rainfall causes groundwater to work its way into the wastewater system via infiltration and inflow. The total flow rates are lower than that of a storm sewer system, but the sanitary sewer system has lower flow capacities and is therefore more sensitive to changes in flow.

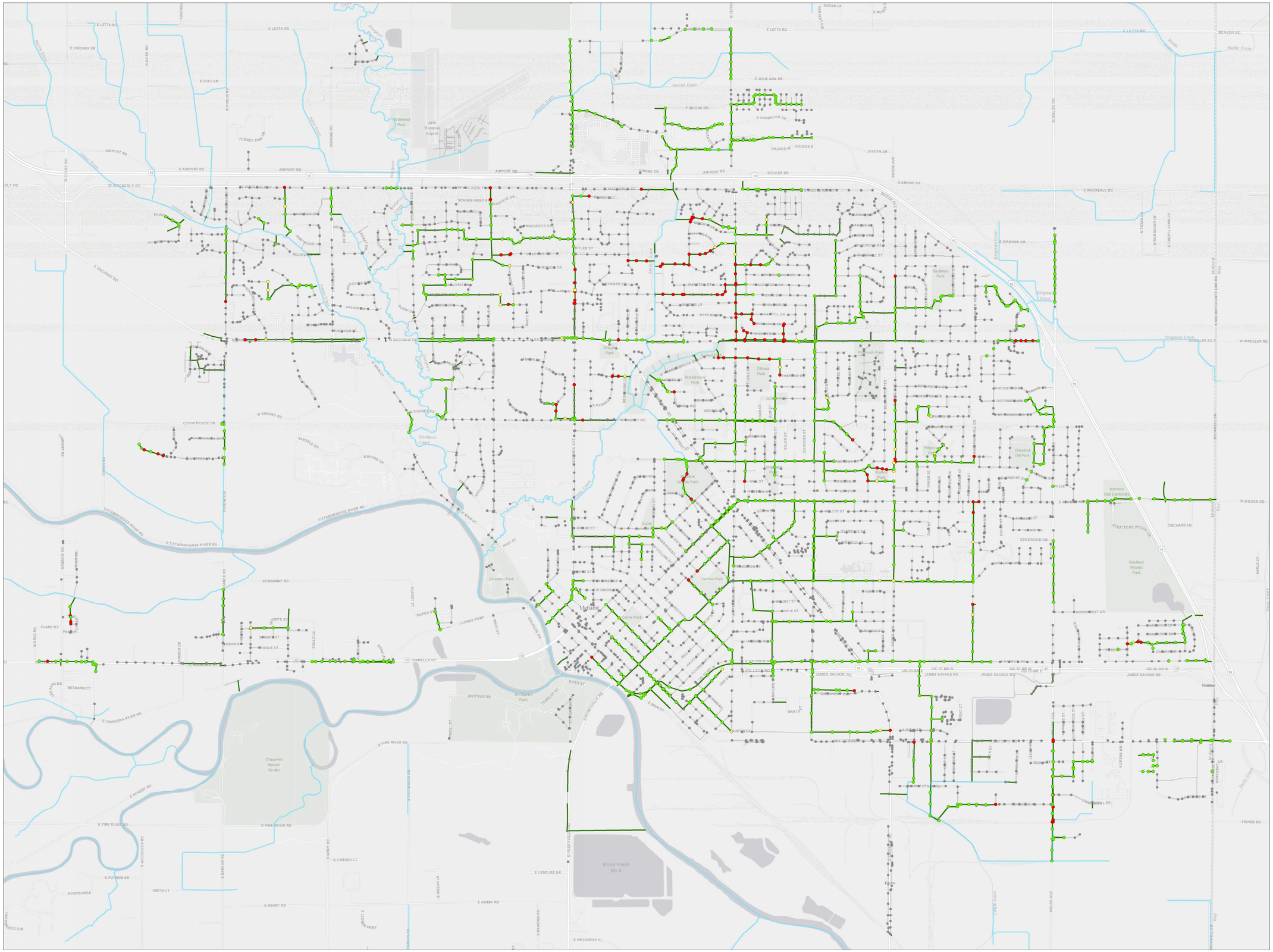
Stormwater systems, on the other hand, are most responsive to short and intense bursts of rainfall, when runoff enters the sewer system from surface connections. However, none of the 7.5 inches of rain on June 17-24, 2017 fell at a high enough intensity that would generally overwhelm a storm sewer system. The peak observed intensity during the June 2017 event, 0.90 inches per hour, is a small fraction of the 10-year peak intensity of 3.6 inches per hour which defines a 10-year recurrence interval storm in Midland.

The peak flow rates in the storm sewer during the June 2017 storm event were roughly equivalent to a 2-year recurrence interval, given that the peak intensity of 0.90 inches per hour did not result in a very high

peak flow. However, the rainfall in the preceding days (June 17-19) saturated the ground and increased the runoff potential, partially filling the detention ponds on the City's north side and causing some roadway flooding.

In some cases, the June 2017 event exceeded the capacity of the storm sewer system (see Figure 8 for locations where hydraulic surcharge and surface flooding was predicted by the model). However, in the Midland Mall area, the model did not predict the same level of flooding as was observed. Due to the large difference in the observed and modeled hydraulic surcharge in the Midland Mall area, the most likely explanation is that there is a hydraulic discrepancy downstream of the mall area along the Jacobs Drain; this could be explained by an unanticipated blockage in the downstream system, including the corrugated metal pipe (CMP) through the County Fairgrounds. Although the Sturgeon Creek backed up due to effects of the Tittabawassee (to elevation 620 feet), it did not directly impact the mall area, as the predominant surface elevation around Midland Mall (along Joe Mann Boulevard) is 633-634 feet, which is about 13-14 feet higher than the peak level observed on the Sturgeon Creek north of Highway 10.

Additionally, the peak flows in the storm sewer system and the cresting of the Tittabawassee/Sturgeon did not occur simultaneously. Instead, the peak of the rainfall event passed through the stormwater collection system and then the Tittabawassee and Sturgeon began to rise and cause backwater to flood low-lying areas after the peak rainfall occurred.



City of Midland

Depth of Water
Above Ground Elevation
Design Event :
June Storm Event

Figure 8

Water Depth Above Ground Elevation

- 0"
- 0" to 5"
- 5" and Above
- Stormwater Manhole
- Drains
- Modeled Gravity Main
- Stormwater Gravity Main

N

0 1,400 2,800
Feet

1" = 1,400'

Source: Data provided by City of Midland. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: April 26, 2018

[**FIGURE 8 – June 2017 Inundation Map**]

2. Rainfall Intensities

Rainfall intensity, measured in inches/hour, is the key driver in peak flow and is the key variable used in sizing storm sewers. Although the June 2017 storm reflected a large volume of rainfall, that rain fell over a long time period and the highest intensity was well below the design threshold of a typical storm sewer system.

The selected design storm event (10-year, 24-hour storm), has a peak intensity of 3.6 inches per hour, which is four times that of the June 2017 storm. Table 2 includes a list of various storms along with the peak hourly intensity, which, as previously discussed, typically dictates the performance of storm sewer systems in urban areas. As such, we would expect that the City's storm sewer system would be under more hydraulic surcharge and would cause significantly more surface flooding during the design storm than was observed in June 2017 (with the exception of the Tittabawassee and Sturgeon floodplain areas, which may not flood during a localized storm that does not impact the entire watershed.

Table 2: Design Storm Rainfall Depths in the City of Midland (NOAA Atlas 14)

Storm Event	Rainfall Distribution Type	Total Rainfall (in)	Peak Intensity (in/hr)
June 22-23, 2017	Rainfall Gage	4.74	0.9
2-year, 24-hour	SCS Type II, 24-hour Duration	2.31	2.4
5-year, 24-hour	SCS Type II, 24-hour Duration	2.83	3.0
10-year, 24-hour	**SCS Type II, 24-hour Duration**	**3.36**	**3.6**
2-year, 2-hour	Huff 1st Quartile, 2-hour Duration	1.37	2.3
5-year, 2-hour	Huff 1st Quartile, 2-hour Duration	1.75	2.9
10-year, 2-hour	Huff 1st Quartile, 2-hour Duration	2.08	3.5

G. Modeling Methodology: Hydraulics

Per the scope of the study, the hydraulic model was limited to storm sewers with a diameter equal to or larger than 24 inches, which represents the 'backbone' of the City's stormwater collection system.

XP-SWMM includes a hydraulic flow routing model for both open channel and closed conduits. The model performs dynamic routing of stormwater flows throughout the major storm drainage system to the outfall points of the receiving drainage system.

For those sewers that discharge to the Snake Creek, the hydraulics of Snake Creek were accurately represented in the model as an open channel with culverts. As such, the tailwater conditions for those sewers should be representative of actual wet weather conditions. The same modeling technique was used for the Jacobs Drain and Dingman Drain.

For the Sturgeon Creek and Tittabawassee River, it was not necessary to model the river hydraulics separately because of the relative size of those watersheds, which are much larger than the City's system. Due to the size difference, we would not expect the peak flows in those rivers to coincide with peak flows in the City's collection system. As such, static boundary conditions were selected for these outlets to reflect higher-than normal water levels in the Tittabawassee River and Sturgeon Creek. The following boundary conditions for the stormwater model were as follows:

- A fixed water elevation of 605.1 feet for any outfall to the Tittabawassee or Sturgeon Creek. This elevation reflects the seasonal high water level of the Tittabawassee/Sturgeon that is observed about once every 2 years. The appropriate water elevations for the Sturgeon Creek outfalls should be re-evaluated upon a more detailed hydraulic analysis of the Sturgeon Creek.
- A free outfall for any other outfall (or any invert with an invert elevation above 605)
- For the calibration storm, the June 22-23, 2017 USGS gage data for the Tittabawassee was used to establish actual boundary conditions. The peak stage elevation during the June 22-23 storm event was 612.32 feet.

The fixed water elevation of 605.1 reflects a Tittabawassee gage height of 25 feet, which, according to the last 10-15 years of USGS data, reflects a seasonal high water level. The FEMA Study only provides gage height data starting at the 10-year recurrence interval storm event, which is above 605.1. The seasonal high water level of 605.1 is most likely a 1 or 2-year recurrence interval event, which is a conservative boundary condition for the City of Midland model and is an appropriate boundary condition for a 10-

year design storm when the receiving water body has a much larger drainage area than the collection system draining to it.

The modeled storm sewers was based on GIS data provided by the City of Midland and supplemental survey data for missing rims and invert elevations. Friction coefficients reflected typical values for the respective pipe materials. In all cases, the sewers were assumed to be unobstructed and flowing freely.

1. Surface Flood Storage and Dual Drainage

When a storm sewer system is surcharged above the surface, it is necessary to quantify the storage and/or conveyance that occurs on the surface; this is often referred to as 'dual drainage', where the flows in a storm sewer system are separated between the primary flows (in the sewer pipes and culverts) and secondary flow (roadways and flood routes).

This scenario is useful when modeling areas where surcharging and roadway flooding are predicted. When the hydraulic grade line exceeds the street level, the excess volume is "stored" and then released back into the system as the hydraulic surge subsides. This has a secondary benefit of quantifying the impact of increased flows that results from sewer improvements. If smaller sewers are replaced with larger sewers as part of a Capital Improvement Plan, the surface flood storage is reduced (or goes away) and the attenuation (as a result of the flood storage) is reduced or eliminated. This increases downstream peak flows.

As part of the modeling effort in this study, the impacts of reduced flood attenuation was accounted for. Table 3 shows that the proposed storm sewer improvements will increase peak flows to several key outlets.

However, those increases should be acceptable, as the outlets are generally directed to open channels that have adequate capacity for those increased flows.

Table 3: Peak Flow Comparison

Location	Existing		With Proposed Improvements	
	10-year Peak Flow (cfs)	**10-year Peak Velocity (fps)**	**10-year Peak Flow (cfs)**	**10-year Peak Velocity (fps)**
Snake Creek: Culvert at Eastman Boulevard	267	2.96	410	3.40
Snake Creek: East Sugnet Road (at the confluence of the West Branch of Snake Creek)	248	1.24	412	1.92
Snake Creek at Sylvan Lane	107	0.59	124	0.97
Outfall from St Mary's Drive to Sturgeon Creek*	211	10.55	264	11.78
Outfall from Abigail Lane to Sturgeon Creek*	121	9.37	267	8.37
State Street Outfall to the Tittabawassee River (downtown)	818	13.21	812	13.17

** Improvements to sewers discharging to Sturgeon creek should not occur until the channel (including bridges/culverts) has been cleared of debris and a representative design event hydraulic profile has been established.*

The proposed improvements to the storm sewer system will significantly increase peak flows in the Snake Creek. However, proposed improvements to culverts along this reach of the Snake Creek should provide adequate conveyance without exacerbating flooding downstream. Analysis of downstream reaches of Snake Creek, using GIS-based contours and existing/proposed flood profile data from the XP-SWMM model, reveal that the water surface will increase due to the proposed improvements; however, the increases in water surface elevations do not appear to adversely impact homes, businesses, or facilities along this reach.

Although peak flows to the Sturgeon Creek would also be increased for those branches where improvements are recommended, those increased flows should not coincide with the peak flood profile in the Sturgeon Creek, as the drainage areas within the City are much smaller than the 64-square-mile Sturgeon Creek watershed (see Section D for a discussion on coincidental probabilities). However, given the public feedback on debris blockages along the Sturgeon Creek, storm sewer improvements in these areas should be delayed until the debris issue has been fully addressed.

The existing 120-inch sewer in downtown Midland (State Street Outfall) would actually see a slight reduction in peak flow due to proposed off-line flood storage in the branches that discharge to this sewer.

Flow velocities are very high for the outfalls to the Sturgeon Creek and the Tittabawassee River, and potentially higher under proposed conditions. This will require special consideration during the implementation of the CIP to ensure adequate erosion control measures are in place.

H. Scalability of Model

The XP-SWMM model can easily be expanded in the future, at the City's discretion, to include additional storm sewers that are not yet modeled and to verify the impacts of future land development on the existing system. Potential uses for model expansion include:

- Modeling the impacts of proposed developments or redevelopments, aiding in the sizing and location of detention storage and stormwater conveyance.
- Updating flood risk maps, including a more accurate representation of the Sturgeon Creek floodplain.
- Modeling actual rainfall events to compare to observed conditions (continued model calibration and/or validation).
- Demonstrating flow dynamics to the public to aid in their understanding of why and how flooding occurs in specific areas.
- Future updates to the Capital Improvement Plan.
- Modeling the impacts of infiltration Best Management Practices (BMPs) on peak flows and flow volumes.
- Quantifying the buildup, wash-off, and transport of common pollutants in stormwater to identify the need for future water quality controls.

I. Model Calibration

The model results were compared to the observed flooding from the June 2017 rainfall event. The June 2017 rainfall event was well documented with residential call-ins and photos from the City and County. Although the majority of flood complaints were related to basement backups that were most likely linked to the City's wastewater system, there is general concurrence between the overall flood complaint areas and the June 2017 sewer surcharging locations (see Figure 8 in Section F of this report).

Several neighborhoods, including Gibson Street (just north of Saginaw Road), North Campau Drive (in the vicinity of Dilloway Drive), and Sylvan Pines (north of Wheeler and east of Eastman), were all areas with a high occurrence of flooding complaints. The model results in these areas indicate high potential for system surcharge (above the surface) and correlate well to observed conditions.

The area in the vicinity of the Midland Mall did not correlate well to observed conditions, as the area flooded during the June 2017 event, but the model did not predict flooding. This could be due to an unanticipated blockage in the system; the long CMP under the County Fairgrounds should be inspected to determine if there is a blockage or structural failure.

J. Existing Conditions: Key Findings

The *Existing Conditions* model was used to identify the storm sewers and bridges/culverts within the watershed that are undersized. The *Existing Conditions* model revealed that the City's stormwater collection system can generally handle the 2-year recurrence interval storm event (50% annual exceedance probability) without surcharging above the surface elevation.

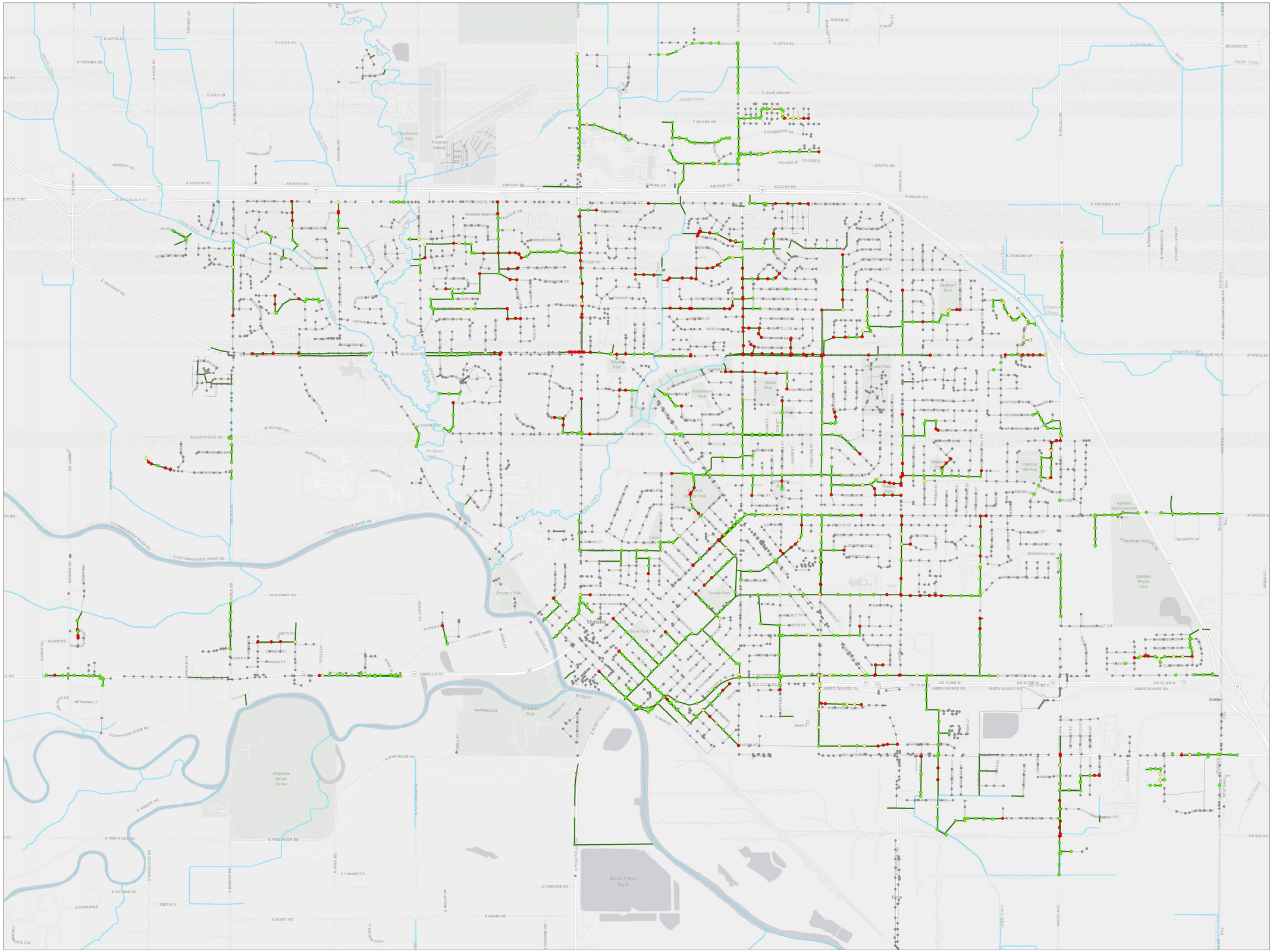
For many parts of the system, both the 5-year and 10-year events resulted in predicted hydraulic surcharge and flooding in multiple areas, exceeding the 5-inch maximum surface flooding depth agreed to as the desired LOS for the collection system.

The data presented in this section references specific storm sewer segments by ID. Each ID reflects the primary watershed the sewer is in and includes a reference number to separate it from other sewer segments within the same watershed.

Figure 9 illustrates the locations of sewer surcharge above the LOS threshold for the 10-year / 24-hour event (5 inches above the surface elevation) throughout the modeled portion of the storm sewer system. The areas of surcharging were used to develop a targeted list of locations for proposed hydraulic improvements. Generally, this figure shows that the surcharging for the design event is more severe than that predicted for the June 2017 event. This is expected, given that the peak rainfall intensity for the 10-year event is four times that of the June 2017 event.

1. Undersized Storm Sewers

A storm sewer is considered to be undersized if it causes the 10-year hydraulic grade line to exceed the ground elevation by more than 5 inches at the peak of the storm. Appendix A includes sewer segment location maps and hydraulic profiles for both existing and proposed conditions. The hydraulic profiles illustrate the magnitude of the surcharging for identified reaches of storm sewer.



City of Midland

Depth of Water
Above Ground Elevation
Design Event :
10-Year, 24 Hours

Figure 9

Water Depth Above Ground Elevation

- 0"
- 0" to 5"
- 5" and Above
- Stormwater Manhole
- Drains
- Modeled Gravity Main
- Stormwater Gravity Main

N

0 1,400 2,800
Feet

1" = 1,400'

Source: Data provided by City of Midland. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: April 26, 2018

2. Undersized Bridges/Culverts

A culvert is considered to be undersized if one of the following conditions occur:

- The headwater resulting from a 10-year storm exceeds the roadway surface elevation and results in roadway flooding (this increases the likelihood of a roadway washout)
- The headwater resulting from a 10-year storm creates a hydraulic surcharge that adversely impacts upstream storm sewer systems

Multiple culverts were identified as undersized; these culverts are located along the Snake Creek (see Appendix A for recommended culvert replacement locations). Replacing these culverts will lower the flood profile along the Snake Creek and thereby improve the tailwater conditions for multiple connecting storm sewers. Furthermore, these culverts are necessary to accommodate increased flows resulting from recommended storm sewer improvements in the Snake Creek watershed.

Although the Sturgeon Creek culverts were not modeled in this study, it is recommended that they are modeled in Phase 2. This is due to public feedback received during the review of the draft report, as well as flood event aerial videos that revealed a higher flood profile than indicated in the FEMA Flood Insurance Study.

In most cases, existing circular culverts are recommended to be replaced with larger box culverts.

K. Proposed Activities

1. Capital Improvement Plan

The recommended Capital Improvement Plan (CIP) focuses on maintaining a minimum LOS as defined earlier in this report. Achieving this LOS will reduce the potential for surface flooding during and immediately after intense rainfall events.

The list of recommended projects is fairly long and will require a significant investment over a long period of time. Unless a new funding source is developed for stormwater (see *Section K.3. – Stormwater Funding* for more info), it will likely take the City of Midland several decades, or longer, to implement these improvements.

Two priority levels (Priority 1 and Priority 2) were developed to provide the City with a reduced (and less costly) list of capital projects that will have the greatest initial impact. This study recommends that the City begin to move Priority 1 projects into the annual budgeting process. Priority 2 projects should occur after the completion of all Priority 1 projects; as such, it is likely that Priority 2 projects will have a long time horizon before implementation.

The recommended improvements are intended to directly address known and suspected flooding due to undersized components of the City's stormwater collection system. The recommended improvements consist primarily of sewer size increases to safely convey the 10-year peak flow without excessive flooding on the surface. Wherever possible, stormwater detention areas were identified to help provide additional flood storage at or near the source; this helps to defray the magnitude of the sewer size increase and helps to mitigate the impacts of increased peak flows due to sewer enlargement.

Stormwater detention, where proposed, is listed as "EQ Basins" ('equalization basins') in Appendix A, as these areas would be intended as temporary flood storage during wet weather events but designed to completely drain afterwards. As such, some recreational fields (soccer/baseball areas) were identified as potential storage areas. EQ Basins were identified in open space areas (private or public property) adjacent to surcharged storm sewers. In the event that identified areas are not available to serve as flood storage, it is likely that either another storage area should be identified or the proposed sewer size should be increased to accommodate the higher resulting peak flows. In general, stormwater detention should be used wherever possible to control the impact sewer improvements have on increased downstream peak flows.

Stormwater detention should be used wherever possible to control the impact of increased peak flows.

The identified improvements are based on hydraulic modeling in the context of the LOS defined in this study and provide only a preliminary list of potential projects. The identified projects should be individually vetted prior to preliminary design. During this process, it is possible that some projects may be eliminated or modified to reduce overall cost; especially if the project is located in an area that would not impact adjacent structures or would not result in excessive roadway flooding.

Fully implementing the CIP is important for several key reasons:

1. Reduced flood potential increases public safety, reduces the threat of property damage due to overland flooding, and increases the overall quality of life for Midland's residents.
2. Reducing the magnitude and duration of floodwaters on the City's streets will reduce inflow into the City's wastewater collection system; this is a critical component of RDII reduction in the sanitary sewer system.
3. Climate patterns are changing, and the City should be prepared to adapt to increases in total precipitation and rainfall intensity. According to the EPA and the National Climate Assessment, annual precipitation in Michigan is expected to increase up to 4 inches (12% more annually) and heavy rains will be more frequent and increase in intensity by 10%-20%. This means that the LOS of the existing system can be expected to *decrease* without active measures taken to increase flow capacity.

See Appendix A for project location figures and existing/proposed hydraulic profiles.

The proposed project locations are illustrated in Appendix A, including hydraulic profiles of the existing and proposed conditions. Planning-level cost estimates are based on recent bid tabulations for similar work. Unit prices assume work in urban conditions, which includes increased costs for utility relocations, pavement removal and restoration, and traffic control. Table 4 summarizes the overall CIP costs. Table 5 lists the Priority 1 projects.

Table 4: CIP – Planning-Level Costs

Sewer Replacement			
Diameter (in)	**Total Length (ft)**	**Unit Cost**	**Total Cost**
30	904	$300	$272,000
36	17,563	$400	$7,026,000
42	11,880	$500	$5,941,000
48	44,008	$560	$24,645,000
54	3,055	$700	$2,139,000
60	12,988	$800	$10,391,000
66	2,521	$1,120	$2,824,000
72	6,124	$1,500	$9,187,000
		Subtotal (sewer replacement)	$62,400,000
Stormwater Detention (Storage)			
Location	**Total Volume (CF)**	**Unit Cost**	**Total Cost**
Northwest	5,000,000	$2	$10,000,000
Central	2,600,000	$2	$5,200,000
		Subtotal (detention storage)	$15,200,000
Culvert Replacement			
Watershed	**Quantity (EA)**	**Unit Cost**	**Total Cost**
Snake Creek (6' x 12')	3	$250,000	$750,000
Snake Creek (8' x 12')	1	$300,000	$300,000
		Subtotal (culverts)	$1,050,000
		Grand Total (CIP)	$78,650,000

Table 5: Priority 1 Projects

Project	Type	Size (pipe diameter, culvert dimensions, or pond volume)	Length (ft)	Project Cost	Location/Crossroads
CPW-2	Sewer	48”	1,843	$1,040,000	Avon St between Smith Rd and Wildes St
DGM-2	Sewer	36”, 48”	2,397	$1,110,000	Lawndale Dr to Sweetbrier Tr to Waldo Ave
GS-1	Sewer	54”, 60”	3,403	$2,600,000	Eastlawn Dr between Abbott Rd and Washington St
GS-2	Sewer	48”, 60”	1,035	$1,700,000	Dartmouth Dr between Airfield Ln and Jefferson Ave
PC-1	Sewer	48”, 60”	2,665	$1,930,000	Prairie Dr and Clay St
RD-1	Sewer	36”, 42”, 48”	2,928	$1,360,000	Plumtree Ln and Dublin Ave
SNC-1	Sewer	48”, 72”	9,900	$7,380,000	E Wheeler St between Swede Ave and Jefferson Ave
SNC-7	Sewer	42”	2,052	$1,030,000	Sylvan Ln and Nakoma Dr
SNC-14	Sewer	48”	5,006	$2,810,000	Eastman Ave between W Wackerly St and N Saginaw Rd
SNC-17	Sewer	48”, 60”	2,910	$1,930,000	Arbor Dr to Linden Dr to W Sugnet Rd
STC-2	Sewer	48”	3,919	$2,200,000	N Saginaw Rd between Sturgeon Creek Pkwy and Dublin Ave
STC-9	Sewer	42”, 48”	1,719	$970,000	Portridge Ln between W Wackerly St and Brambieridge Ln
SNC-C-1	Culvert Replacement	6’ x 12’ (rise x span)	301	$250,000	Snake Creek at Sylvan Ln.
SNC-C-2	Culvert Replacement	8’ x 12’	124	$300,000	Snake Creek at W Wheeler Rd
SNC-C-3	Culvert Replacement	6’ x 12’	207	$250,000	Snake Creek south of Castle Dr
SNC-C-4	Culvert Replacement	6’ x 12’	157	$250,000	Snake Creek at N Saginaw Rd
GS-EQ1	Detention Pond	60,000 cu. ft.	N/A	$120,000	Dartmouth Dr between Airfield Ln and Jefferson Ave
GS-EQ2	Detention Pond	79,000 cu. ft.	N/A	$158,000	Dartmouth Dr between Airfield Ln and Jefferson Ave
GS-EQ3	Detention Pond	40,000 cu. ft.	N/A	$79,000	Dartmouth Dr between Airfield Ln and Jefferson Ave
GS-EQ5	Detention Pond	142,000 cu. ft.	N/A	$283,000	Eastlawn Dr between Abbott Rd and Washington St
GS-EQ6	Detention Pond	157,000 cu. ft.	N/A	$314,000	Eastlawn Dr between Abbott Rd and Washington St
GS-EQ7	Detention Pond	1,070,000 cu. ft.	N/A	$2,134,000	Eastlawn Dr between Abbott Rd and Washington St
			Total	**$30,200,000**	

2. Operations & Maintenance (O&M)

A functional storm sewer collection system requires regular inspection and maintenance. Since storm sewer systems generally have limited budgets, most cities have significant inspection backlogs for storm sewer pipes. Based on recent asset management planning work throughout Michigan, we have observed widespread problems with storm sewer systems, including both structural failure and excessive sediment/debris buildup (see Figure 10 for an example).

Fortunately, the City currently cleans the storm sewer system on a 4-year cycle. Sewers are generally not televised unless there is a significant blockage. Given the need to understand the structural condition of the system, we recommend that the entire storm sewer system be systematically televised during the next 3 year period.

Based on the City's current GIS stormwater database, there are approximately 1 million lineal feet of storm sewer. Televising the entire system during the next three years will require approximately 333,333 lineal feet per year.

Additionally, the GIS vertical datum difference and pipe size discrepancies noted in this study reveal the need for future model enhancements to resolve the differences between the NAVD88 and local vertical datum. Having a consistent datum is important for stormwater modeling, as surface topography is an important component and it is ideal to have the sewer system and surface topography linked to the same datum. As such, we recommend that the stormwater model components all reference NAVD88.

The cost to perform this work is listed in Table 6:

Table 6: Initial O&M Costs (Years 1-3)

3-year Inspection/Cleaning Program (Initial O&M)			
	Quantity (LF)	Unit Cost	Total Cost
Televising	1,000,000.00	$2	$2,000,000
Annual allowance for repair/rehab			$500,000
Subtotal (inspection/rehab)			$2,500,000

This translates to a cost of about $830,000 per year for a 3-year program. Although this could be spread out to a 5-year program (annual costs of $500,000), this work should be completed in a shorter time period so as to identify and address blockages and structural issues. Actual repair/rehab costs may vary, but an allowance is included to address emergency repairs based on structural failures or major obstructions.

This inspection will reveal locations where debris buildup or structural failures exist, and this information can be used to target emergency maintenance and repair work.

Figure 10 – Storm Sewer Blockage Example
(not a Midland sewer, but typical of similar systems)

Given the size of Midland's stormwater collection system, we recommend the City establish an initial annual budget of $830,000 for televising and emergency repair/rehabilitation work. This assumes that the City will continue its current 4-year cleaning cycle. This budget should allow the City to do the following:

- Inspect the entire collection system during the next 3 years
- Implement targeted sewer cleaning and emergency repairs (as identified by the televising process)
- Expand the City's GIS to include pipe structural condition data

These efforts, separate from the Capital Improvement Plan recommendations, will help the City to establish a robust O&M plan that is based on actual condition data, which is a critical component of providing a base LOS for the collection system.

Upon the completion of the sewer televising effort (after the first three years of this program), the annual investment should be adjusted to reflect actual maintenance and repair/rehabilitation needs. This could either increase or decrease the annual investment, depending on the results of the inspection effort. Beyond the first three years, the City should establish an ongoing sewer televising/inspection program that allows the entire storm sewer system to be inspected on a 7-10 year cycle.

3. Stormwater Funding

There are three core principles when looking to develop a fiscally sustainable financing mechanism. Debate and discussion on how best to move forward will be most productive if it begins with a set of principles to benchmark the merits of ideas put forth in the process. These principles are:

1. When estimating the amount of revenue needed and the amount to be charged, the math will ALWAYS include the cost of four things: capital, operation, maintenance, and replacement. These represent the true short- and long-term costs of infrastructure service. Any weak link in this chain seriously compromises reliability.

2. The City of Midland should not rely on federal or state government to subsidize local utility services. The subsidies are never adequate, not everyone gets them, and even those who do get them will not receive them in perpetuity. Recent difficulties at the state and federal level to increase infrastructure spending reveal that communities are most likely going to need to raise revenues locally for infrastructure projects.

3. The City of Midland will earn and maintain the public trust by choosing a funding strategy that is transparent and fair regarding:

   - How costs are calculated, and
   - How charges are allocated to customers.

Applying the above principles to the City's stormwater collection system, the City's long-term needs would be best met by funding the stormwater system in the same manner as with sanitary sewer services: through the establishment and use of a utility-based enterprise fund.

A Stormwater Utility provides a dedicated funding source for a Stormwater system. In the City of Midland, the stormwater system includes storms sewers, catch basins, manholes, detention ponds, culverts, bridges, open channels, and any other part of the infrastructure that impacts the conveyance or treatment of stormwater.

Currently, most communities in Michigan continue to fund stormwater-related activities through General Funds, supplemented by street/road funding. However, the stormwater system tends to be the first to be "cut off" from General Funds when priorities change and funds are diverted to other programs. Stormwater infrastructure suffers when priorities are shifted, and stormwater systems become obsolete and/or ineffective as they exist without an adequate source of funding.

According to the most recent annual Stormwater Utility Survey from Western Kentucky University (Campbell, Dymond, et. al., 2016), there are over 1,600 cities in the United States with a stormwater utility (i.e. enterprise fund for stormwater infrastructure). However, only eight cities in Michigan have stormwater utilities while our neighbor to the south, Ohio, has over 100 cities with stormwater utilities and Wisconsin has over 120 cities with stormwater utilities.

The lack of stormwater utilities in Michigan is primarily due to judicial precedent stemming from the following two cases:

- Bolt v Lansing, Michigan Supreme Court (1998)
- Jackson County v City of Jackson, Michigan Court of Appeals (2013)

These cases deemed the stormwater fee an "illegal tax" and a violation of the Headlee Amendment. Pending legislation (Senate Bill 756, a/k/a 'Stormwater Utility Act') would make it easier for communities like the City of Midland to establish enterprise funds for their stormwater collection systems. If this bill becomes law, Midland will have the tools it needs to develop a stormwater utility. This Stormwater Master Plan is a key foundation on which the City can rely to establish an appropriate and defensible budget.

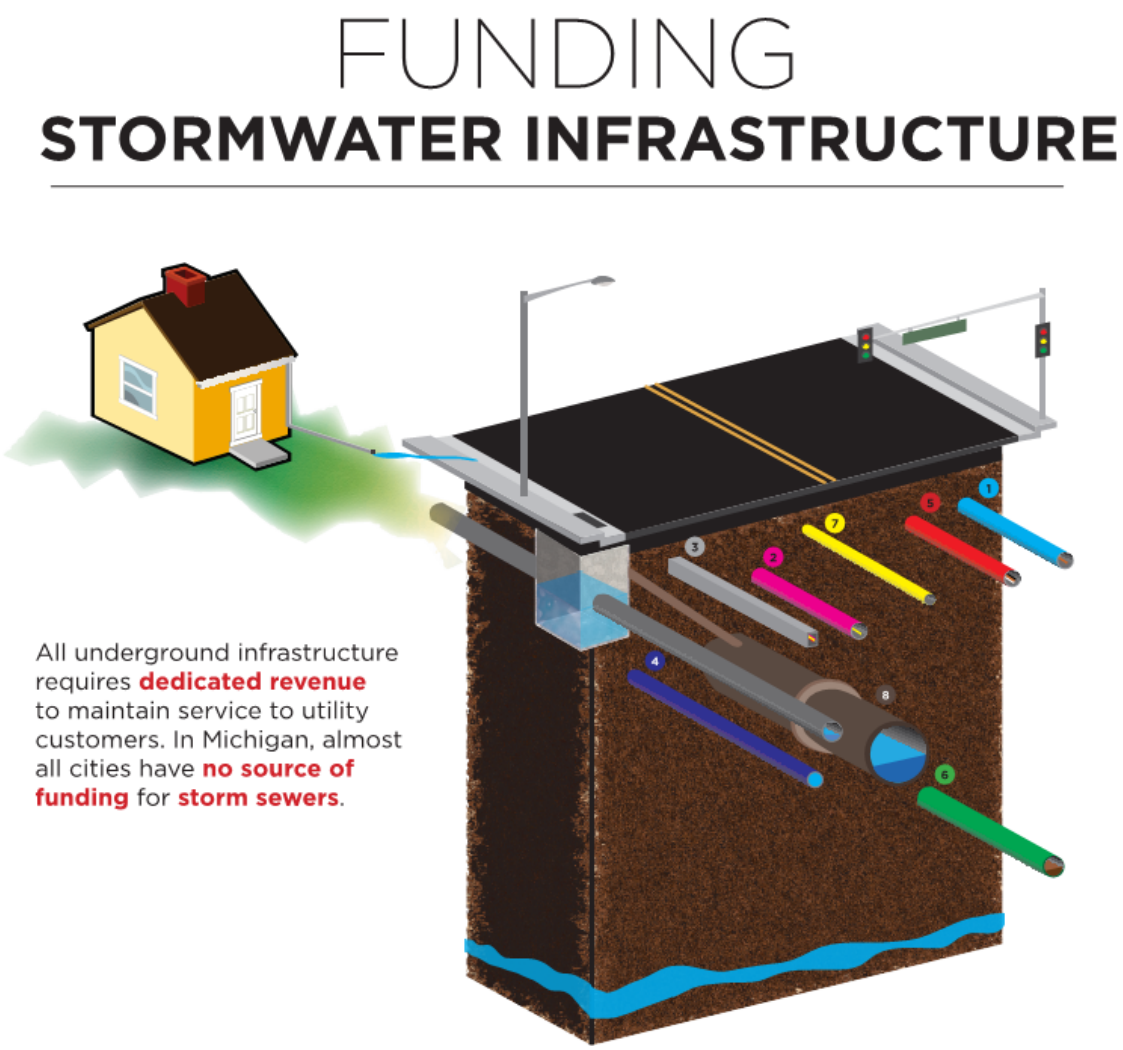


Figure 11 – Underground Utilities – Revenue Sources

Based on revenues in other Midwest US cities that have stormwater utilities, the average per capita stormwater revenue is about $50/year, understanding that the range is wide based on individual community need. Recently-completed asset management plants (funded by the MDEQ's SAW Grant) revealed that the true stormwater funding need for Michigan communities is likely closer to $100 per capita per year.

Based on Midland's population and CIP needs identified in this study, we would expect that annual stormwater revenues would fall on the upper end of the $50-$100 per year per capita range, say, $4.2 million per year. Based on this revenue, the City could implement the recommendations in this study over a reasonable time frame. This revenue should allow the City to address the identified deficiencies in its stormwater system during a span of about 20 years.

Given the magnitude of the costs identified in the CIP, we recommend the City explore the development of a storm sewer enterprise fund (a/k/a stormwater utility) to collect the revenues necessary to maintain an adequate LOS for the City's residents and businesses. The establishment of an enterprise fund would be the most equitable way to share the costs with those who place the highest demand on the system. The revenues from a stormwater enterprise fund, by law, can only be used to support the stormwater infrastructure, but these activities are fairly broad, including:

- Flood control (replacing undersized drainage assets)
- Inspection (televising)
- Jetting/cleaning
- Sewer pipe rehabilitation and replacement
- Manhole rehabilitation and replacement
- Street sweeping
- Creek maintenance
- Detention pond maintenance
- Emergency repairs and flood response
- MDEQ NPDES permit compliance
- GIS/mapping needs
- Personnel and administrative costs related to the stormwater program
- Culvert and bridge repair and replacement
- ***Drainage component of roadway project (often 5%-10% of roadway construction costs)***

The final component above is very significant, as communities with stormwater utilities can stretch their roadway budgets by paying for drainage components through a separate funding source. This allows the City to stretch its road repair dollars and rebuild more lane miles each year.

4. Stormwater Master Plan: Phase 2

This report reflects Phase 1 of the Stormwater Master Plan, which identifies key hydraulic deficiencies and establishes a robust CIP. Phase 2 should focus on initial CIP investments, the rollout of a sewer inspection and O&M plan, expansion of the City's existing asset management plan for the City's stormwater infrastructure, and the establishment of a dedicated revenue source for stormwater. Recommended Phase 2 activities, to be performed in Years 1-3, include:

- Preliminary Engineering and Design: Snake Creek Culverts (4)
- Survey and model the Sturgeon Creek, identify undersized bridges and culverts, and calculate the 10-year and 100-year flood profiles from Sugnet Road to the airport
- Model updates to shift GIS-based sewer elevations to NAVD88 vertical datum (this is necessary to maintain consistency between surface contours, which are based on the NAVD88 datum, and the sewer rim and invert elevations)
- Identify sewer projects that coincide with roadway replacement projects (for the next 2 years)
    - Preliminary engineering and design for sewer replacement
- Establish storm sewer televising program
    - Assist with contractor selection and contract admin
- Update stormwater GIS geodatabase with PACP (structural and O&M) data
- Develop sewer rehab/repair CIP (based on sewer televising)
- Explore feasibility of a Stormwater Utility; potential activities include:
    - Develop stormwater rate model
    - Develop stormwater program/budget
    - Provide recommendations to City Council (including draft Rate Ordinance, if applicable)

5. Ongoing Public Education and Flooding Risk Awareness

Increasing local awareness of stormwater infrastructure is critical to gaining support for future investments. This can start through a public campaign to educate property owners on the level of protection provided by the existing system and discussing the level of investment necessary to increase that protection.

It is important to do all of this in the context of:

- Limited future support from state and federal government
- Impacts of climate change on future level of service expectations
- Realities of an aging infrastructure

Just like roads and bridges, storm sewers have a limited service life, and it is important to communicate that those assets will eventually need to be replaced. Starting that process now will help to ensure adequate protection for current and future generations.

For those who live in the floodplain of the Tittabawassee River or Sturgeon Creek, providing access to online resources will help homeowners to understand how that risk impacts their home. As it is

unrealistic to assume that any future flood control projects will reduce the floodplains for these watercourses, it is important for the City and property owners are aware of neighborhoods that are at higher risk. The City can work with those property owners to develop emergency action plans to protect their homes against flooding. This may consist of sandbagging or other temporary waterproofing of vulnerable parts of structures.

The Frequently Asked Questions (FAQs) below provide additional background information that can be used to communicate stormwater issues with property owners in Midland:

Frequently Asked Questions - Stormwater

Q: How can I tell if my property is in the floodplain?

A: The Federal Emergency Management Agency (FEMA) maintains flood risk maps and has a useful online portal to view current (effective) floodplain boundaries (link below). This link will take you to an interactive map where you can zoom into your neighborhood and see where your home is relative to the floodplain.

https://msc.fema.gov/portal/search?AddressQuery=midland%2C%20mi#searchresultsanchor

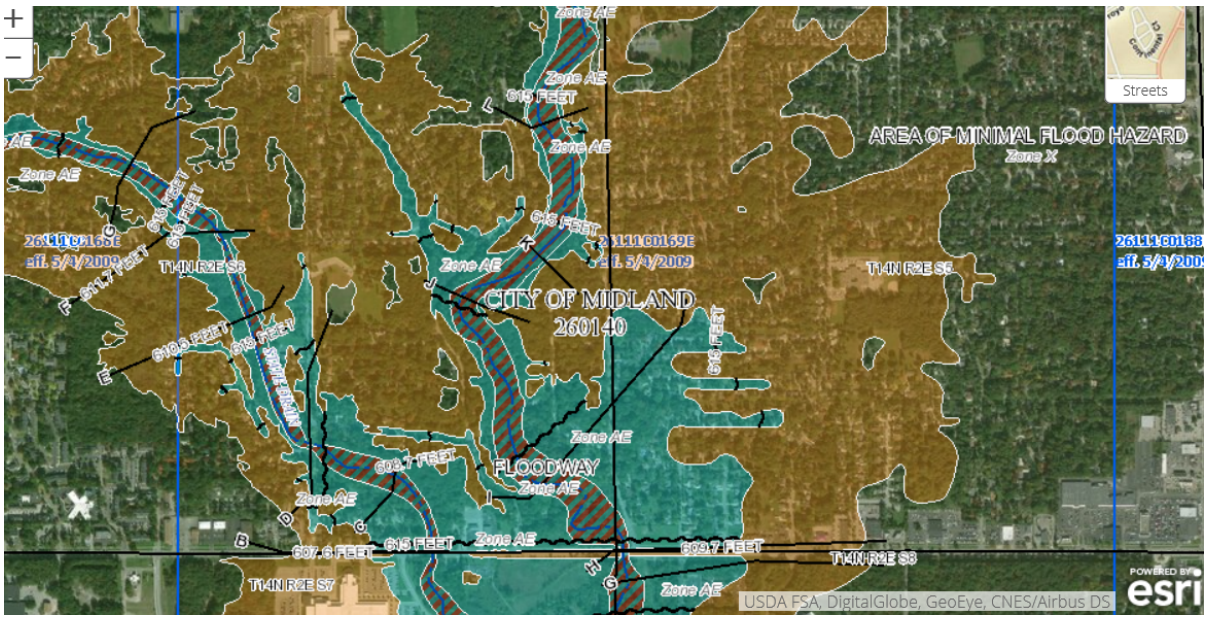


Figure 12 – FEMA Floodplain Map – Sturgeon Creek between Saginaw and Wackerly

Q: What is overland flooding? What can the City do to prevent it from damaging my home? What causes it in Midland?

A: Overland flooding occurs when heavy rainfall creates so much runoff that it can't all get into the storm sewer system at once. Storm Sewers are typically designed for a 10 year frequency event (i.e. a storm that has a 10% chance of being exceeded in any given year).Flooding can be a result of clogged inlets and/or undersized sewer pipes. This can result in temporary street flooding; floodwaters can sometimes creep up to homes and business and enter through windows or doors. Although overland flooding is temporary, it can result in property damage and impassable roadways.

Q: How do I know if my flooding was from overland flooding or a sanitary sewage backup?

A: Usually, the smell test is best; if the flooding comes up through the basement drain and smells like sewage, it is likely from the sanitary sewer. Flooding that comes in from windows, cracked basement walls, or exterior doors is most likely due to surface flooding from stormwater or high groundwater along the foundation wall.

Q: What is the difference between a stormwater collection system and a sanitary sewage collection system? What is a combined system? Do all Cities have the same systems as Midland?

A: A stormwater collection system is designed to collect and convey only surface runoff from roads, parking lots, rooftops, grassed areas, and other natural surfaces. Stormwater is generally discharged to receiving water bodies with minimal or no treatment.

A sanitary sewage collection system is designed to collect only wastewater from residents, businesses, and industrial operations. Wastewater is treated and disinfected before being discharged to receiving water bodies.

Combined sewers collect both wastewater and stormwater. Although most combined sewage goes to a treatment plant, during large storm events a combined system is designed to relieve itself and overflow into receiving water bodies. Combined sewer systems are a relic of old design standards, and many communities have systematically eliminated their combined sewers in favor of separate sanitary and storm systems.

The City of Midland has separate wastewater and stormwater collection systems.

Q: Why are Midland's storm and sanitary systems considered separated if the footing drains are still connected to the sanitary sewage system.

A: Most communities deal with this issue. In the 1950s and 1960s, it was common to connect footing drains to the sanitary sewer, as it was the only sewer deep enough to connect to (storm sewers are usually too shallow for this connection). Building standards have evolved, and it is no longer acceptable to connect footing drains to sanitary sewers. Cities throughout

Michigan have been addressing this issue by disconnecting footing drains from the sanitary sewers and connecting them to storm sewers or discharging them to rear yards.

Q: What is a footing drain?

A: A footing drain is a perforated (slotted) pipe that is installed around the perimeter of a home's foundation (around the bottom exterior of the basement or foundation wall). These pipes allow the sandy soils along the outside of the foundation wall to drain and therefore avoid excessive pressures which can cause walls to crack and basements to flood. Many footing drains installed prior to 1987 are connected directly to the sanitary sewer, and are partially responsible for excessive flows in the sanitary sewer system. Flow from footing drains is typically discharged to a nearby storm sewer (which is larger and can handle the water from footing drains) or to a home's rear yard.

Q: What is a restrictor? How do I know if my neighborhood has restrictors and if they are working properly?

A: Restrictors are metal covers on curb inlets (stormwater system) that reduce the flow of surface water into the storm sewer system. This helps to prevent the sewer system from being overwhelmed by high peak flow rates, although this can result in temporary flooding on the surface. This design practice for peak flow control lasted from the late 1980s until about 2000 in the City. Today, developers construct detention ponds for peak flow control. [a photo would be good here – can the City provide an example photo of a restrictor cover and basin?]

Q: What can I install personally in my home to prevent flooding from occurring again?

A: The risk of flooding can never be eliminated, but it can be reduced by minimizing the potential for surface water or sanitary sewage to access your home through basement drains, foundation cracks, windows, and doors.

Installing a sanitary sump pump in your basement for your sewage pipes will isolate your basement drain from the sewer main. This will isolate your home and reduce the risk of backlow and basement backups.

If you have a footing drain, hire a contractor to determine whether it connects to the sanitary or storm sewer. If it connects to the sanitary sewer, disconnect it, install a sump pump for the footing drain, and reconnect it to the storm sewer or discharge it to the surface at the lowest point on your property.

It is wise to regularly inspect and replace sump pumps, as they will wear out and fail; often within 10-15 years of installation. You can also install a back up pump to avoid basement flooding.

Some flooding is difficult to prevent. If your home is within or adjacent to a floodplain, occasional overland/surface flooding may occur. This type of flooding is not preventable, although if you have low-lying windows or doors, you can prevent flooding in your home by temporarily installing sand bags to isolate your home from floodwaters.

Q: Why did my neighborhood flood when other City neighborhoods did not?

A: There are many potential explanations for this:

- Your neighborhood is at a lower elevation than other neighborhoods and is more susceptible to flooding due to rising creek/river levels.
- Your neighborhood is connected to a sanitary and/or storm sewer that is older and was built under outdated design standards; this causes the sewer to back up more often than newer sewers.
- Your neighborhood is older, with most homes built under outdated building code and plumbing standards. This may result in footing drains and basement floor drains being directly connected to sewers that frequently back up.

Q: Why did my house flood when my neighbor's did not?

A: There are many potential explanations for this:

- Your neighbor may have sump pumps that isolate/protect their home from the sewer systems.
- Your neighbor's home may be at a higher elevation than yours (even a minor, say, one foot, difference in first floor or basement elevation can be enough to make the difference between flooding and not flooding.
- There may be a blockage in the sewer main between your and your neighbor's homes, where the blockage impacted your home but your neighbor was downstream of the blockage.
- Your neighbor's foundation wall is in excellent structural condition with no cracking and adequate waterproofing, while your foundation wall has minor cracking that allows seepage during wet weather.

Q: How often are the sanitary and storm pipes inspected?

A: The City inspects and cleans the sanitary collection system on a 2 year frequency. Storm sewers are addressed as needs or maintenance issues occur.

Q: How often are the sanitary and storm pipes cleaned?

A: The City cleans the sanitary sewer every 2 years and addresses the storm sewers as maintenance needs arise.

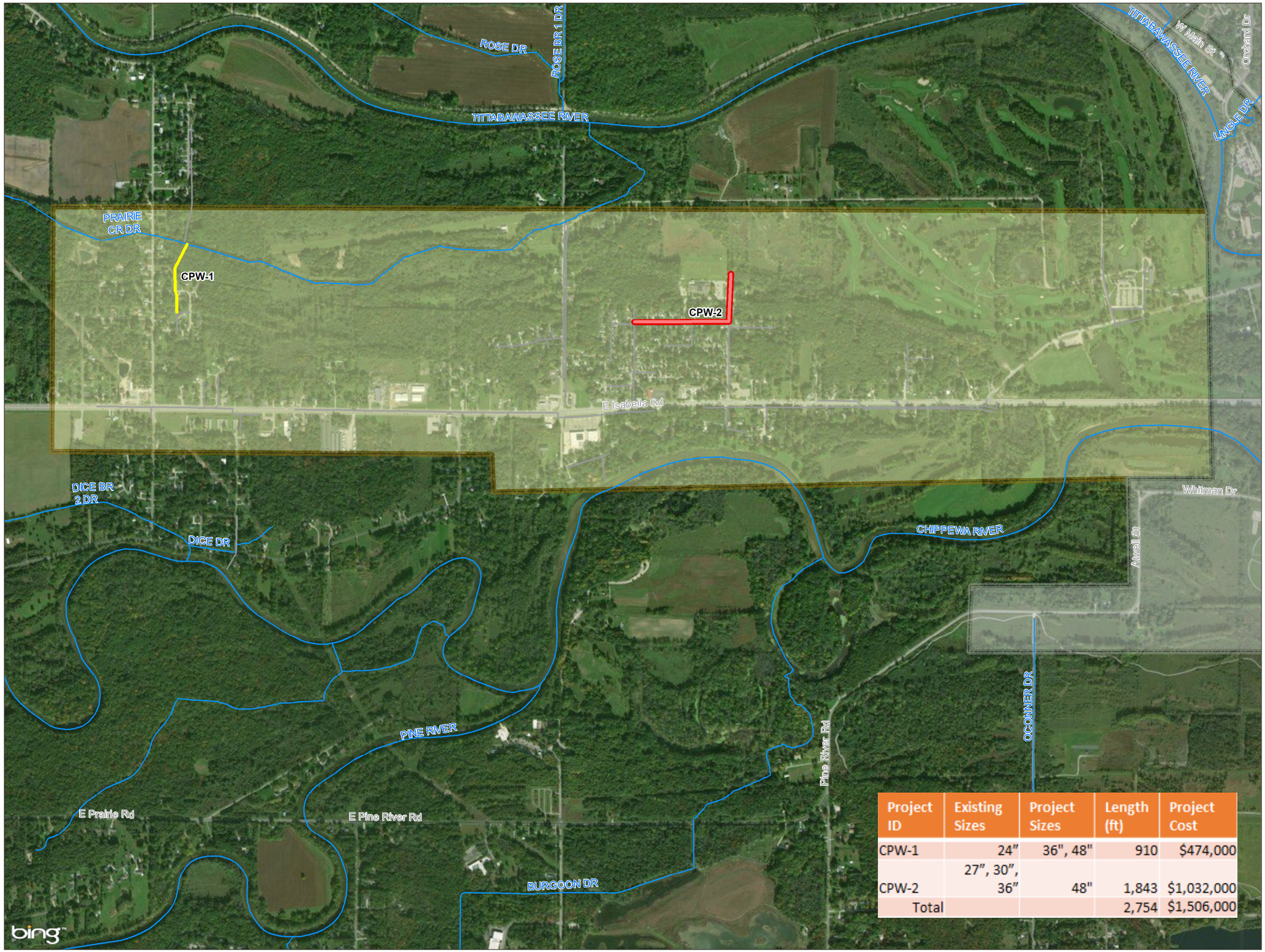
Q: Do downed trees cause drains to flood?

A: Yes, downed trees will impede flow in the City's drains. The severity will depend on where they fall and how large they are. Other debris, such as trash, beaver dams, shopping carts, etc. will also restrict/impede flow. It is important to treat open channels as an integral part of the stormwater conveyance system and inspect it regularly to ensure it is functioning properly, as it represents the backbone of the City's drainage system.

Appendix A

City of Midland
Chippewa Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
CPW-1	24"	36", 48"	910	$474,000
CPW-2	27", 30", 36"	48"	1,843	$1,032,000
Total			2,754	$1,506,000

Storm Sewer Improvements

- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements
- Storm Sewer Gravity Main
- Drains

N

0 2,000
Feet

1" = 1,200'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

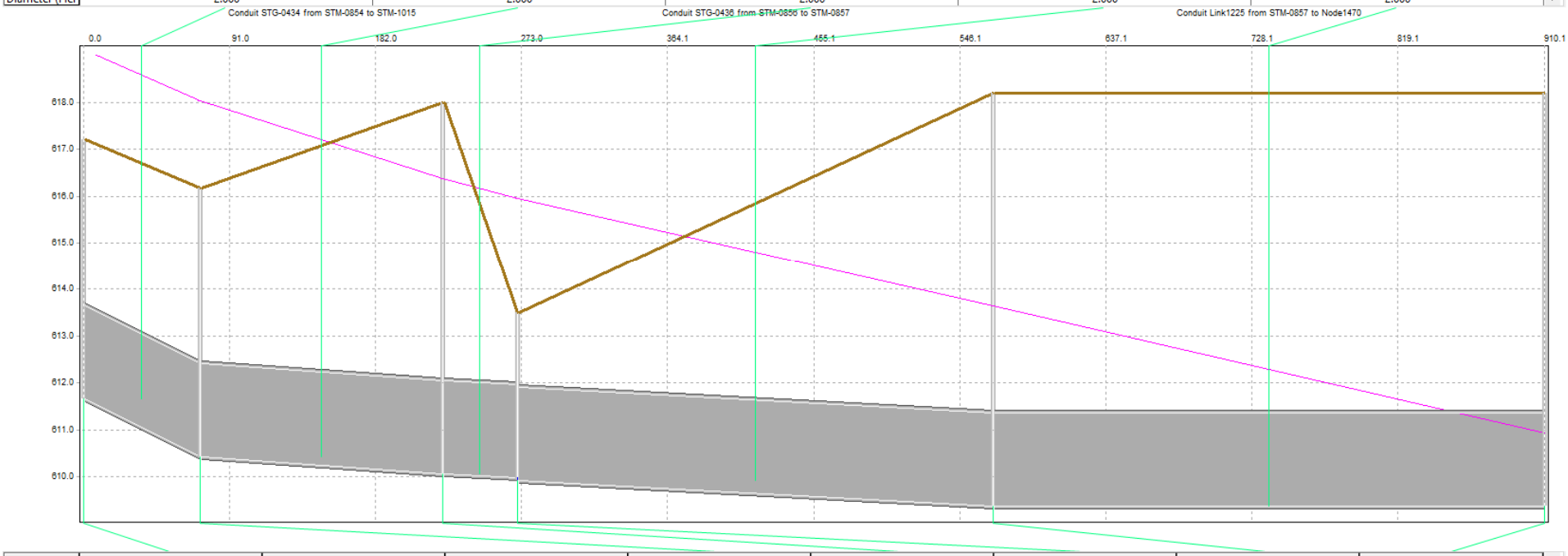
OHM

Project CPW-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0433	STG-0434	STG-0435	STG-0436	Link1225
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	611.660	610.420	610.070	609.930	609.380
Downstream I	610.420	610.070	609.980	609.380	609.380
Roughness	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000



	STM-0855	STM-0855	STM-0855	STM-0854	STM-1015	STM-0856	STM-0857	Node1470
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3					
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	617.200			616.170	618.000	613.500	618.200	618.200
Slope	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

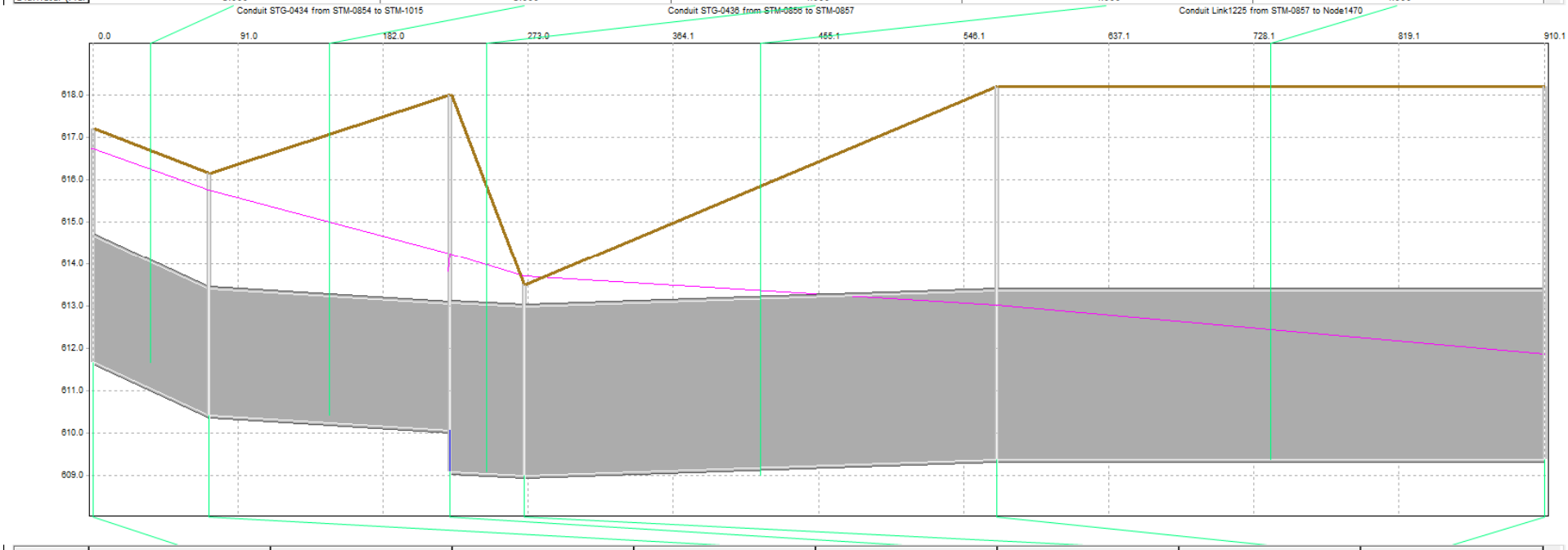
Manhole Parameters | Runoff Info | MH duration and depth

Project CPW-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0433	STG-0434	STG-0435	STG-0436	Link1225
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	611.660	610.420	609.070	608.980	609.380
Downstream I	610.420	610.070	608.980	609.380	609.380
Roughness	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	4.000	4.000	4.000



	STM-0855	STM-0855	STM-0855	STM-0854	STM-1015	STM-0856	STM-0857	Node1470
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3					
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	617.200			616.170	618.000	613.500	618.200	618.200
Slope	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

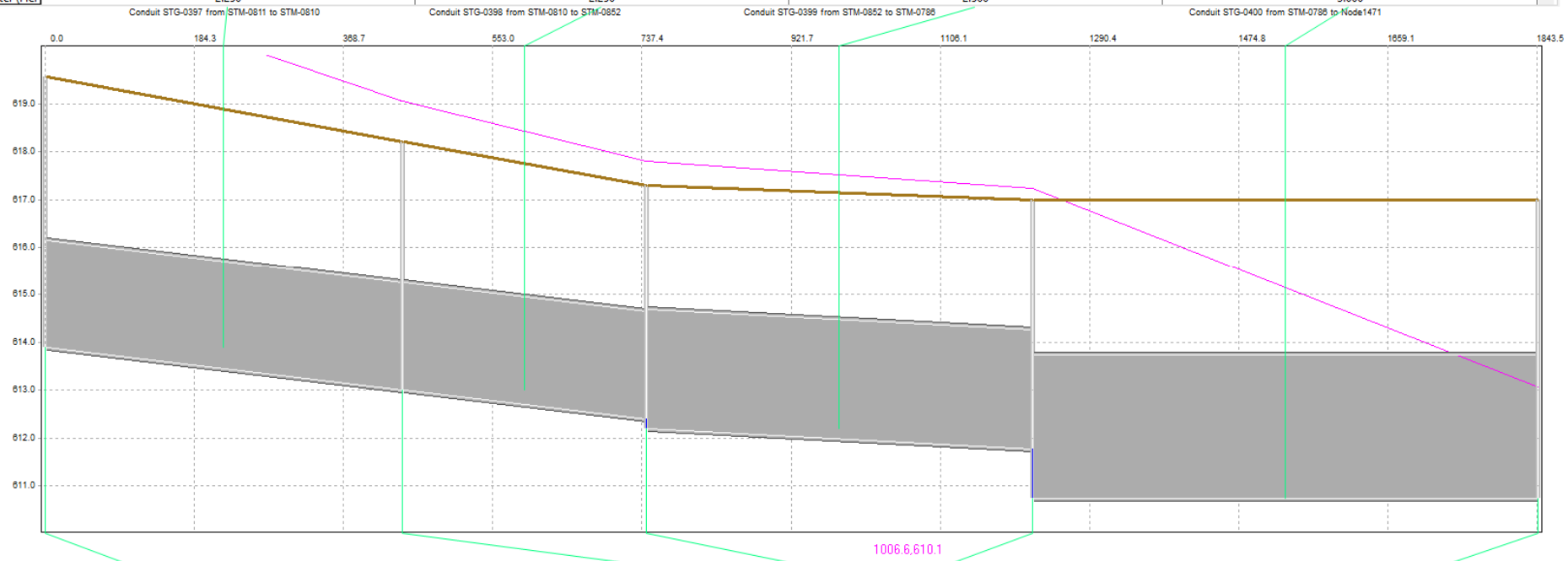
Manhole Parameters | Runoff Info | MH duration and depth

Project CPW-2: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0397	STG-0398	STG-0399	STG-0400
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	613.890	613.000	612.200	610.740
Downstream I	613.000	612.400	611.770	610.740
Roughness	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular
Diameter (Hei	2.250	2.250	2.500	3.000



	STM-0811	STM-0811	STM-0811	STM-0810	STM-0852	STM-0786	STM-0786	STM-0786	Node1471
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS			10-year SCS
Subcatchment	1	2	3			1	2	3	
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed
Ground Elevati	619.570			618.200	617.300	617.000			617.000
Slope	0.014	0.014	0.014	0.000	0.000	0.008	0.008	0.008	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000

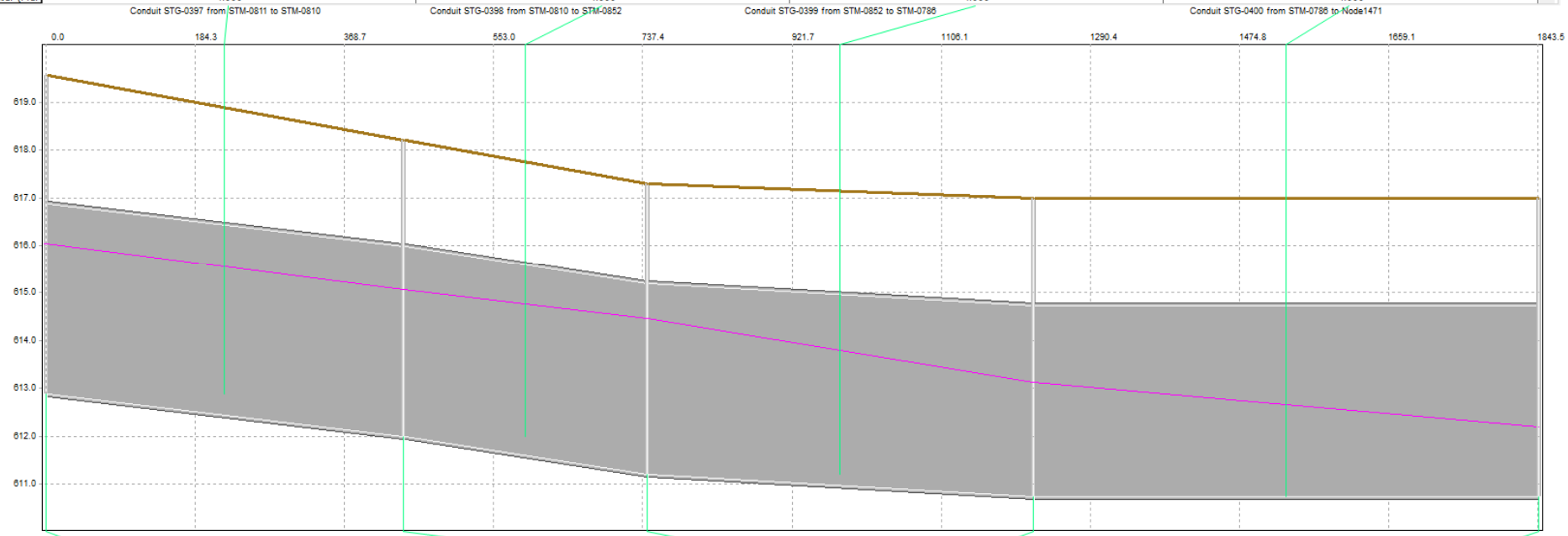
Manhole Parameters | Runoff Info | MH duration and depth

Project CPW-2: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0397	STG-0398	STG-0399	STG-0400
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	612.890	612.000	611.200	610.740
Downstream I	612.000	611.200	610.740	610.740
Roughness	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Rectangular
Diameter (Hei	4.000	4.000	4.000	4.000

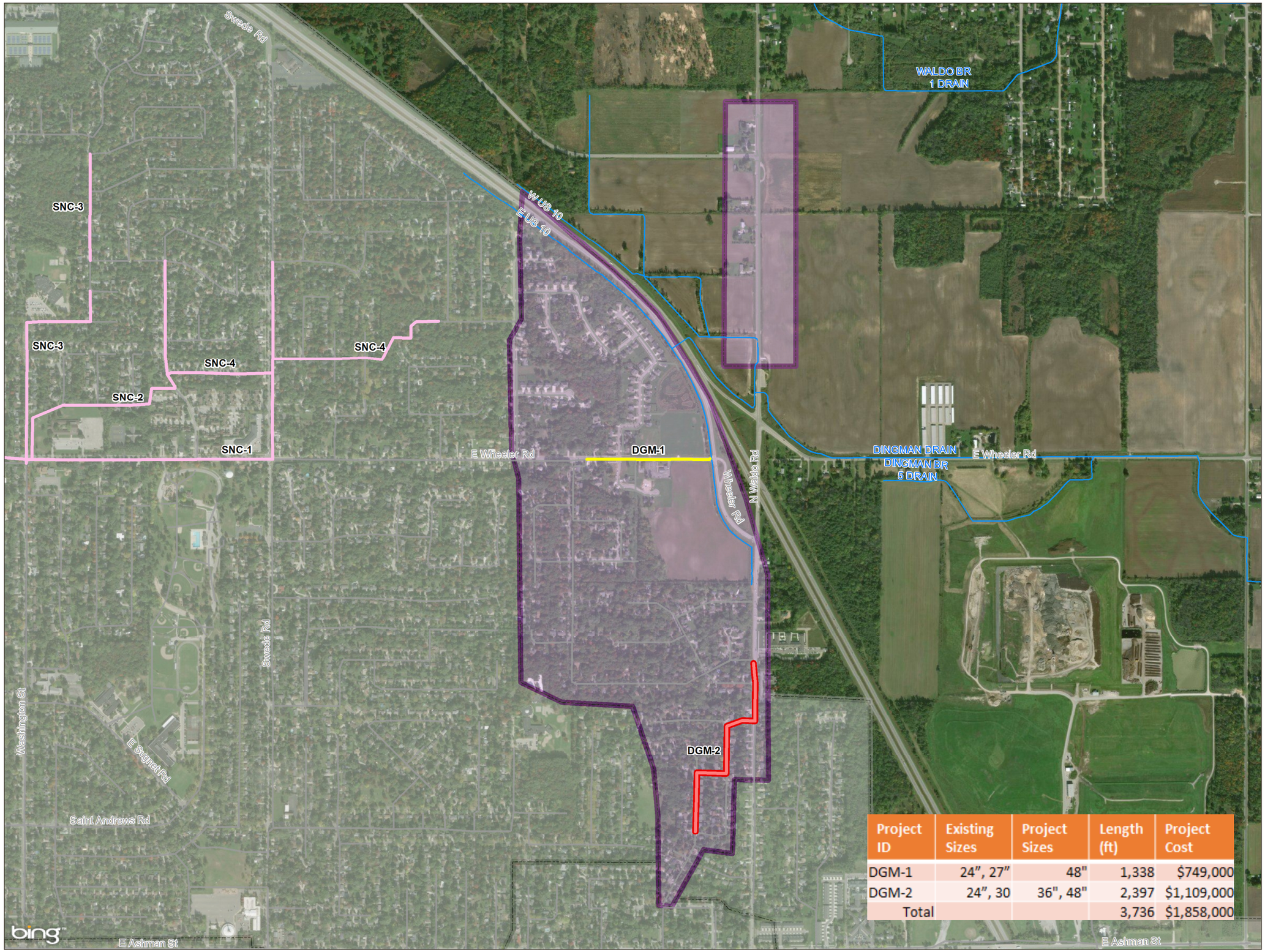


	STM-0811	STM-0811	STM-0811	STM-0810	STM-0852	STM-0786	STM-0786	STM-0786	Node1471
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS			10-year SCS
Subcatchment	1	2	3			1	2	3	
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed
Ground Elevati	619.570			618.200	617.300	617.000			617.000
Slope	0.014	0.014	0.014	0.000	0.000	0.008	0.008	0.008	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000

Manhole Parameters | Runoff Info | MH duration and depth

City of Midland
Dingman Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
DGM-1	24", 27"	48"	1,338	$749,000
DGM-2	24", 30	36", 48"	2,397	$1,109,000
Total			3,736	$1,858,000

Storm Sewer Improvements

- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements
- Storm Sewer Gravity Main
- Drains

N

0 2,000
Feet

1" = 1,000'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

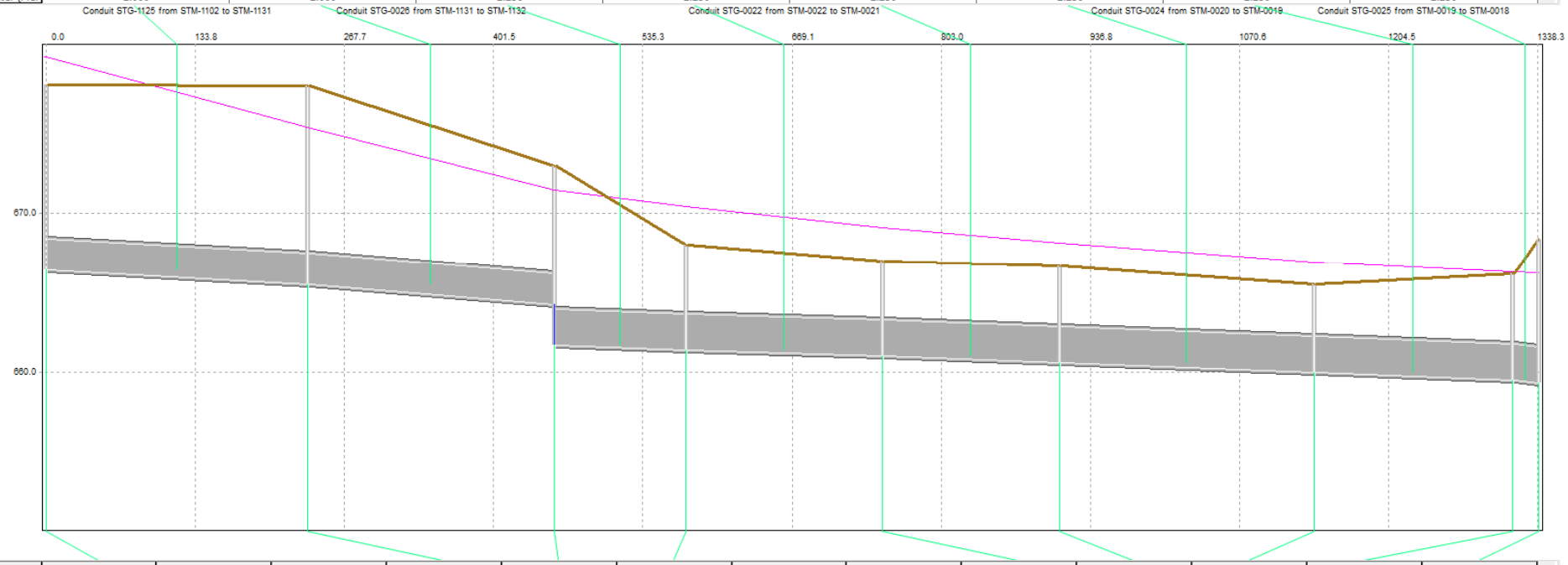
OHM

Project DGM-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1125	STG-0026	STG-1390	STG-0022	STG-0023	STG-0024	STG-0025	STG-0046
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	666.430	665.530	661.700	661.400	661.000	660.600	660.000	659.500
Downstream I	665.530	664.220	661.400	661.000	660.600	660.000	659.500	659.300
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.250	2.250	2.250	2.250	2.250	2.250



	STM-1102	STM-1102	STM-1102	STM-1131	STM-1132	STM-0022	STM-0022	STM-0022	STM-0021	STM-0020	STM-0019	STM-0018	Node1231
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3			1	2	3					
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	None
Ground Elevati	678.100			678.000	673.000	668.000			667.000	666.700	665.500	666.200	668.383
Slope	0.009	0.009	0.009	0.000	0.000	0.016	0.016	0.016	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

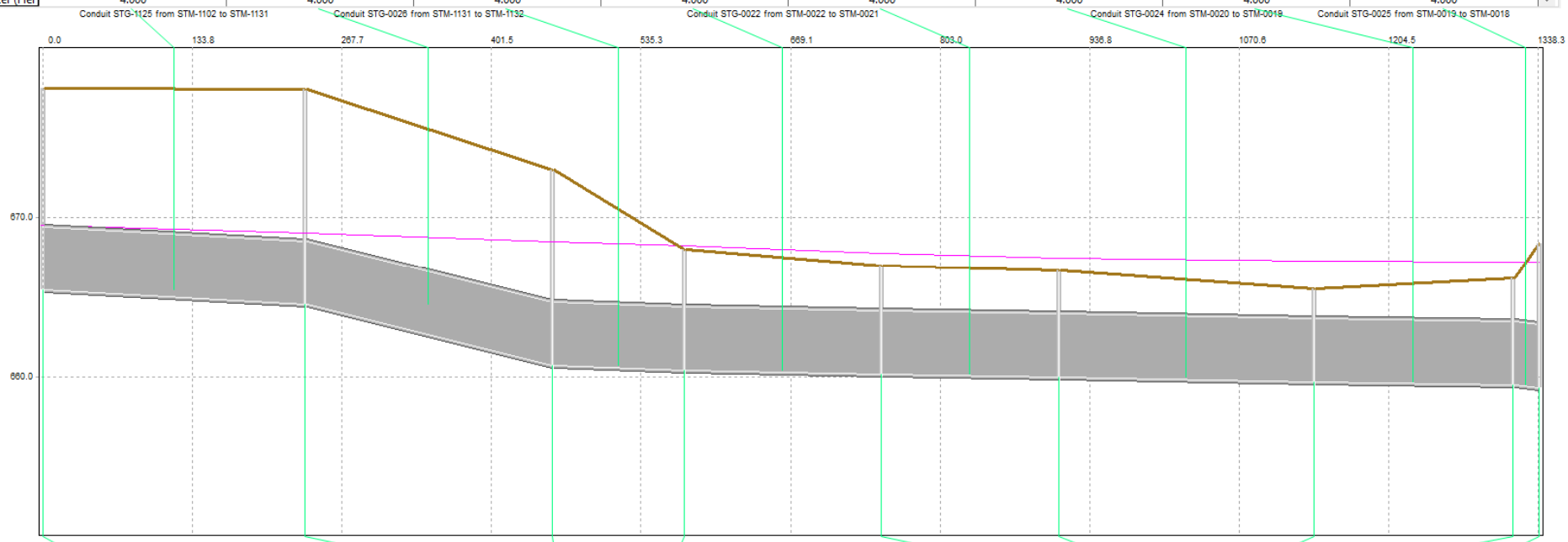
Manhole Parameters | Runoff Info | MH duration and depth

Project DGM-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1125	STG-0026	STG-1390	STG-0022	STG-0023	STG-0024	STG-0025	STG-0046
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	665.430	664.530	660.700	660.400	660.200	660.000	659.700	659.500
Downstream I	664.530	660.700	660.400	660.200	660.000	659.700	659.500	659.300
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000



	STM-1102	STM-1102	STM-1102	STM-1131	STM-1132	STM-0022	STM-0022	STM-0022	STM-0021	STM-0020	STM-0019	STM-0018	Node1231
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3			1	2	3					
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	None
Ground Elevati	678.100			678.000	673.000	668.000			667.000	666.700	665.500	666.200	668.383
Slope	0.009	0.009	0.009	0.000	0.000	0.016	0.016	0.016	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

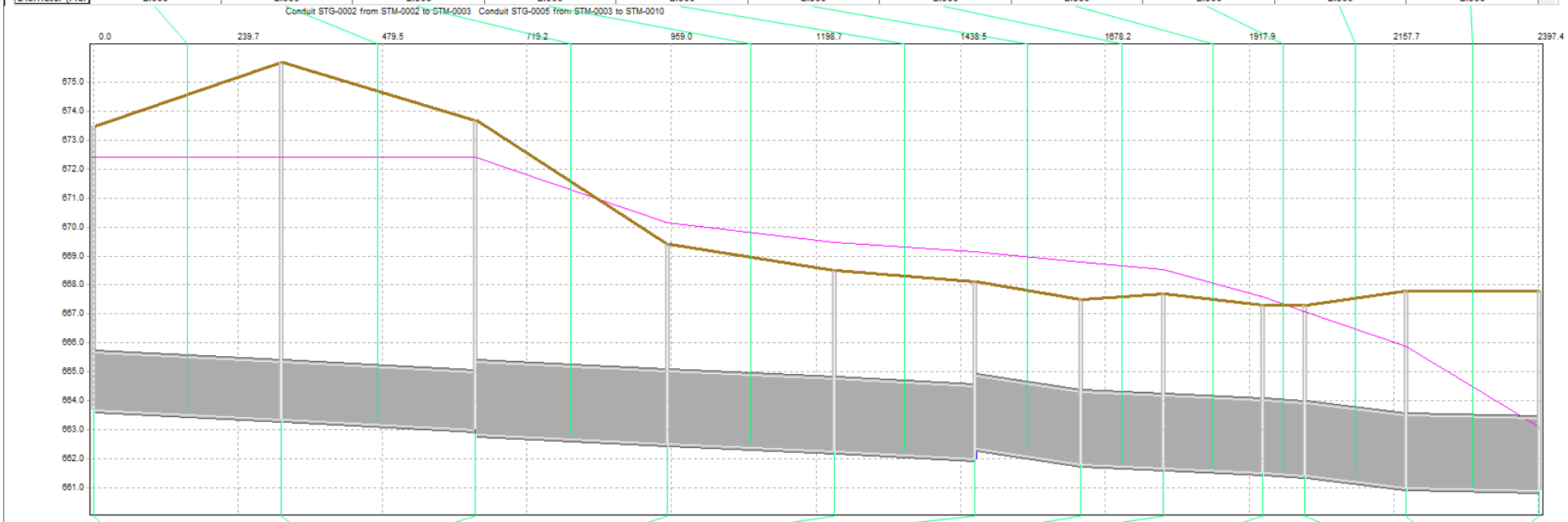
Manhole Parameters | Runoff Info | MH duration and depth

Project DGM-2: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0001	STG-0002	STG-0005	STG-0006	STG-0003	STG-0027	STG-0028	STG-0014	STG-0012	STG-0013	STG-0285
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	663.660	663.350	662.830	662.510	662.240	662.360	661.800	661.680	661.500	661.420	661.000
Downstream I	663.350	663.000	662.510	662.240	662.000	661.800	661.680	661.500	661.420	661.000	660.890
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500



	STM-0001	STM-0001	STM-0001	STM-0002	STM-0003	STM-0003	STM-0003	STM-0010	STM-0012	STM-0014	STM-0014	STM-0014	STM-0016	STM-1025	STM-1025	STM-1025	STM-0006	STM-0006	STM-0006	STM-0005	STM-0004	2
Storm	10-year SCS			10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS			10-year SCS			10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3		1	2	3			1	2	3		1	2	3	1	2	3			
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed			Allowed			Allowed	Allowed	Allowed
Ground Elevati	673.500			675.700	673.700			669.400	668.500	668.100			667.500	667.700			667.300			667.300	667.800	667.800
Slope	0.011	0.011	0.011	0.000	0.047	0.047	0.047	0.000	0.000	0.013	0.013	0.013	0.000	0.012	0.012	0.012	0.011	0.011	0.011	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000

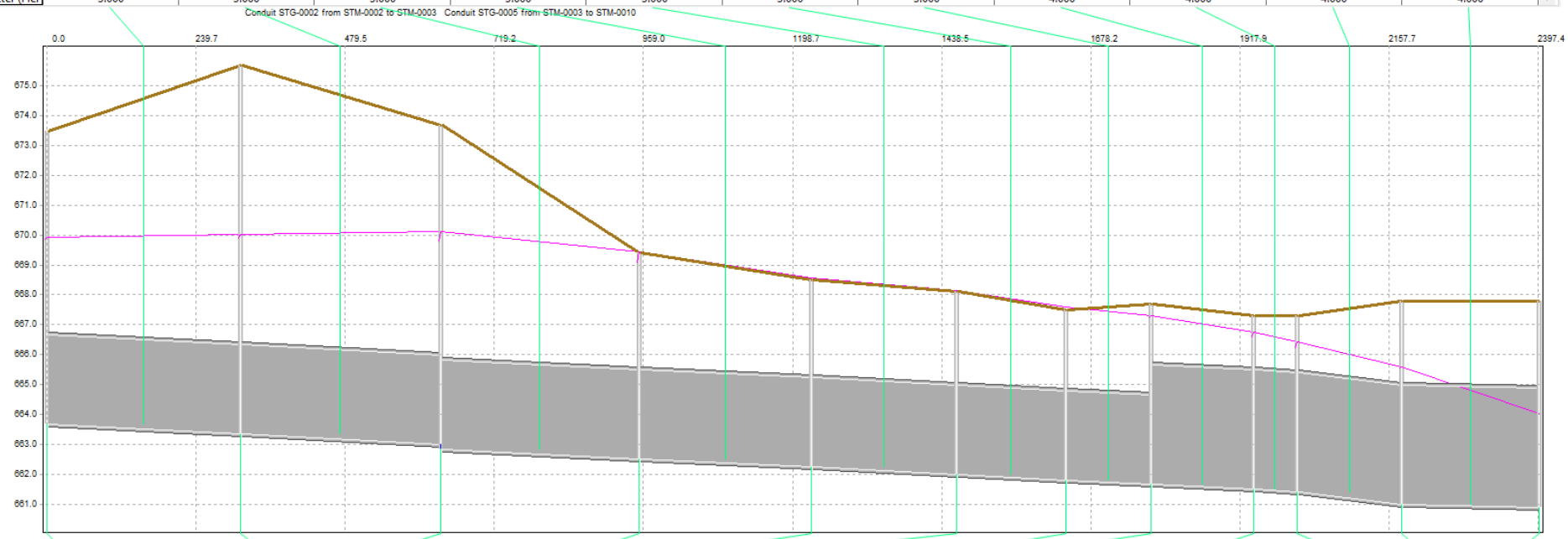
Manhole Parameters | Runoff Info | MH duration and depth

Project DGM-2: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0001	STG-0002	STG-0005	STG-0006	STG-0003	STG-0027	STG-0028	STG-0014	STG-0012	STG-0013	STG-0285
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	663.660	663.350	662.830	662.510	662.240	662.000	661.800	661.680	661.500	661.420	661.000
Downstream I	663.350	663.000	662.510	662.240	662.000	661.800	661.680	661.500	661.420	661.000	660.890
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000	4.000	4.000	4.000

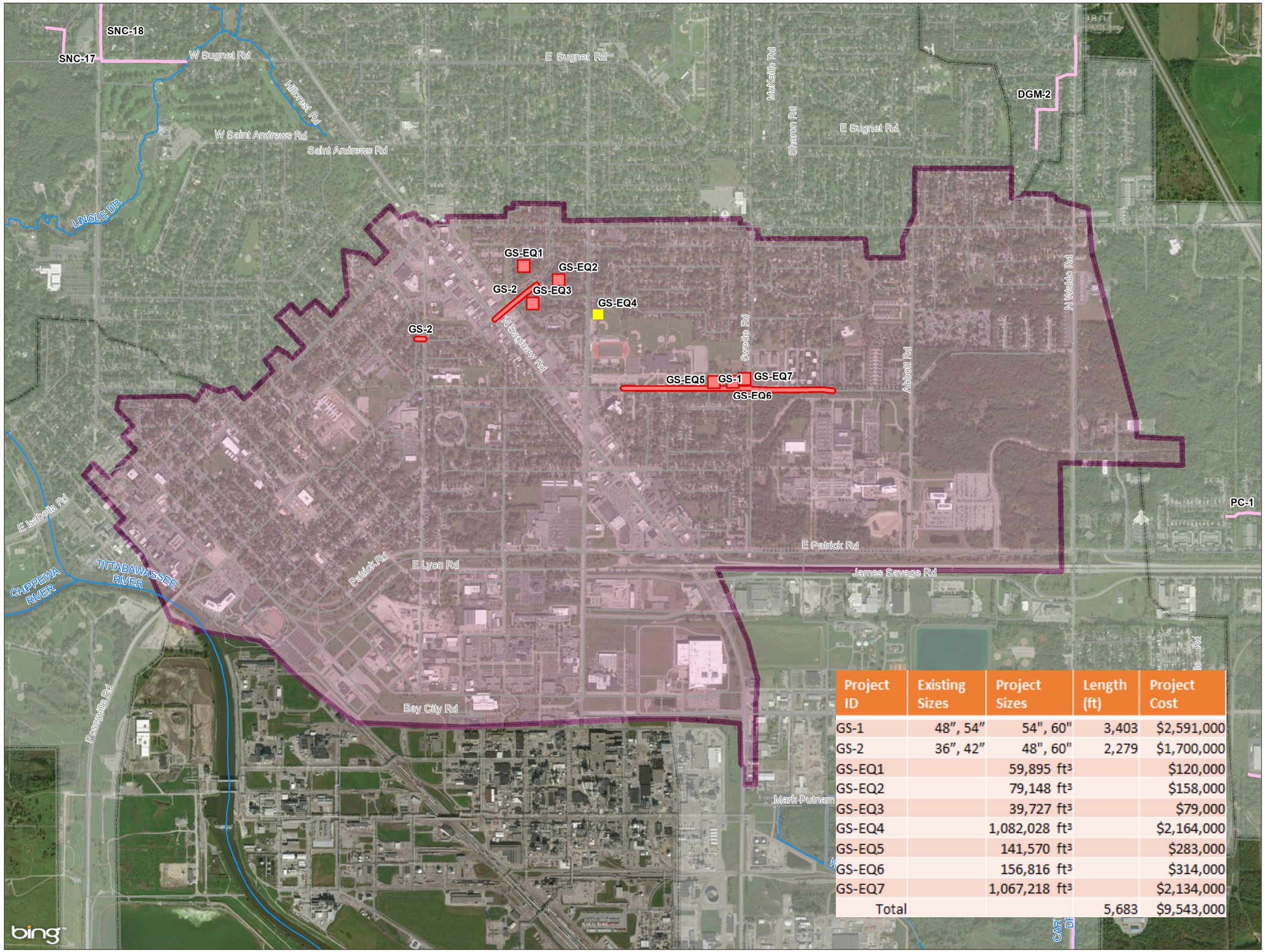


	STM-0001	STM-0001	STM-0001	STM-0002	STM-0003	STM-0003	STM-0003	STM-0010	STM-0012	STM-0014	STM-0014	STM-0014	STM-0016	STM-1025	STM-1025	STM-1025	STM-0006	STM-0006	STM-0006	STM-0005	STM-0004	2
Storm	10-year SCS			10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS			10-year SCS			10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3		1	2	3			1	2	3		1	2	3	1	2	3			
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed			Allowed			Allowed	Allowed	Allowed
Ground Elevat	673.500			675.700	673.700			669.400	668.500	668.100			667.500	667.700			667.300			667.300	667.800	667.800
Slope	0.011	0.011	0.011	0.000	0.047	0.047	0.047	0.000	0.000	0.013	0.013	0.013	0.000	0.012	0.012	0.012	0.011	0.011	0.011	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000

Manhole Parameters | Runoff Info | MH duration and depth

City of Midland
George Street Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
GS-1	48", 54"	54", 60"	3,403	$2,591,000
GS-2	36", 42"	48", 60"	2,279	$1,700,000
GS-EQ1		59,895 ft^3		$120,000
GS-EQ2		79,148 ft^3		$158,000
GS-EQ3		39,727 ft^3		$79,000
GS-EQ4		1,082,028 ft^3		$2,164,000
GS-EQ5		141,570 ft^3		$283,000
GS-EQ6		156,816 ft^3		$314,000
GS-EQ7		1,067,218 ft^3		$2,134,000
Total			5,683	$9,543,000

Storm Sewer Improvements
- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements

EQ Basins
- EQ Basins Outside of Watershed
- High Priority EQ Basin
- Low Priority EQ Basin
- Storm Sewer Gravity Main
- Drains

N

0 2,000
Feet

1" = 1,500'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

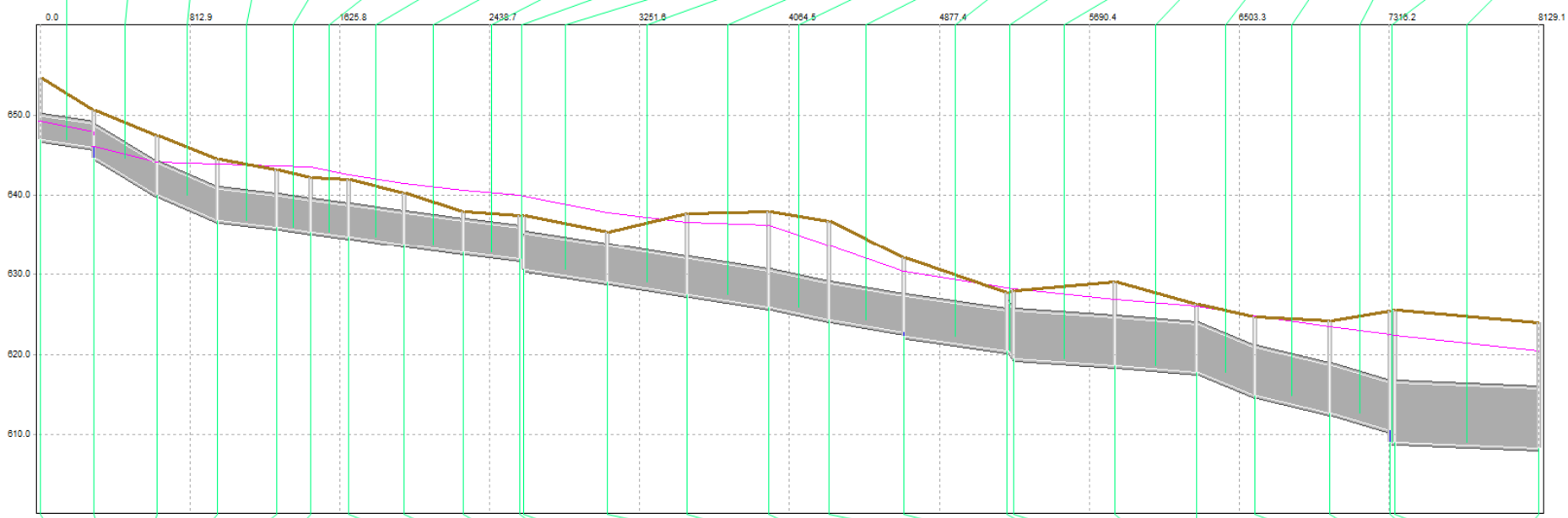
OHM

Project GS-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters | Pipe Results

	STG-0312	STG-0311	STG-0310	STG-0309	STG-0462	STG-0463	STG-0308	STG-0307	STG-0306	STG-0460	STG-0247	STG-0248	STG-0249	STG-0250	STG-0251	STG-0252	STG-0458	STG-1358	STG-0456	STG-0455	STG-0238	STG-1286	STG-1287	STG-1288
Storm	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS
Downstream I	645.930	640.000	636.920	635.960	635.370	634.790	633.880	632.890	632.000	630.720	629.130	627.540	625.950	624.300	622.760	620.470	619.460	618.590	617.850	614.820	612.670	610.560	609.060	608.300
Upstream Inve	646.900	644.670	640.000	636.920	635.960	635.370	634.790	633.880	632.890	632.000	630.720	629.130	627.540	625.950	624.300	622.260	620.470	619.460	618.590	617.850	614.820	612.670	609.060	609.060
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.500	4.500	4.500	4.500	4.500	5.000	6.000	6.000	6.000	6.000	6.000	6.000	7.000	7.500



	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-11	STM-08	STM-12	STM-02	STM-08	STM-08	STM-08	STM-01	STM-11	STM-12	STM-01	Node25
Storm	10-year	10-year	10-year	10-year	10-year	10-year			10-year	10-year	10-year	10-year	10-year			10-year	10-year	10-year			10-year	10-year	10-year	10-year	10-year	10-year			10-year	10-year	10-year	10-year	10-year
Subcatchment						1	2	3					1	2	3			1	2	3						1	2	3					
Ponding Type	Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo
Ground Elevat	654.600	650.600	647.400	644.500	643.200	642.200			642.000	640.300	638.000	637.500	637.500			635.400	637.700	637.900			636.800	632.100	627.800	628.000	629.100	626.300			624.700	624.200	625.500	625.600	624.000
Slope	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.009	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.000	0.000	0.019	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

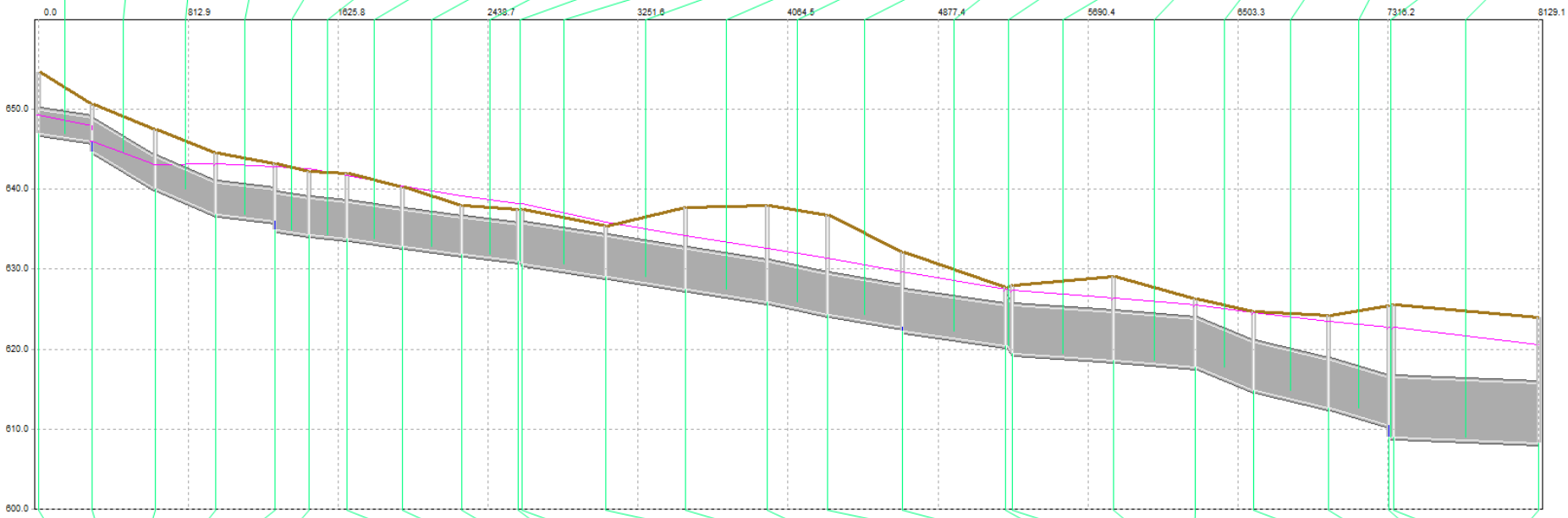
Manhole Parameters | Runoff Inputs | MH Duration and Depth

Project GS-1: Proposed (includes storage)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters | Pipe Results

	STG-0312	STG-0311	STG-0310	STG-0309	STG-0462	STG-0463	STG-0308	STG-0307	STG-0306	STG-0460	STG-0247	STG-0248	STG-0249	STG-0250	STG-0251	STG-0252	STG-0458	STG-1358	STG-0456	STG-0455	STG-0238	STG-1286	STG-1287	STG-1288
Storm	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS
Downstream I	645.930	640.000	636.920	635.960	634.370	633.790	632.880	631.890	631.000	630.720	629.130	627.540	625.950	624.300	622.760	620.470	619.460	618.590	617.850	614.820	612.670	610.560	609.060	608.300
Upstream Inve	646.900	644.670	640.000	636.920	634.960	634.370	633.790	632.880	631.890	631.000	630.720	629.130	627.540	625.950	624.300	622.260	620.470	619.460	618.590	617.850	614.820	612.670	609.060	609.060
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	4.000	4.000	4.000	4.500	4.500	4.500	4.500	4.500	5.000	5.000	5.000	5.000	5.000	5.000	5.000	6.000	6.000	6.000	6.000	6.000	6.000	7.000	7.500



	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-01	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-02	STM-11	STM-08	STM-12	STM-02	STM-08	STM-08	STM-08	STM-01	STM-11	STM-12	STM-01	Node25
Storm	10-year	10-year	10-year	10-year	10-year	10-year			10-year	10-year	10-year	10-year	10-year			10-year	10-year	10-year			10-year	10-year	10-year	10-year	10-year	10-year			10-year	10-year	10-year	10-year	10-year
Subcatchment						1	2	3					1	2	3			1	2	3						1	2	3					
Ponding Type	Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo
Ground Elevati	654.600	650.600	647.400	644.500	643.200	642.200			642.000	640.300	638.000	637.500	637.500			635.400	637.700	637.900			636.800	632.100	627.800	628.000	629.100	626.300			624.700	624.200	625.500	625.600	624.000
Slope	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.009	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.000	0.000	0.019	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

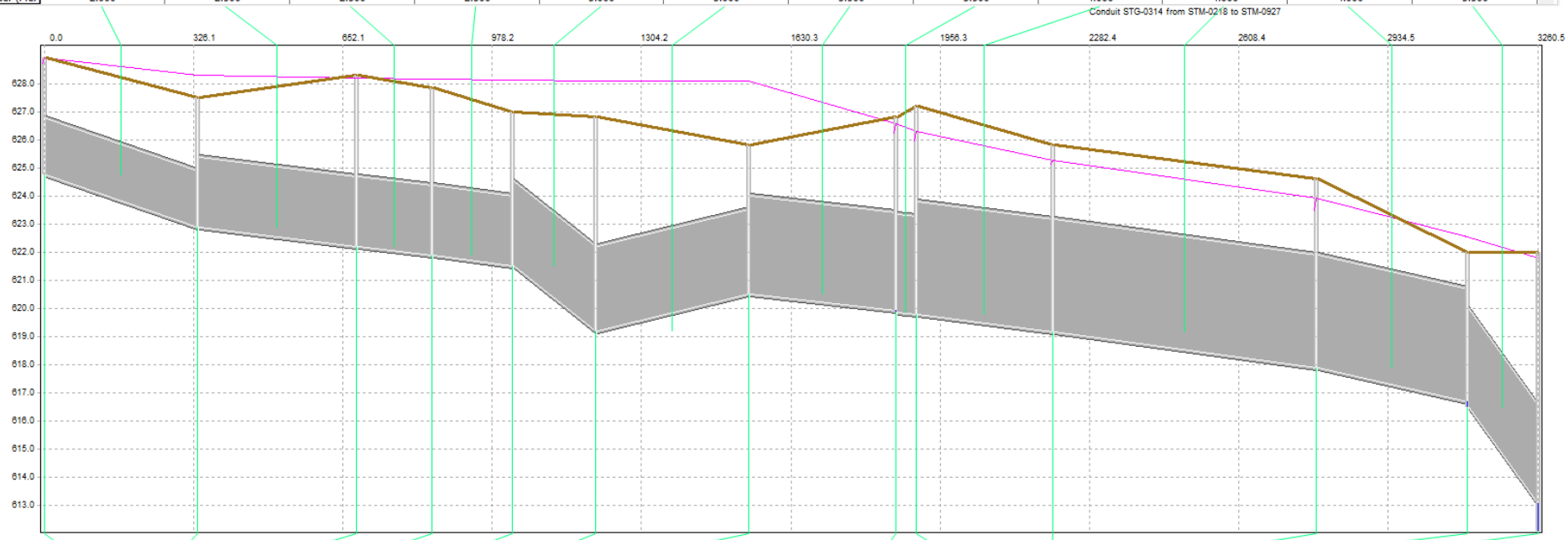
Manhole Parameters | Runoff Inputs | MH Duration and Depth

Project GS-2: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters | Pipe Results

	STG-1122	STG-0197	STG-0198	STG-0199	STG-0200	STG-0201	STG-0202	STG-0203	STG-1136	STG-0314	STG-0313	STG-0367
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Downstream I	622.900	622.200	621.900	621.530	619.200	620.500	619.930	619.800	619.170	617.900	616.700	613.100
Upstream Inve	624.760	622.900	622.200	621.900	621.530	619.200	620.500	619.870	619.800	619.170	617.900	616.500
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.500	2.500	2.500	3.000	3.000	3.500	3.500	4.000	4.000	4.000	3.500



	STM-0121	STM-0288	STM-0120	STM-0119	STM-0289	STM-0118	STM-0290	STM-0290	STM-0290	STM-0949	STM-0126	STM-0218	STM-0927	Node2508	Node2509	Node2509	Node2509
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS		
Subcatchment							1	2	3						1	2	3
Ponding Type	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevat	628.900	627.500	628.300	627.850	627.000	626.800	625.800			626.800	627.200	625.800	624.600	622.000	622.000		
Slope	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
Impervious Pe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

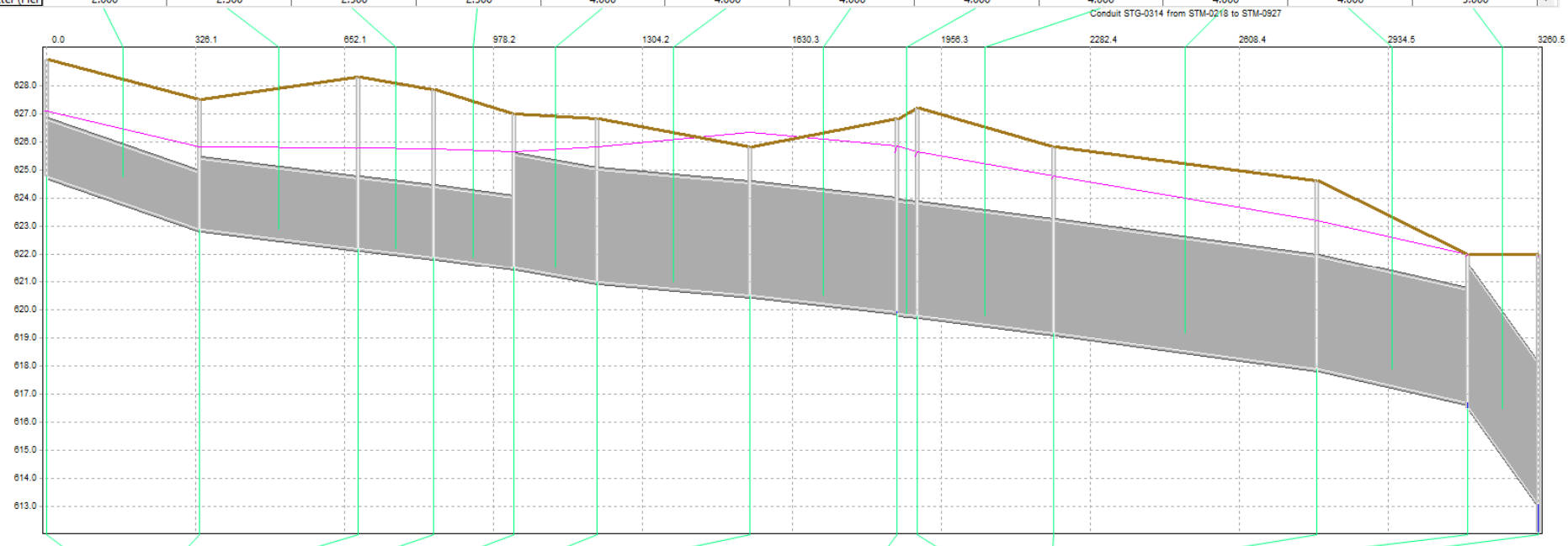
Manhole Parameters | Runoff Inputs | MH Duration and Depth

Project GS-2: Proposed (includes storage)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters | Pipe Results

	STG-1122	STG-0197	STG-0198	STG-0199	STG-0200	STG-0201	STG-0202	STG-0203	STG-1136	STG-0314	STG-0313	STG-0367
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Downstream I	622.900	622.200	621.900	621.530	621.000	620.500	619.930	619.800	619.170	617.900	616.700	613.100
Upstream Inve	624.760	622.900	622.200	621.900	621.530	621.000	620.500	619.870	619.800	619.170	617.900	616.500
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.500	2.500	2.500	4.000	4.000	4.000	4.000	4.000	4.000	4.000	5.000

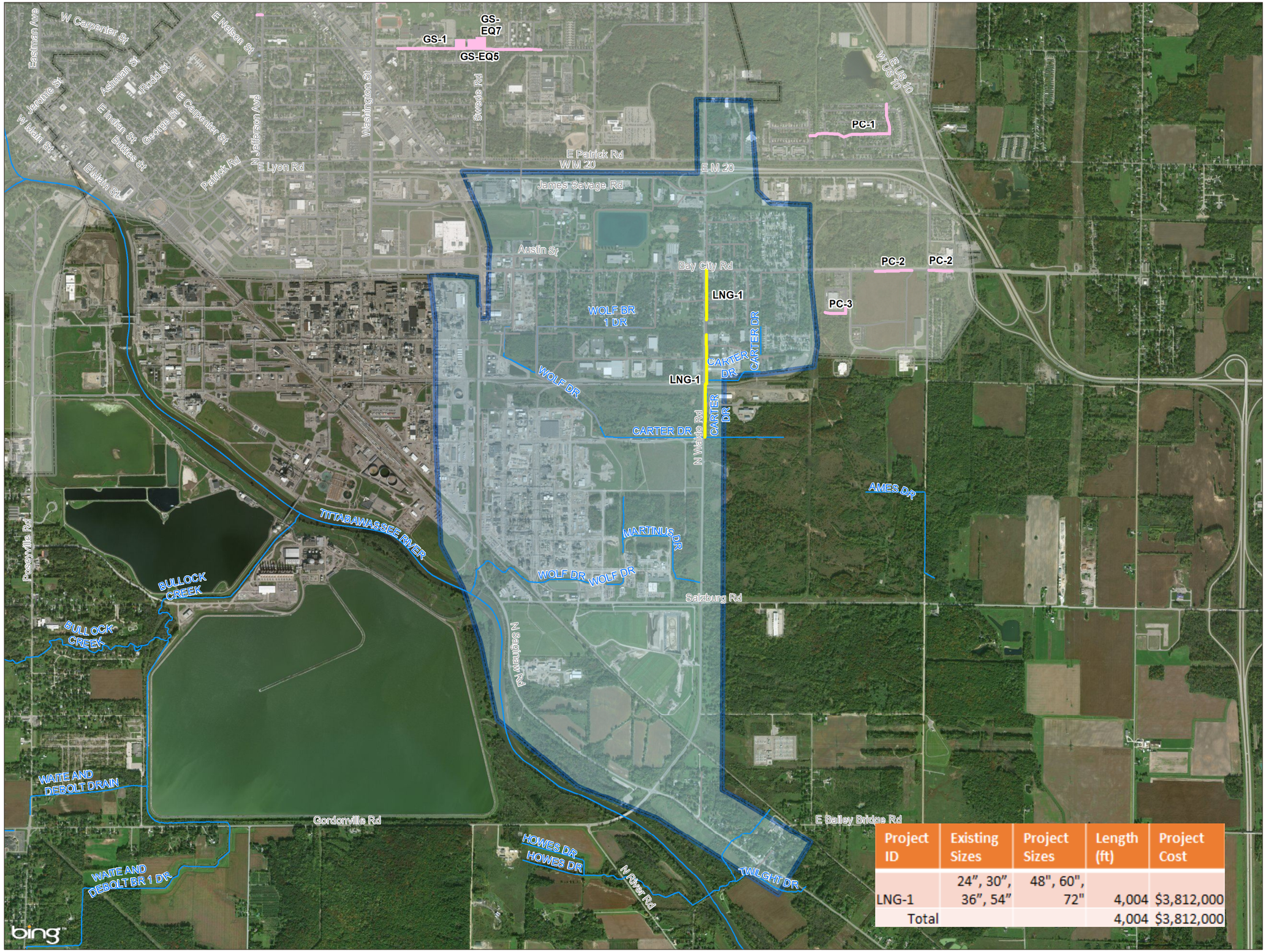


	STM-0121	STM-0288	STM-0120	STM-0119	STM-0289	STM-0118	STM-0290	STM-0290	STM-0290	STM-0949	STM-0126	STM-0218	STM-0927	Node2508	Node2509	Node2509	Node2509
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS		
Subcatchment							1	2	3						1	2	3
Ponding Type	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevati	628.900	627.500	628.300	627.850	627.000	626.800	625.800			626.800	627.200	625.800	624.600	622.000	622.000		
Slope	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
Impervious Pe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

Manhole Parameters | Runoff Inputs | MH Duration and Depth

City of Midland
Lingle Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
LNG-1	24", 30", 36", 54"	48", 60", 72"	4,004	$3,812,000
Total			4,004	$3,812,000

Storm Sewer Improvements

- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements

EQ Basins

- EQ Basins Outside of Watershed
- High Priority EQ Basin
- Low Priority EQ Basin
- Storm Sewer Gravity Main
- Drains

N

0 4,000
Feet

1" = 2,200'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

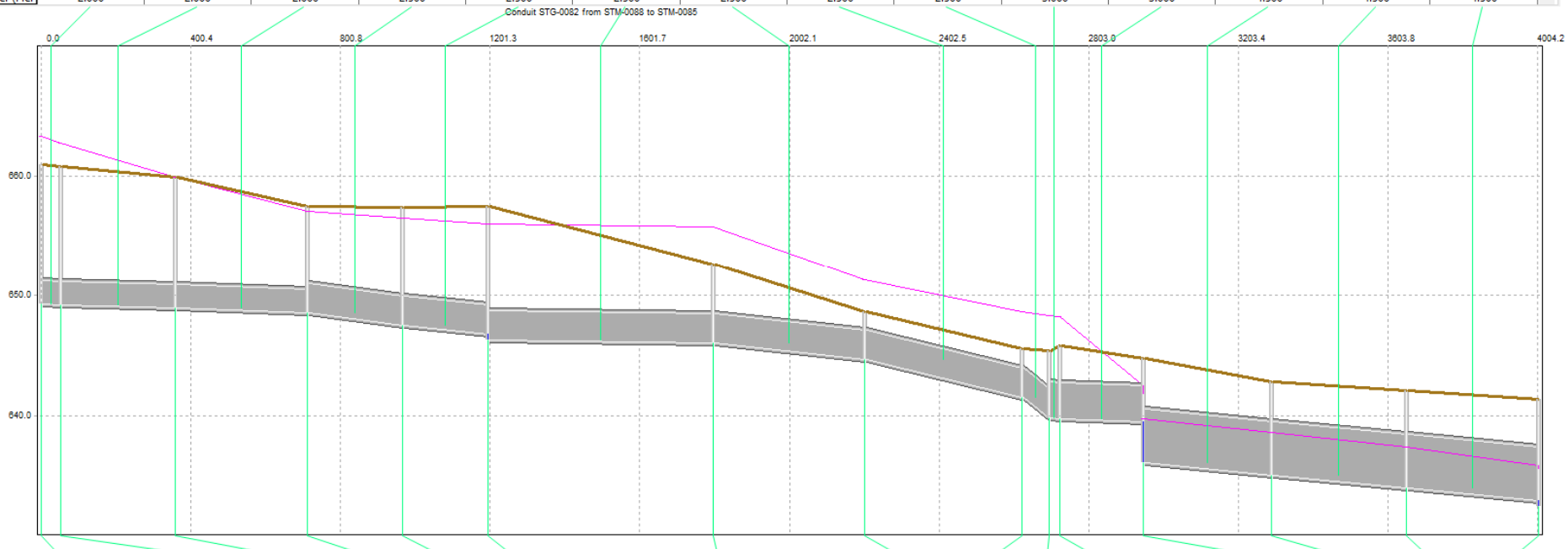
OHM

Project LNG-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0444	STG-0075	STG-0076	STG-0077	STG-0078	STG-0082	STG-0084	STG-0086	STG-0088	STG-0089	STG-0090	STG-0092	STG-0093	STG-0094
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	649.310	649.240	648.960	648.590	647.570	646.300	646.100	644.690	641.520	639.800	639.720	636.100	635.050	634.000
Downstream I	649.240	648.960	648.590	647.570	646.800	646.100	644.690	641.520	639.800	639.720	639.500	635.050	634.000	632.930
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.500	2.500	2.500	2.500	2.500	2.500	3.000	3.000	4.500	4.500	4.500



	STM-0912	STM-0912	STM-0912	STM-0104	STM-0103	STM-0102	STM-0076	STM-0088	STM-0088	STM-0088	STM-0085	STM-0085	STM-0085	STM-0915	STM-0914	STM-0913	STM-0081	STM-0081	STM-0081	STM-0080	STM-0079	STM-0078	STM-0077
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3					1	2	3	1	2	3				1	2	3				
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed			Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	661.000			660.800	659.900	657.500	657.400	657.500			652.600			648.700	645.600	645.400	645.800			644.800	642.800	642.100	641.400
Slope	0.004	0.004	0.004	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.009	0.009	0.009	0.000	0.000	0.000	0.005	0.005	0.005	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

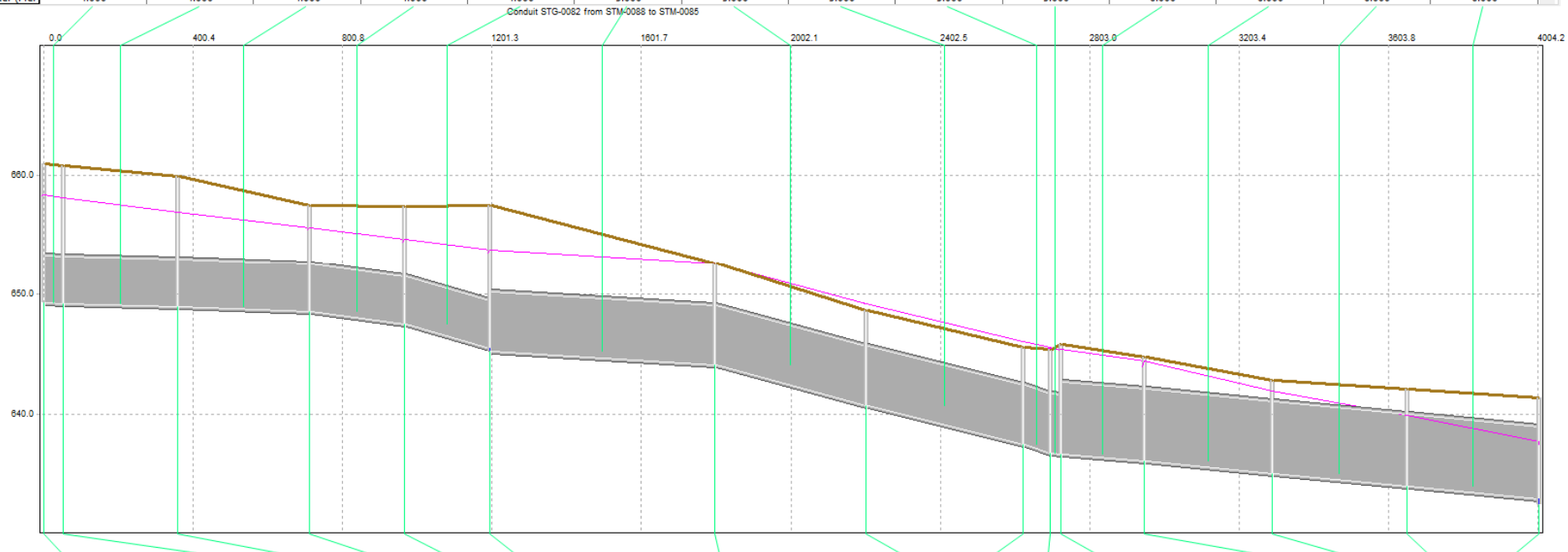
Manhole Parameters | Runoff Info | MH duration and depth

Project LNG-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0444	STG-0075	STG-0076	STG-0077	STG-0078	STG-0082	STG-0084	STG-0086	STG-0088	STG-0089	STG-0090	STG-0092	STG-0093	STG-0094
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	649.310	649.240	648.960	648.590	647.570	645.300	644.100	640.690	637.520	636.800	636.720	636.100	635.050	634.000
Downstream I	649.240	648.960	648.590	647.570	645.500	644.100	640.690	637.520	636.800	636.720	636.100	635.050	634.000	632.930
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	5.000	5.000	5.000	5.000	5.000	6.000	6.000	6.000	6.000

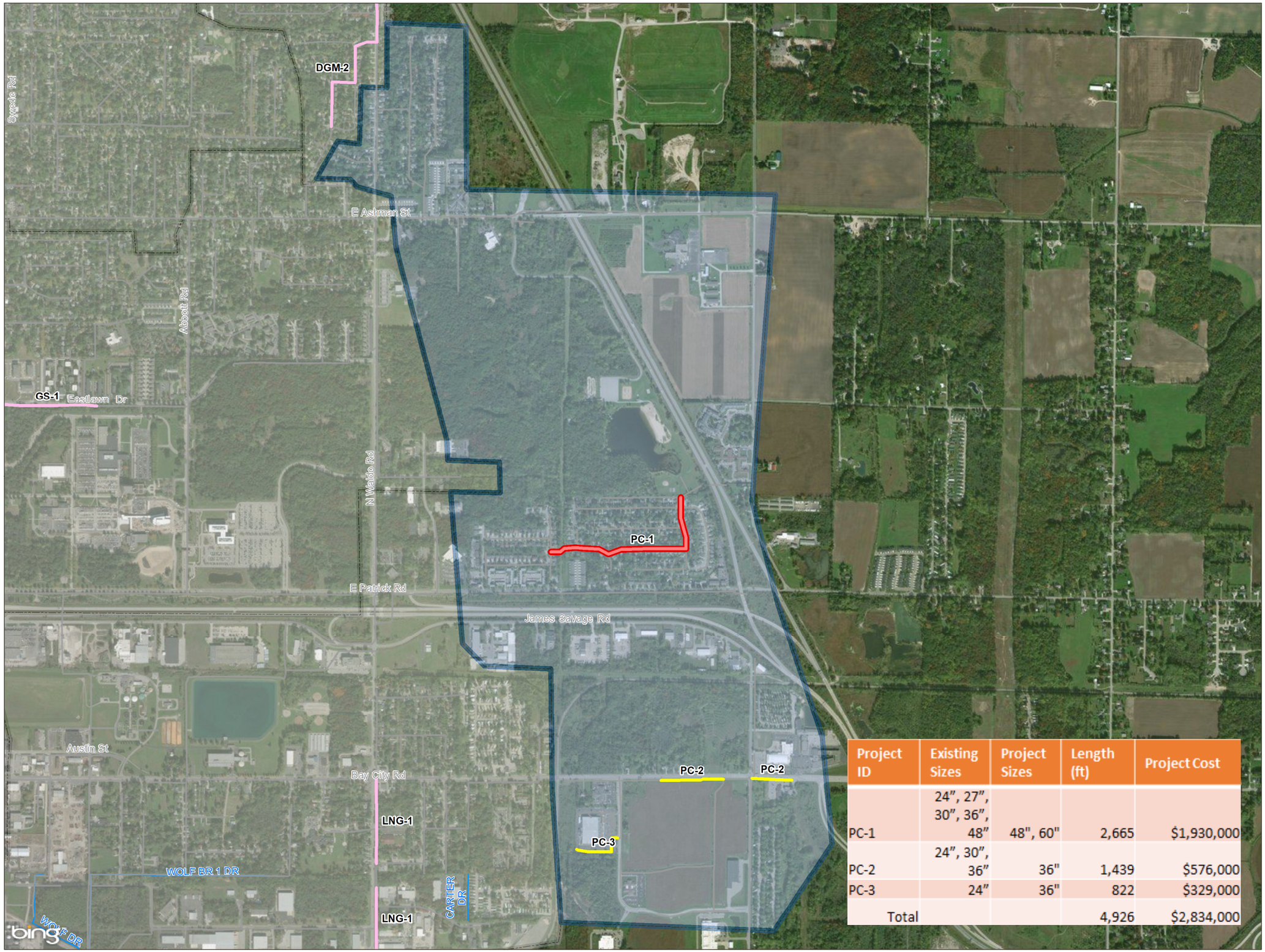


	STM-0912	STM-0912	STM-0912	STM-0104	STM-0103	STM-0102	STM-0076	STM-0088	STM-0088	STM-0088	STM-0085	STM-0085	STM-0085	STM-0915	STM-0914	STM-0913	STM-0081	STM-0081	STM-0081	STM-0080	STM-0079	STM-0078	STM-0077
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3					1	2	3	1	2	3				1	2	3				
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed			Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	661.000			660.800	659.900	657.500	657.400	657.500			652.600			648.700	645.600	645.400	645.800			644.800	642.800	642.100	641.400
Slope	0.004	0.004	0.004	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.009	0.009	0.009	0.000	0.000	0.000	0.005	0.005	0.005	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

Manhole Parameters | Runoff Info | MH duration and depth

City of Midland
Perry Creek Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
PC-1	24", 27", 30", 36", 48"	48", 60"	2,665	$1,930,000
PC-2	24", 30", 36"	36"	1,439	$576,000
PC-3	24"	36"	822	$329,000
Total			4,926	$2,834,000

Storm Sewer Improvements

- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements
- Storm Sewer Gravity Main
- Drains

N

0 2,000
Feet

1" = 1,300'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

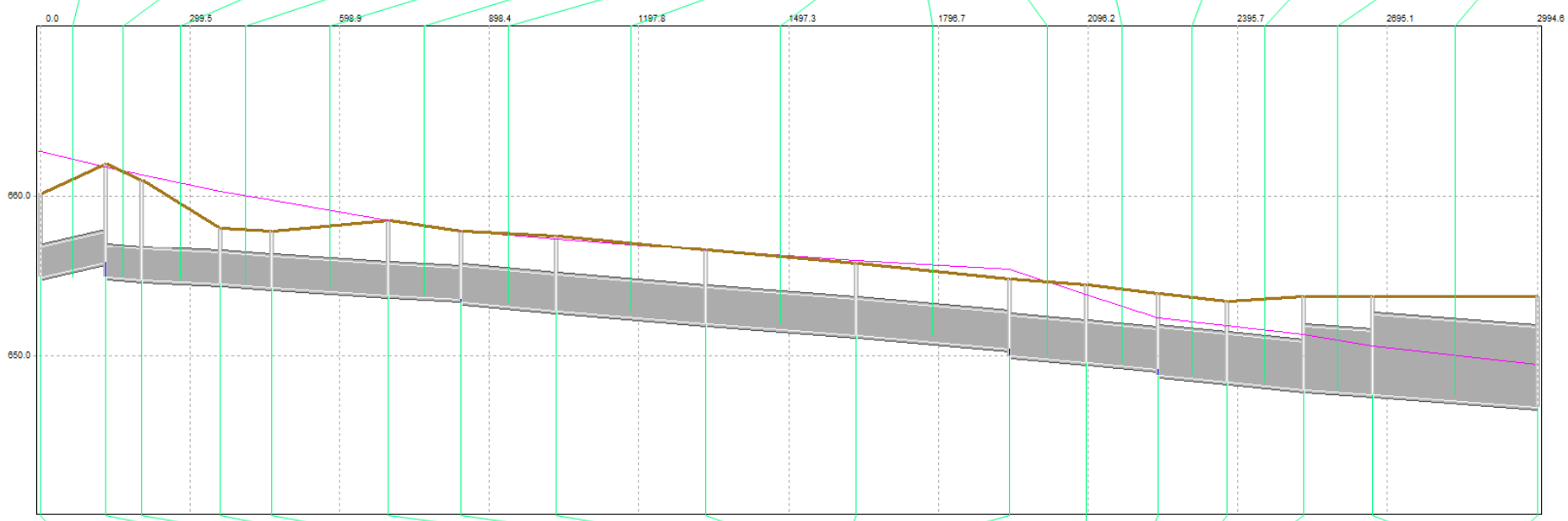
OHM

Project PC-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0994	STG-1033	STG-0993	STG-0062	STG-0061	STG-0060	STG-0055	STG-0056	STG-0057	STG-0058	STG-0054	STG-0053	STG-0052	STG-0051	STG-0995	STG-1128
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	654.900	654.900	654.700	654.470	654.260	653.780	653.300	652.800	652.020	651.240	650.000	649.580	648.760	648.320	647.870	647.590
Downstream I	655.820	654.700	654.470	654.260	653.780	653.500	652.800	652.020	651.240	650.430	649.580	649.150	648.320	647.870	647.590	646.760
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.000	2.250	2.250	2.250	2.250	2.500	2.500	3.000	3.000	4.000	5.000



	STM-0056	STM-0056	STM-0056	STM-1042	STM-1020	STM-0052	STM-0051	STM-0051	STM-0051	STM-0050	STM-0049	STM-0053	STM-0054	STM-0055	STM-0048	STM-0048	STM-0048	STM-0047	STM-0046	STM-0045	STM-0044	STM-0044	STM-0044	Node1482	310
Storm	10-year SC			10-year SC	10-year SC	10-year SC	10-year SC			10-year SC	10-year SC	10-year SC	10-year SC	10-year SC	10-year SC			10-year SC	10-year SC	10-year SC	10-year SC			10-year SC	10-year SC
Subcatchment	1	2	3				1	2	3						1	2	3				1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevati	660.200			662.000	661.000	658.000	657.800			658.500	657.800	657.500	656.600	655.740	654.800			654.400	653.900	653.400	653.700			653.700	653.700
Slope	0.014	0.014	0.014	0.000	0.000	0.000	0.009	0.009	0.009	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.002	0.000	0.000	0.000	0.004	0.004	0.004	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000

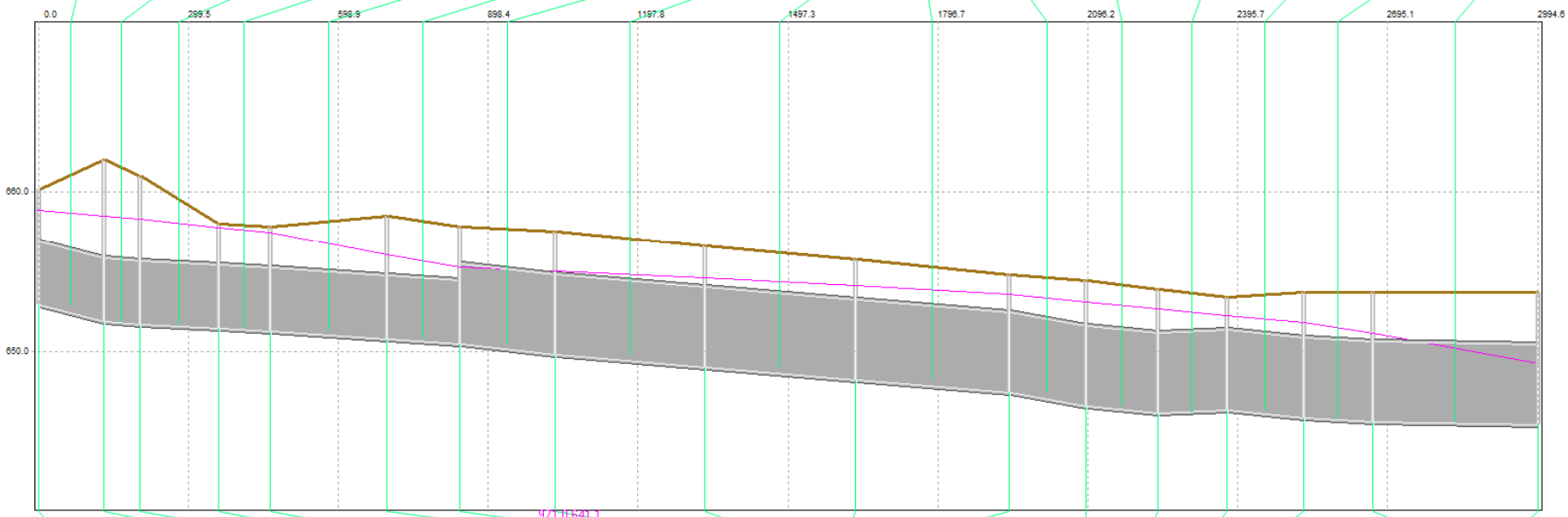
Manhole Parameters | Runoff Info | MH duration and depth

Project PC-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0994	STG-1033	STG-0993	STG-0062	STG-0061	STG-0060	STG-0055	STG-0056	STG-0057	STG-0058	STG-0054	STG-0053	STG-0052	STG-0051	STG-0995	STG-1128
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	652.900	651.900	651.700	651.470	651.260	650.780	650.500	649.800	649.020	648.240	647.430	646.580	646.150	646.320	645.870	645.590
Downstream I	651.900	651.700	651.470	651.260	650.780	650.500	649.800	649.020	648.240	647.430	646.580	646.150	646.320	645.870	645.590	645.460
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000



	STM-0056	STM-0056	STM-0056	STM-1042	STM-1020	STM-0052	STM-0051	STM-0051	STM-0051	STM-0050	STM-0049	STM-0053	STM-0054	STM-0055	STM-0048	STM-0048	STM-0048	STM-0047	STM-0046	STM-0045	STM-0044	STM-0044	STM-0044	Node1482	310
Storm	10-year SC			10-year SC	10-year SC	10-year SC	10-year SC			10-year SC	10-year SC	10-year SC	10-year SC	10-year SC	10-year SC			10-year SC	10-year SC	10-year SC	10-year SC			10-year SC	10-year SC
Subcatchment	1	2	3				1	2	3						1	2	3				1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	660.200			662.000	661.000	658.000	657.800			658.500	657.800	657.500	656.600	655.740	654.800			654.400	653.900	653.400	653.700			653.700	653.700
Slope	0.014	0.014	0.014	0.000	0.000	0.000	0.009	0.009	0.009	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.002	0.000	0.000	0.000	0.004	0.004	0.004	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000

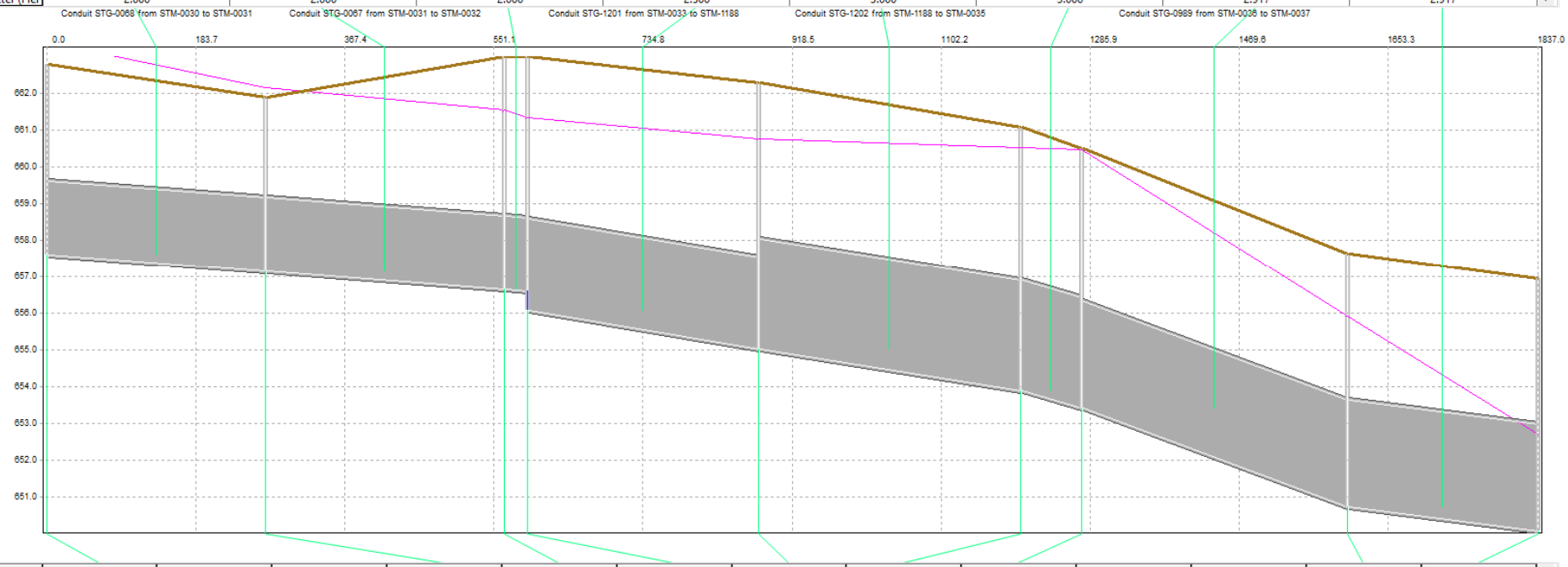
Manhole Parameters | Runoff Info | MH duration and depth

Project PC-2: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0068	STG-0067	STG-0066	STG-1201	STG-1202	STG-0064	STG-0989	STG-1191
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	657.630	657.170	656.670	656.080	655.050	653.920	653.440	650.760
Downstream I	657.170	656.670	656.630	655.050	653.920	653.440	650.760	650.095
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.500	3.000	3.000	2.917	2.917



	STM-0030	STM-0030	STM-0030	STM-0031	STM-0032	STM-0033	STM-1188	STM-0035	STM-0036	STM-0036	STM-0036	STM-0037	STM-0038
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS
Subcatchment	1	2	3						1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	662.800			661.900	663.000	663.000	662.310	661.100	660.500			657.650	656.955
Slope	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000

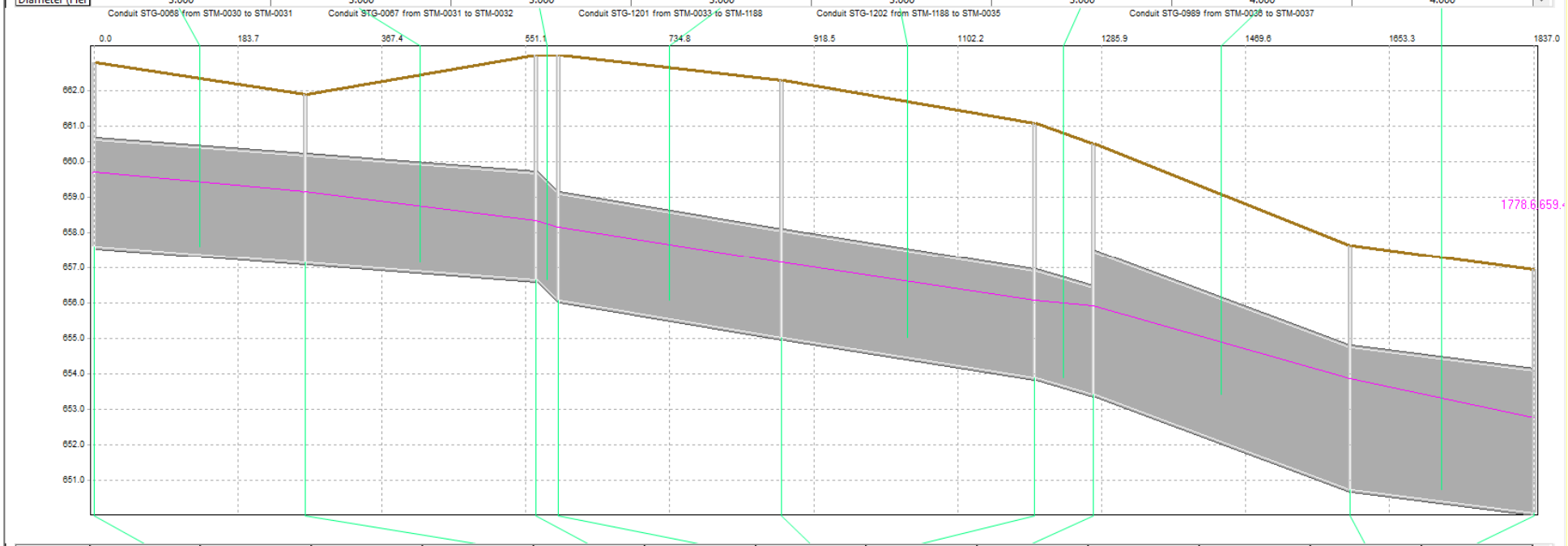
Manhole Parameters | Runoff Info | MH duration and depth

Project PC-2: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0068	STG-0067	STG-0066	STG-1201	STG-1202	STG-0064	STG-0989	STG-1191
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	657.630	657.170	656.670	656.080	655.050	653.920	653.440	650.760
Downstream I	657.170	656.670	656.080	655.050	653.920	653.440	650.760	650.095
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	3.000	4.000	4.000



	STM-0030	STM-0030	STM-0030	STM-0031	STM-0032	STM-0033	STM-1188	STM-0035	STM-0036	STM-0036	STM-0036	STM-0037	STM-0038
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS			10-year SCS	10-year SCS
Subcatchment	1	2	3						1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	662.800			661.900	663.000	663.000	662.310	661.100	660.500			657.650	656.955
Slope	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000

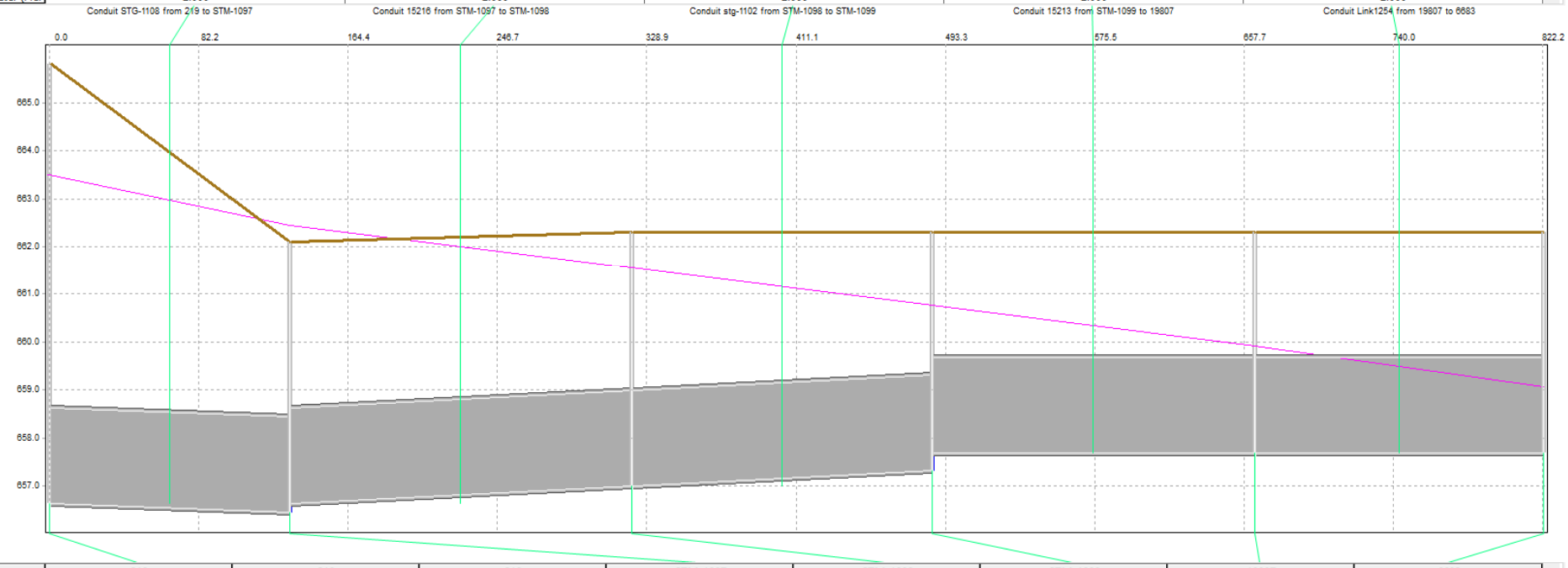
Manhole Parameters | Runoff Info | MH duration and depth

Project PC-3: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1108	15216	stg-1102	15213	Link1254
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	656.630	656.630	657.000	657.690	657.690
Downstream I	656.460	657.000	657.330	657.690	657.690
Roughness	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000



	219	219	219	STM-1097	STM-1098	STM-1099	19807	6683
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3					
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	665.800			662.100	662.300	662.300	662.300	662.300
Slope	0.012	0.012	0.012	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

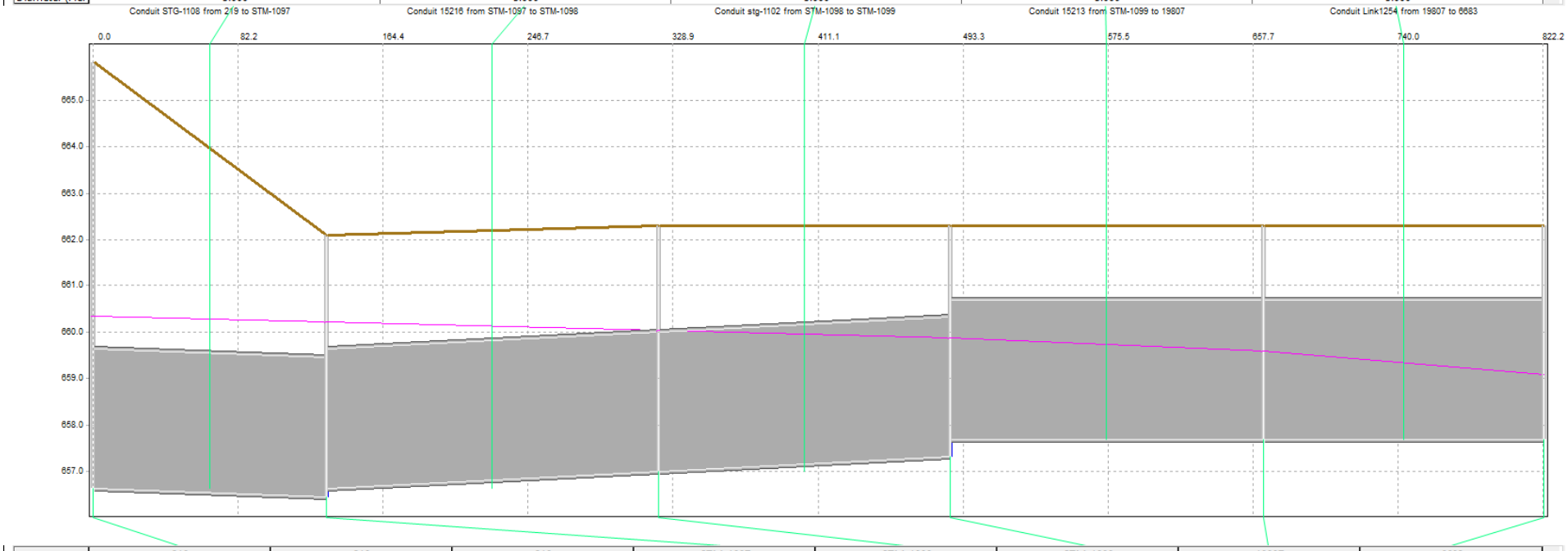
Manhole Parameters | Runoff Info | MH duration and depth

Project PC-3: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1108	15216	stg-1102	15213	Link1254
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	656.630	656.630	657.000	657.690	657.690
Downstream I	656.460	657.000	657.330	657.690	657.690
Roughness	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000

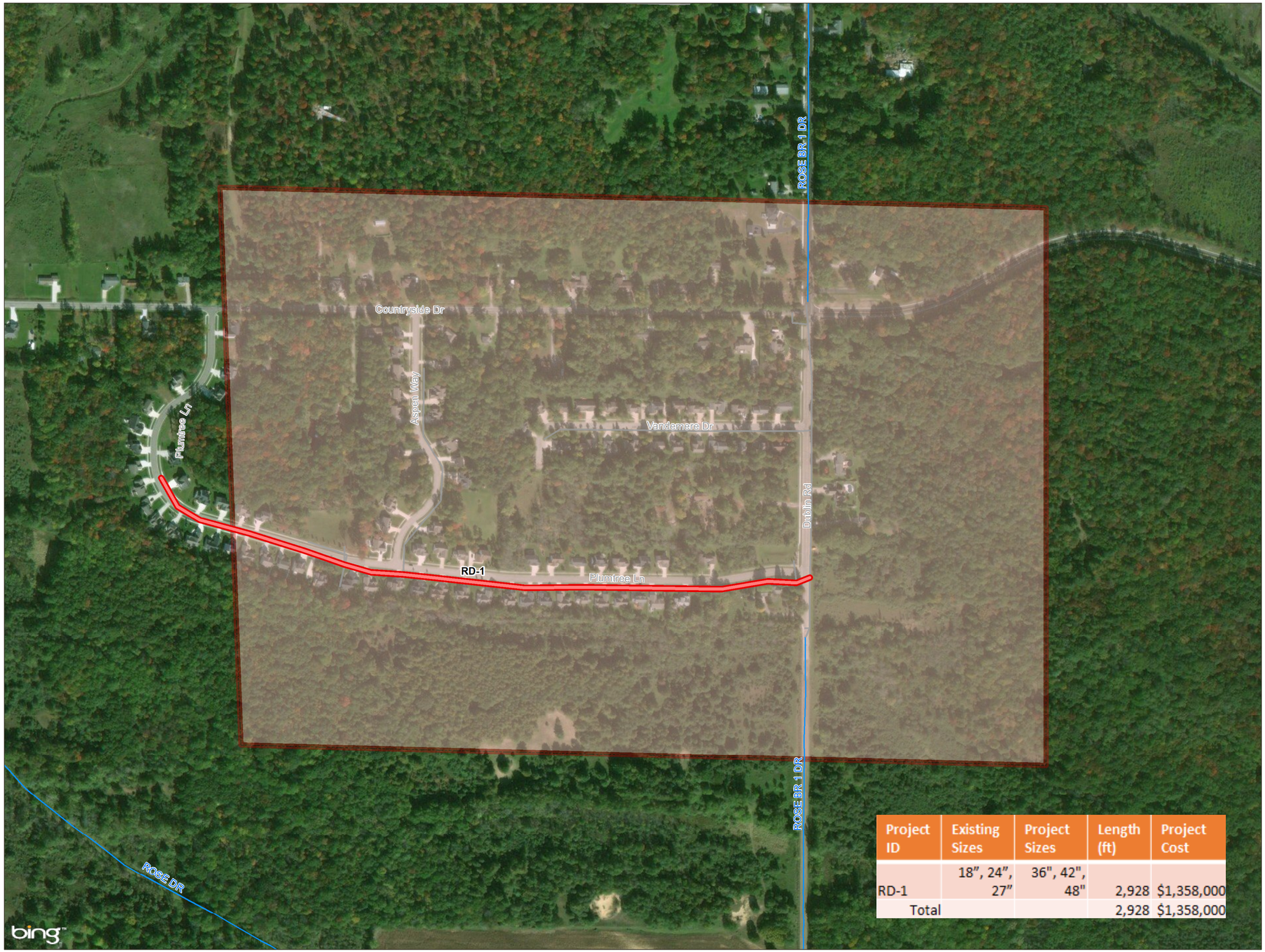


	219	219	219	STM-1097	STM-1098	STM-1099	19807	6683
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3					
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	665.800			662.100	662.300	662.300	662.300	662.300
Slope	0.012	0.012	0.012	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000

Manhole Parameters | Runoff Info | MH duration and depth

City of Midland
Rose Drain Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
RD-1	18", 24", 27"	36", 42", 48"	2,928	$1,358,000
Total			2,928	$1,358,000

Storm Sewer Improvements

- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements
- Storm Sewer Gravity Main
- Drains

N

0 500
Feet

1" = 400'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

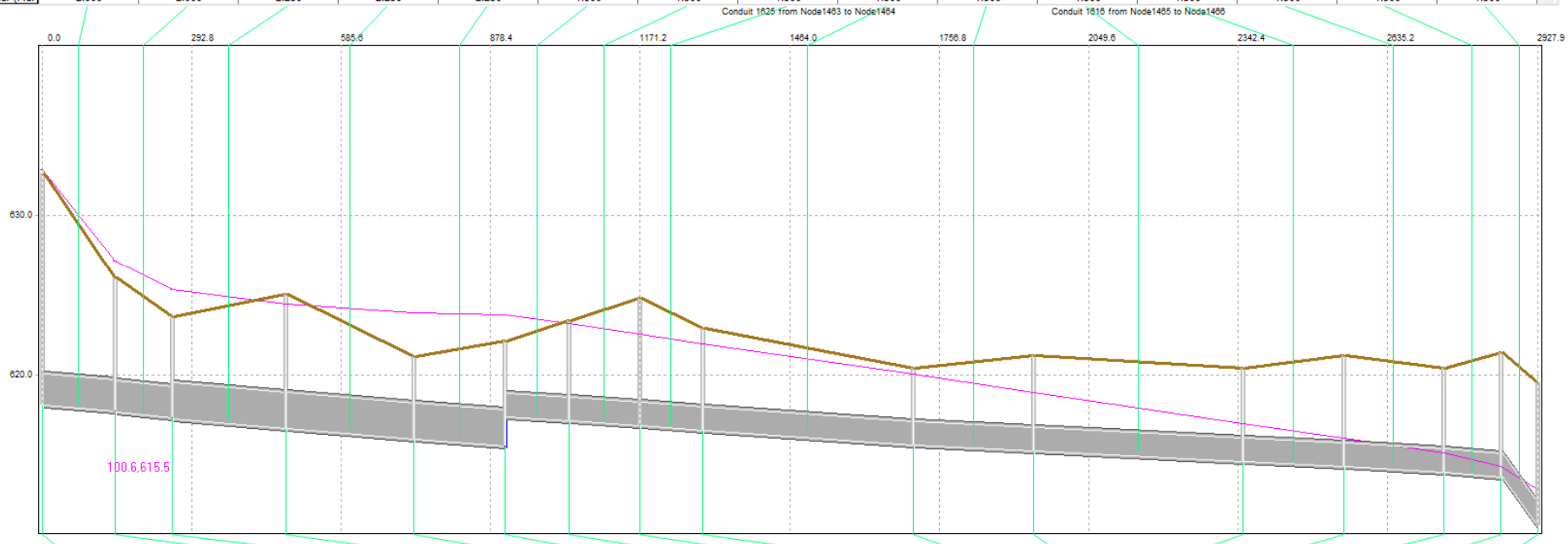
OHM

Project RD-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1161	STG-1162	STG-1163	STG-1164	STG-1165	38475	3789	1623	1625	1617	1616	1615	1614	1612	1609
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	618.120	617.670	617.230	616.640	616.010	617.390	617.130	616.820	616.550	615.640	615.250	614.570	614.290	613.900	613.600
Downstream I	617.760	617.330	616.640	616.010	615.570	617.130	616.820	616.550	615.640	615.250	614.570	614.290	613.900	613.600	610.550
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.250	2.250	2.250	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500



	STM-1171	STM-1171	STM-1171	STM-1172	STM-1170	STM-1169	STM-1168	STM-1167	Node1461	Node1462	Node1463	Node1464	Node1465	Node1466	Node1467	Node1468	Node1469	STM-0618
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3															
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	632.600			626.040	623.630	625.050	621.160	622.140	623.400	624.800	622.900	620.400	621.200	620.400	621.200	620.400	621.400	619.500
Slope	0.006	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

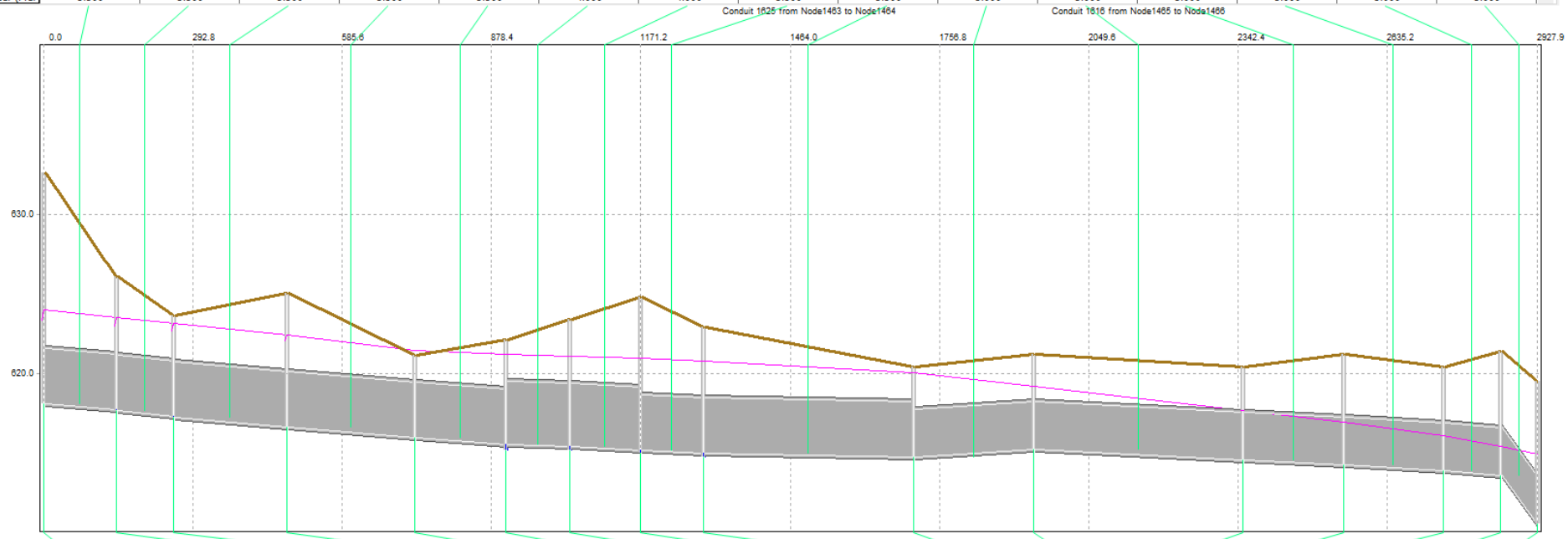
Manhole Parameters | Runoff Info | MH duration and depth

Project RD-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

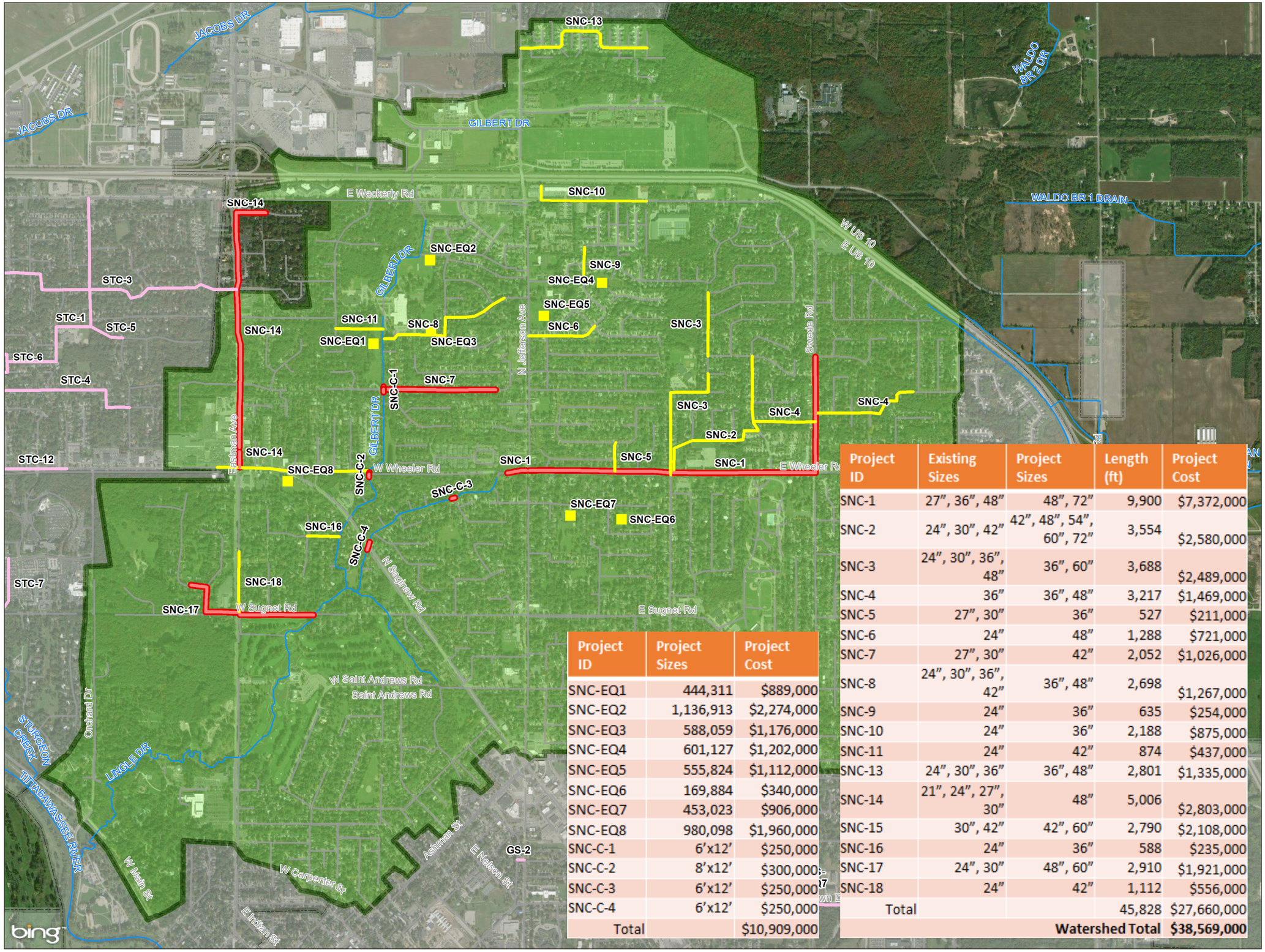
	STG-1161	STG-1162	STG-1163	STG-1164	STG-1165	38475	3789	1623	1625	1617	1616	1615	1614	1612	1609
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	618.120	617.670	617.230	616.640	616.010	615.570	615.450	615.200	615.000	614.750	615.250	614.570	614.290	613.900	613.600
Downstream I	617.760	617.330	616.640	616.010	615.570	615.450	615.200	615.000	614.750	615.250	614.570	614.290	613.900	613.600	610.550
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500	3.500	3.500	4.000	4.000	3.500	3.500	3.000	3.000	3.000	3.000	3.000	3.000



	STM-1171	STM-1171	STM-1171	STM-1172	STM-1170	STM-1169	STM-1168	STM-1167	Node1461	Node1462	Node1463	Node1464	Node1465	Node1466	Node1467	Node1468	Node1469	STM-0618
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3															
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	632.600			626.040	623.630	625.050	621.160	622.140	623.400	624.800	622.900	620.400	621.200	620.400	621.200	620.400	621.400	619.500
Slope	0.006	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Manhole Parameters | Runoff Info | MH duration and depth

City of Midland
Snake Creek Watershed



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
SNC-1	27", 36", 48"	48", 72"	9,900	$7,372,000
SNC-2	24", 30", 42"	42", 48", 54", 60", 72"	3,554	$2,580,000
SNC-3	24", 30", 36", 48"	36", 60"	3,688	$2,489,000
SNC-4	36"	36", 48"	3,217	$1,469,000
SNC-5	27", 30"	36"	527	$211,000
SNC-6	24"	48"	1,288	$721,000
SNC-7	27", 30"	42"	2,052	$1,026,000
SNC-8	24", 30", 36", 42"	36", 48"	2,698	$1,267,000
SNC-9	24"	36"	635	$254,000
SNC-10	24"	36"	2,188	$875,000
SNC-11	24"	42"	874	$437,000
SNC-13	24", 30", 36"	36", 48"	2,801	$1,335,000
SNC-14	21", 24", 27", 30"	48"	5,006	$2,803,000
SNC-15	30", 42"	42", 60"	2,790	$2,108,000
SNC-16	24"	36"	588	$235,000
SNC-17	24", 30"	48", 60"	2,910	$1,921,000
SNC-18	24"	42"	1,112	$556,000
Total			45,828	$27,660,000
			Watershed Total	**$38,569,000**

Project ID	Project Sizes	Project Cost
SNC-EQ1	444,311	$889,000
SNC-EQ2	1,136,913	$2,274,000
SNC-EQ3	588,059	$1,176,000
SNC-EQ4	601,127	$1,202,000
SNC-EQ5	555,824	$1,112,000
SNC-EQ6	169,884	$340,000
SNC-EQ7	453,023	$906,000
SNC-EQ8	980,098	$1,960,000
SNC-C-1	6'x12'	$250,000
SNC-C-2	8'x12'	$300,000
SNC-C-3	6'x12'	$250,000
SNC-C-4	6'x12'	$250,000
Total		$10,909,000

Recommended Storm Sewer Improvements

Storm Sewer Improvements
- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements

Culvert Improvements
- High Priority Improvements

EQ Basins
- EQ Basins Outside of Watershed
- High Priority EQ Basin
- Low Priority EQ Basin
- Storm Sewer Gravity Main
- Drains

N

0 2,000
Feet
1" = 1,700'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

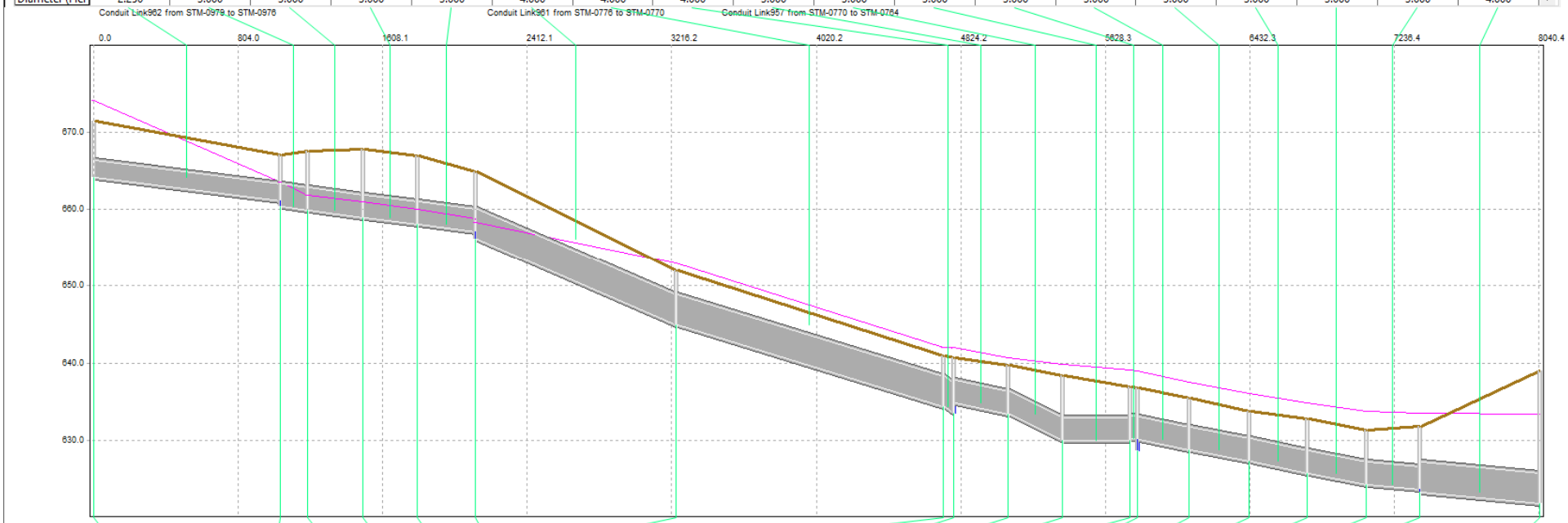
OHM

Project SNC-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	Link962	STG-0671	STG-0670	STG-0669	STG-0668	Link961	Link957	STG-0880	STG-0887	STG-0888	STG-0890	STG-0893	STG-0894	STG-0907	STG-0906	STG-0905	STG-0902	STG-1134
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	664.210	660.340	659.870	658.970	658.070	656.080	644.970	634.400	634.900	633.430	630.030	630.310	630.100	628.800	627.290	625.780	624.270	623.400
Downstream I	661.090	659.870	658.970	658.070	657.080	644.970	634.400	633.570	633.430	630.030	630.030	630.100	628.800	627.290	625.780	624.270	623.710	621.870
Roughness	0.014	0.013	0.013	0.013	0.013	0.014	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.250	3.000	3.000	3.000	3.000	4.000	4.000	4.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000



	STM-0979	STM-0979	STM-0979	STM-0976	STM-0975	STM-0974	STM-0973	STM-0776	STM-0770	STM-0770	STM-0770	STM-0764	STM-0764	STM-0764	STM-0765	STM-0773	STM-0772	STM-0761	STM-0760	STM-0758	STM-0756	STM-0754	STM-0752	STM-0423	STM-0423	STM-0423	Node1250
Storm	10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H
Subcatchment	1	2	3						1	2	3	1	2	3										1	2	3	
Ponding Type	Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe
Ground Elevati	671.400			667.100	667.500	667.800	666.900	664.900	652.000			641.000			640.700	639.700	638.400	636.900	636.800	635.500	633.800	632.800	631.400	631.900			638.949
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.005	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000

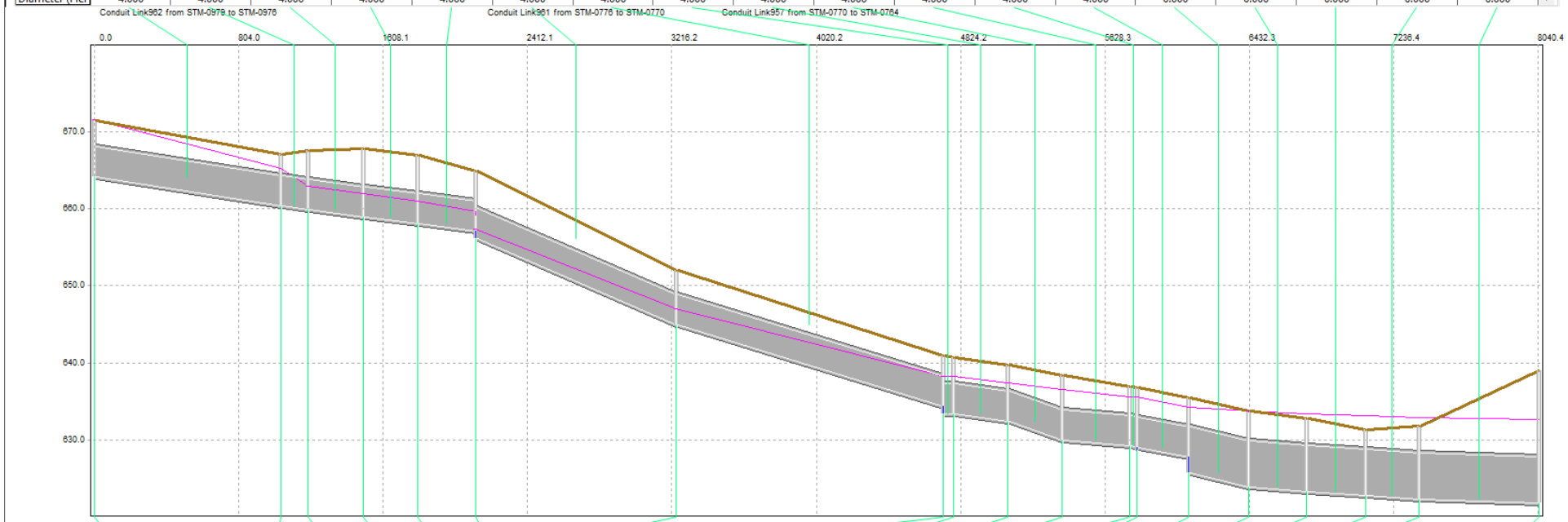
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	Link962	STG-0671	STG-0670	STG-0669	STG-0668	Link961	Link957	STG-0880	STG-0887	STG-0888	STG-0890	STG-0893	STG-0894	STG-0907	STG-0906	STG-0905	STG-0902	STG-1134
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	664.210	660.340	659.870	658.970	658.070	656.080	644.970	633.400	633.400	632.430	630.030	629.310	629.100	625.800	624.000	623.400	622.800	622.400
Downstream I	660.340	659.870	658.970	658.070	657.080	644.970	634.400	633.400	632.430	630.030	629.310	629.100	627.800	624.000	623.400	622.800	622.400	621.870
Roughness	0.014	0.013	0.013	0.013	0.013	0.014	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	6.000	6.000	6.000	6.000	6.000



	STM-0979	STM-0979	STM-0979	STM-0976	STM-0975	STM-0974	STM-0973	STM-0776	STM-0770	STM-0770	STM-0770	STM-0764	STM-0764	STM-0764	STM-0765	STM-0773	STM-0772	STM-0761	STM-0760	STM-0758	STM-0756	STM-0754	STM-0752	STM-0423	STM-0423	STM-0423	Node1250
Storm	10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H
Subcatchment	1	2	3						1	2	3	1	2	3										1	2	3	
Ponding Type	Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe
Ground Elevati	671.400			667.100	667.500	667.800	666.900	664.900	652.000			641.000			640.700	639.700	638.400	636.900	636.800	635.500	633.800	632.800	631.400	631.900			638.949
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.005	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000

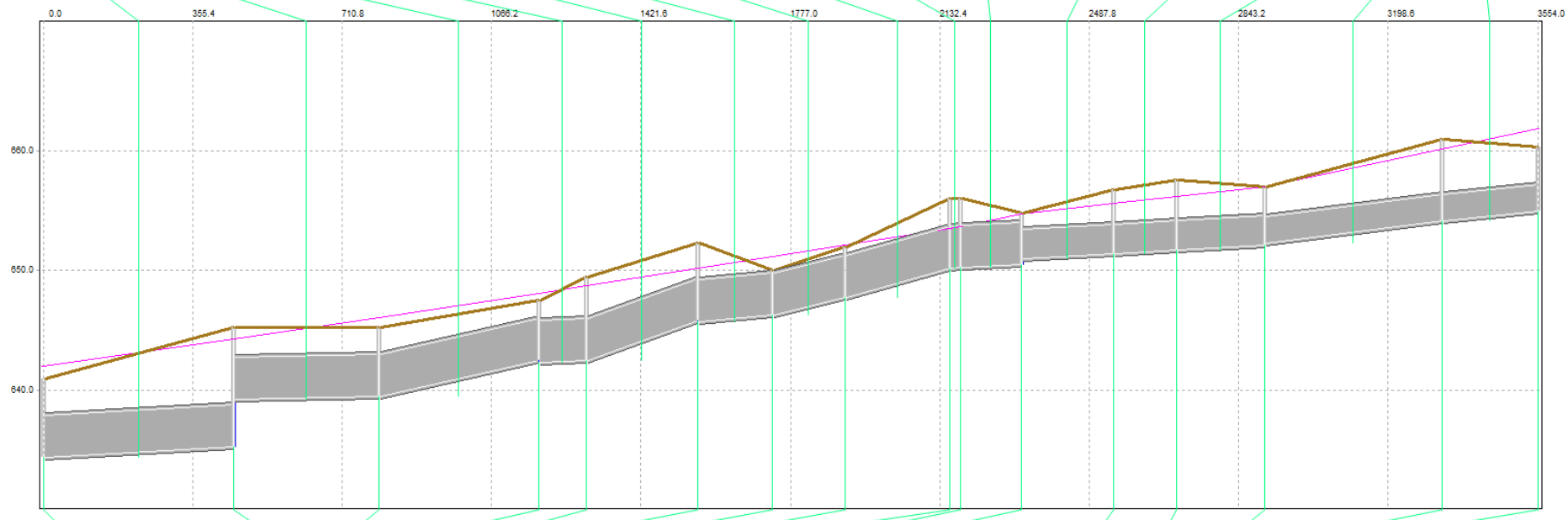
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-2: Existing (downstream – upstream)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0885	7627	STG-1017	STG-1028	STG-1018	STG-1027	STG-1026	STG-1025	STG-0764	STG-0763	STG-0761	STG-0762	STG-0754	STG-0755	STG-0756
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	635.310	639.550	642.500	642.500	645.800	646.300	647.800	650.200	650.280	650.500	651.430	651.730	652.150	654.200	655.000
Downstream I	634.400	639.310	639.550	642.350	642.500	645.750	646.300	647.800	650.200	650.280	651.000	651.430	651.730	652.340	654.200
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	2.500	2.500	2.500	2.250	2.250



	STM-0764	STM-0764	STM-0764	STM-0961	STM-0962	STM-0963	STM-1039	STM-0599	STM-1040	STM-1041	STM-0964	STM-0593	STM-0595	STM-0595	STM-0595	STM-0598	STM-0600	STM-0601	STM-0602	STM-0603	STM-0603	STM-0603
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3										1	2	3					1	2	3
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevat	641.000			645.300	645.300	647.500	649.500	652.300	650.000	652.000	656.000	656.000	654.800			656.800	657.600	657.000	661.000	660.300		
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.008	0.008	0.008
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

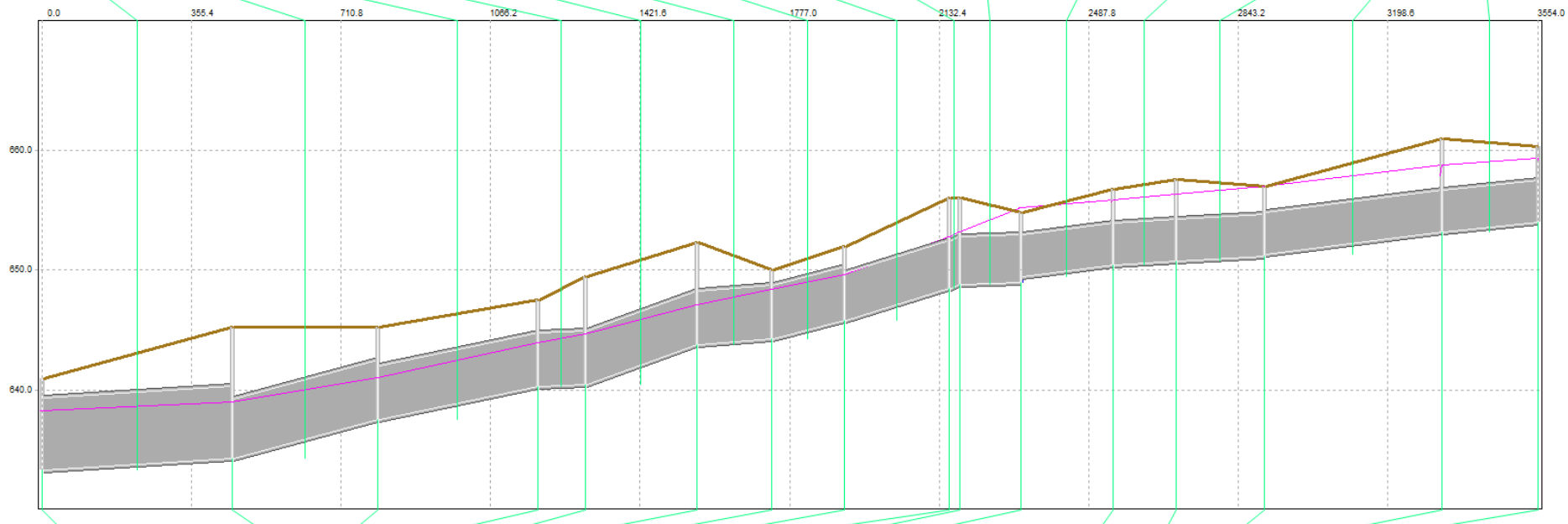
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-2: Proposed (downstream – upstream)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0885	7627	STG-1017	STG-1028	STG-1018	STG-1027	STG-1026	STG-1025	STG-0764	STG-0763	STG-0761	STG-0762	STG-0754	STG-0755	STG-0756
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	634.310	637.550	640.350	640.500	643.800	644.300	645.800	648.500	648.800	649.000	650.430	650.730	651.150	653.200	654.000
Downstream I	633.400	634.310	637.550	640.350	640.500	643.800	644.300	645.800	648.500	648.800	649.500	650.430	650.730	651.340	653.200
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	6.000	5.000	4.500	4.500	4.500	4.500	4.500	4.000	4.000	4.000	3.500	3.500	3.500	3.500	3.500



	STM-0764	STM-0764	STM-0764	STM-0961	STM-0962	STM-0963	STM-1039	STM-0599	STM-1040	STM-1041	STM-0964	STM-0593	STM-0595	STM-0595	STM-0595	STM-0598	STM-0600	STM-0601	STM-0602	STM-0603	STM-0603	STM-0603
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3										1	2	3					1	2	3
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevat	641.000			645.300	645.300	647.500	649.500	652.300	650.000	652.000	656.000	656.000	654.800			656.800	657.600	657.000	661.000	660.300		
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.008	0.008	0.008
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

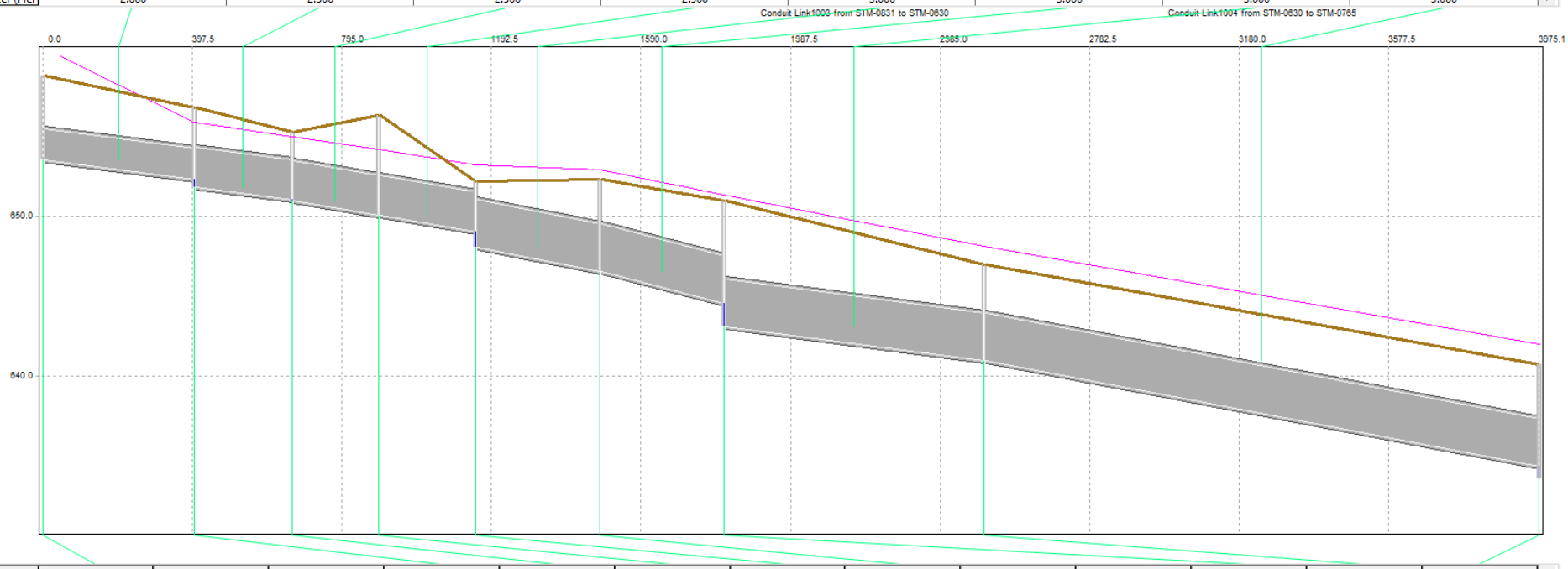
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-3: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0585	STG-0586	STG-0587	STG-0588	STG-0589	STG-0590	Link1003	Link1004
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	653.550	651.830	651.000	650.060	648.050	646.520	643.060	640.970
Downstream I	652.330	651.040	650.060	649.020	646.520	644.540	640.970	634.370
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.500	2.500	2.500	3.000	3.000	3.000	3.000



	STM-0610	STM-0610	STM-0610	STM-0609	STM-0830	STM-0608	STM-0607	STM-0606	STM-0606	STM-0606	STM-0831	STM-0630	STM-0765
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3					1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevati	658.800			656.800	655.300	656.300	652.200	652.300			651.000	647.000	640.700
Slope	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.009	0.009	0.009	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

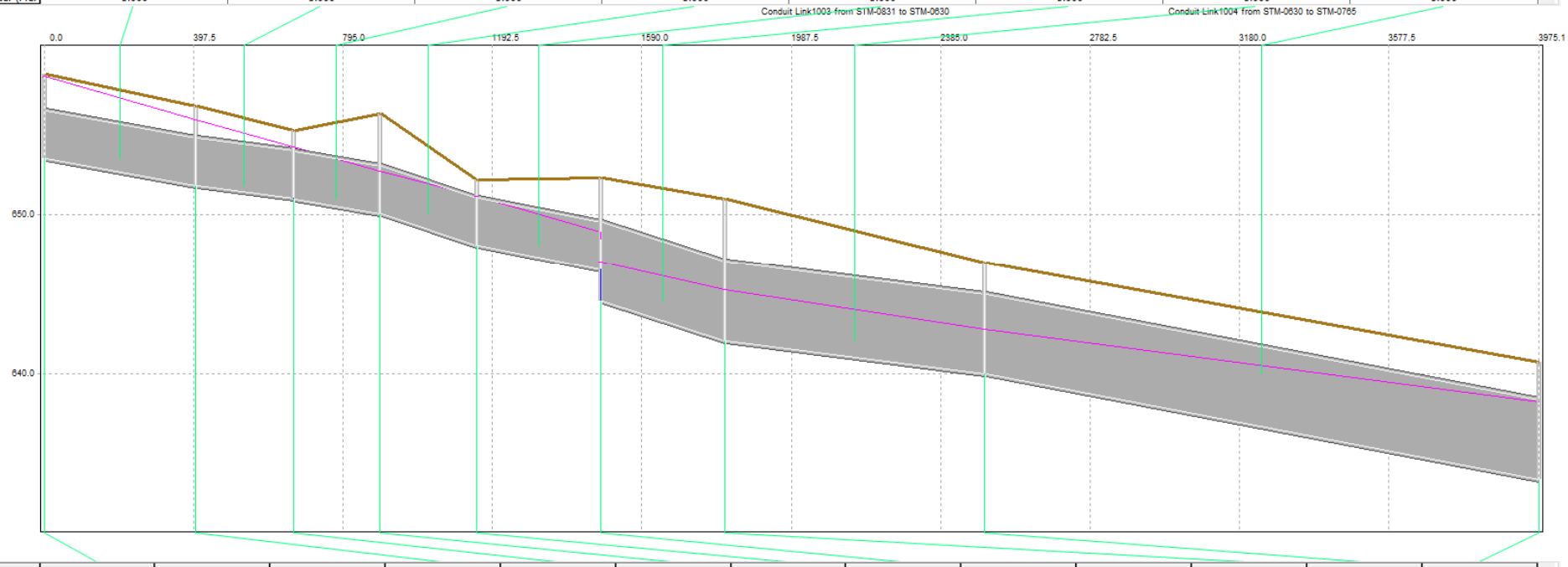
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-3: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0585	STG-0586	STG-0587	STG-0588	STG-0589	STG-0590	Link1003	Link1004
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	653.550	651.830	651.000	650.060	648.050	644.520	642.060	639.970
Downstream I	651.830	651.040	650.060	648.050	646.520	642.060	639.970	633.370
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	5.000	5.000	5.000



	STM-0610	STM-0610	STM-0610	STM-0609	STM-0830	STM-0608	STM-0607	STM-0606	STM-0606	STM-0606	STM-0831	STM-0630	STM-0765
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3					1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevati	658.800			656.800	655.300	656.300	652.200	652.300			651.000	647.000	640.700
Slope	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.009	0.009	0.009	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

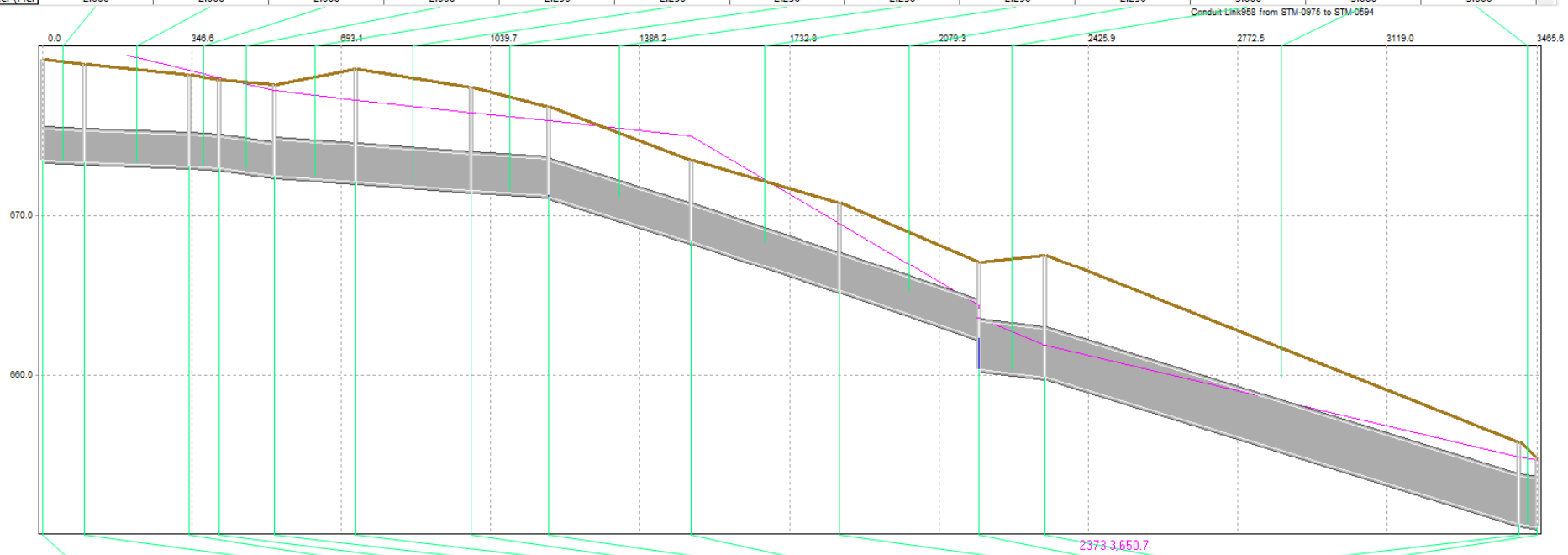
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-4: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0678	STG-0679	STG-0680	STG-0681	STG-0682	STG-0683	STG-0684	STG-0677	STG-0676	STG-0675	STG-0671	Link958	STG-0760
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	673.500	673.380	673.090	672.990	672.500	672.120	671.590	671.190	668.350	665.290	660.340	659.870	650.680
Downstream I	673.380	673.090	672.990	672.500	672.120	671.590	671.290	668.350	665.290	662.300	659.870	650.680	650.500
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.250	2.250	2.250	2.250	2.250	2.250	3.000	3.000	3.000



	STM-0623	STM-0623	STM-0623	STM-0965	STM-0622	STM-0839	STM-0621	STM-0966	STM-0850	STM-0619	STM-0620	STM-0620	STM-0620	STM-0670	STM-0976	STM-0975	STM-0594	STM-0595	STM-0595	STM-0595
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3								1	2	3					1	2	3
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevati	679.800			679.500	678.800	678.500	678.200	679.200	678.000	676.800	673.500			670.800	667.100	667.500	655.800	654.800		
Slope	0.005	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.005	0.000	0.000	0.000	0.000	0.008	0.008	0.008
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

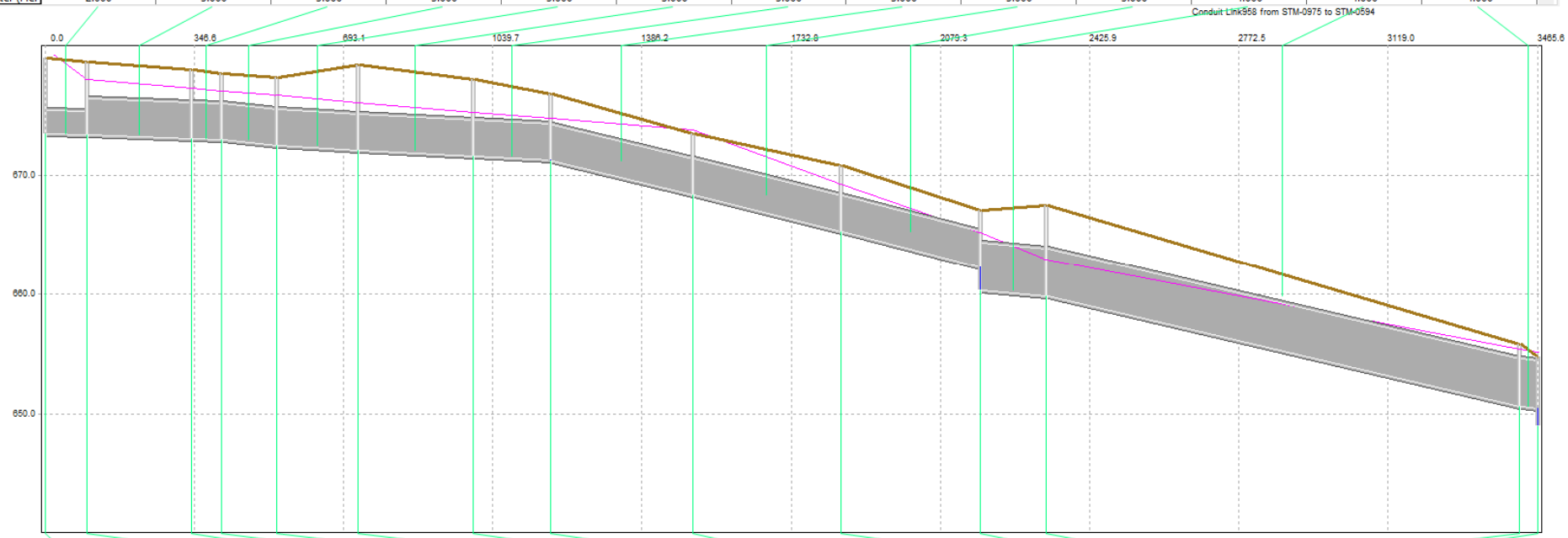
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-4: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0678	STG-0679	STG-0680	STG-0681	STG-0682	STG-0683	STG-0684	STG-0677	STG-0676	STG-0675	STG-0671	Link958	STG-0760
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	673.500	673.380	673.090	672.990	672.500	672.120	671.590	671.190	668.350	665.290	660.340	659.870	650.680
Downstream I	673.380	673.090	672.990	672.500	672.120	671.590	671.290	668.350	665.290	662.300	659.870	650.680	650.500
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000	4.000	4.000



	STM-0623	STM-0623	STM-0623	STM-0965	STM-0622	STM-0839	STM-0621	STM-0966	STM-0850	STM-0619	STM-0620	STM-0620	STM-0620	STM-0670	STM-0976	STM-0975	STM-0594	STM-0595	STM-0595	STM-0595
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3								1	2	3					1	2	3
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevati	679.800			679.500	678.800	678.500	678.200	679.200	678.000	676.800	673.500			670.800	667.100	667.500	655.800	654.800		
Slope	0.005	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.005	0.000	0.000	0.000	0.000	0.008	0.008	0.008
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

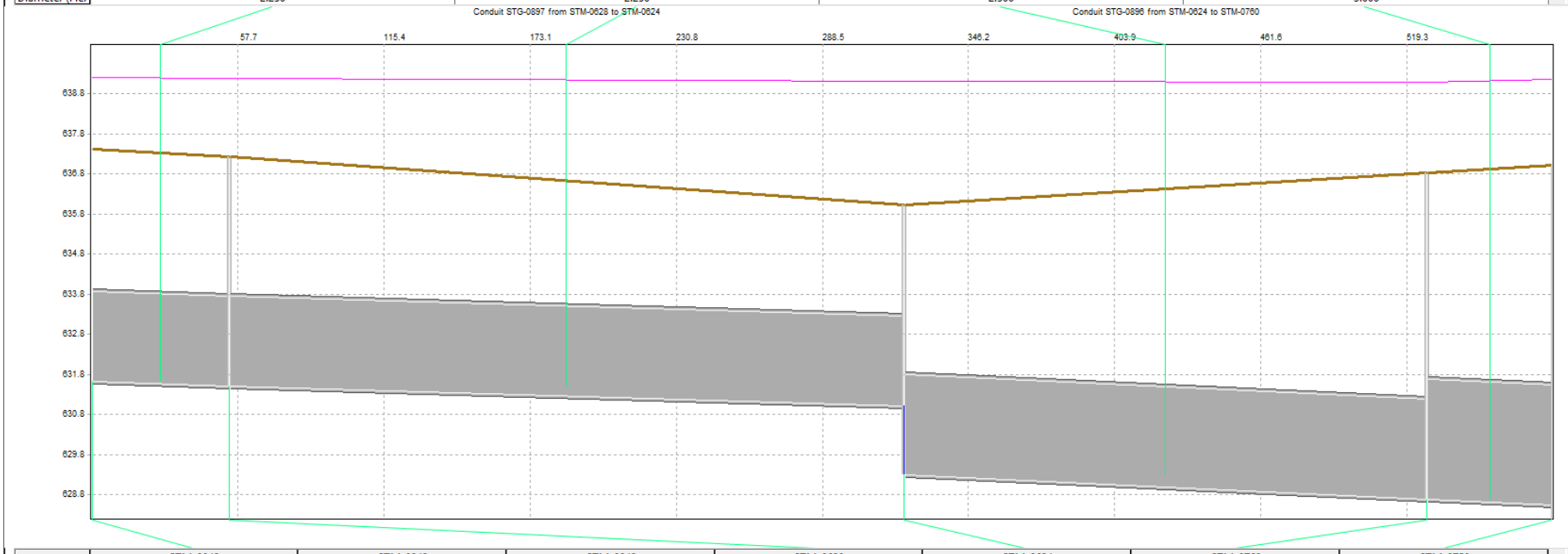
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-5: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0898	STG-0897	STG-0896	STG-0892
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	631.600	631.500	629.290	628.670
Downstream I	631.500	631.000	628.670	628.520
Roughness	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular
Diameter (Hei	2.250	2.250	2.500	3.000



	STM-0842	STM-0842	STM-0842	STM-0628	STM-0624	STM-0760	STM-0759
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3				
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	637.400			637.200	636.000	636.800	637.000
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000

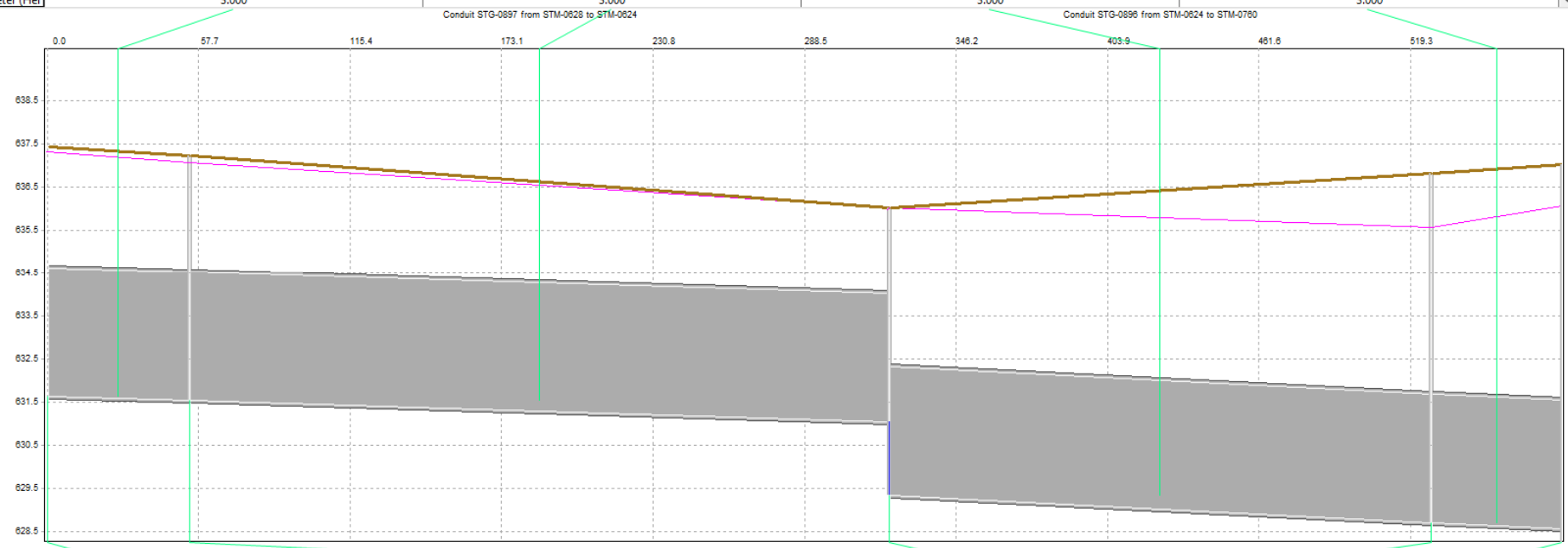
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-5: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0898	STG-0897	STG-0896	STG-0892
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	631.600	631.500	629.290	628.670
Downstream I	631.500	631.000	628.670	628.520
Roughness	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000



	STM-0842	STM-0842	STM-0842	STM-0628	STM-0624	STM-0760	STM-0759
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3				
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	637.400			637.200	636.000	636.800	637.000
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000

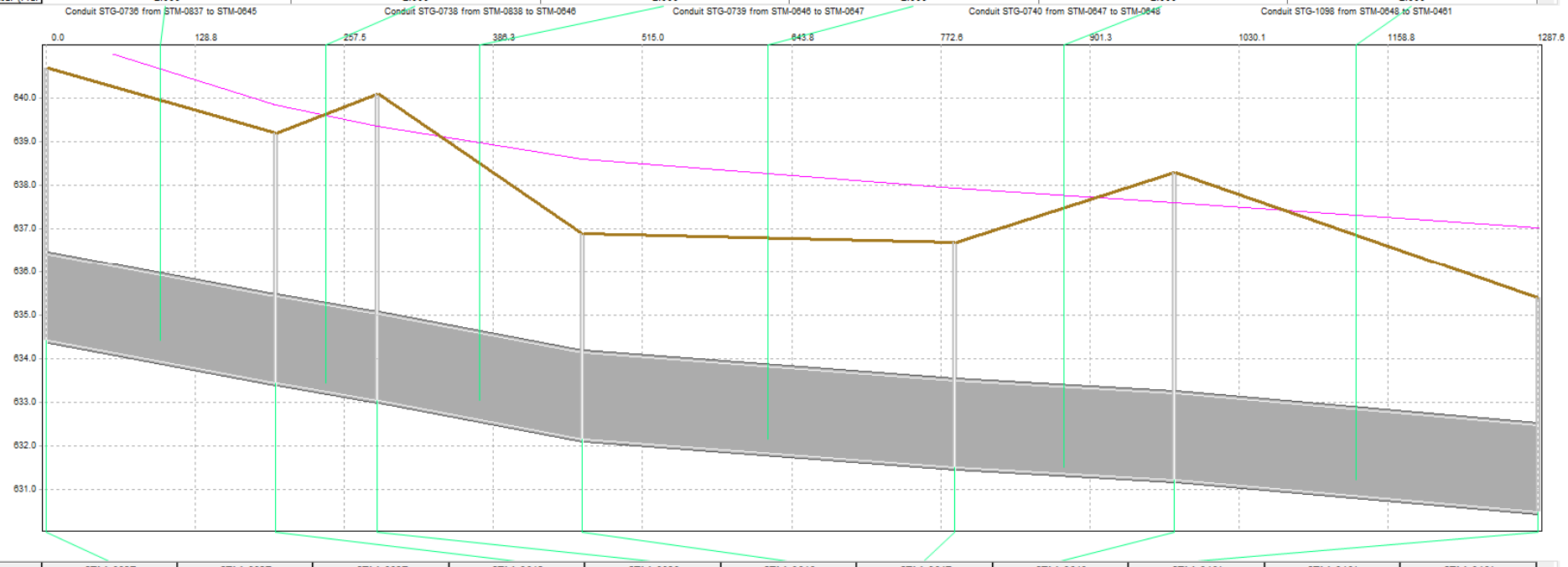
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-6: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0736	STG-0737	STG-0738	STG-0739	STG-0740	STG-1098
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	634.430	633.450	633.040	632.150	631.510	631.210
Downstream I	633.450	633.040	632.150	631.510	631.210	630.480
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.000



	STM-0837	STM-0837	STM-0837	STM-0645	STM-0838	STM-0646	STM-0647	STM-0648	STM-0461	STM-0461	STM-0461
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3						1	2	3
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevati	640.700			639.200	640.100	636.900	636.700	638.300	635.400		
Slope	0.012	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.009
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

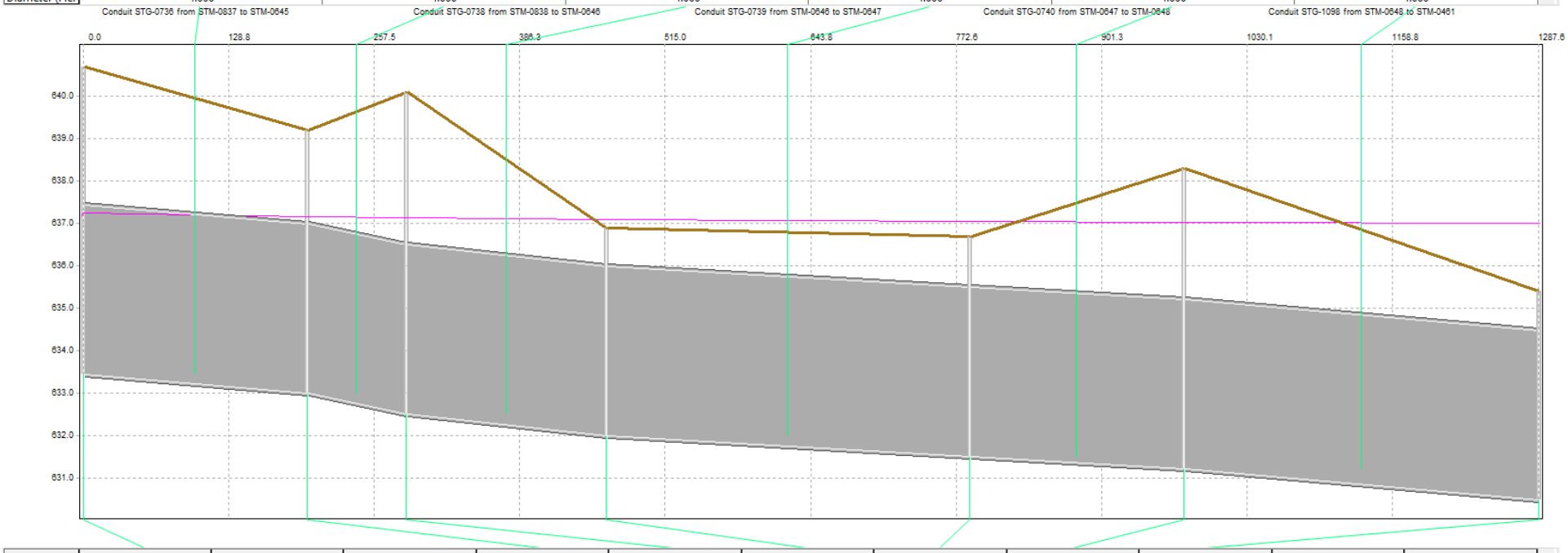
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-6: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0736	STG-0737	STG-0738	STG-0739	STG-0740	STG-1098
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	633.430	633.000	632.500	632.000	631.510	631.210
Downstream I	633.000	632.500	632.000	631.510	631.210	630.480
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000



	STM-0837	STM-0837	STM-0837	STM-0645	STM-0838	STM-0646	STM-0647	STM-0648	STM-0461	STM-0461	STM-0461
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3						1	2	3
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed		
Ground Elevati	640.700			639.200	640.100	636.900	636.700	638.300	635.400		
Slope	0.012	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.009
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000

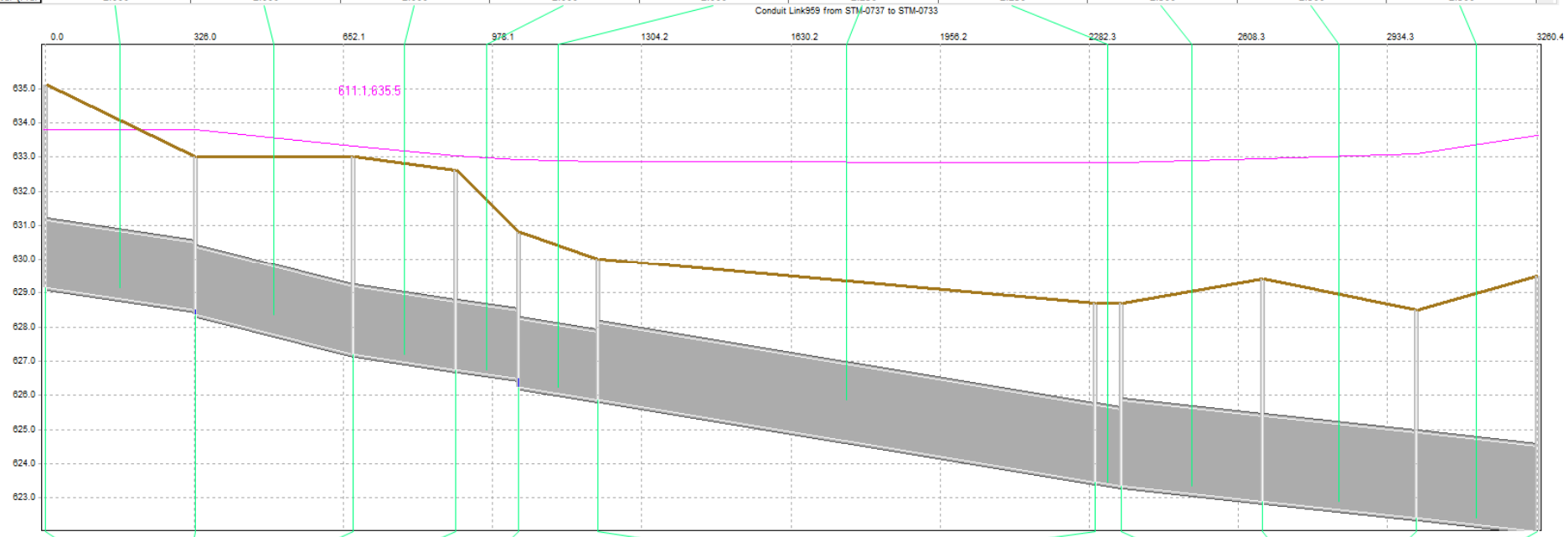
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-7: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0741	STG-0643	STG-0644	STG-0645	STG-0646	Link959	STG-0651	STG-0653	STG-0652	STG-1266
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	629.170	628.350	627.210	626.760	626.240	625.860	623.470	623.340	622.900	622.400
Downstream I	628.500	627.210	626.760	626.490	625.860	623.470	623.340	622.900	622.400	622.000
Roughness	0.013	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.250	2.250	2.500	2.500	2.500



	STM-0650	STM-0459	STM-0740	STM-0739	STM-0738	STM-0738	STM-0738	STM-0737	STM-0733	STM-0733	STM-0733	STM-0732	STM-0731	STM-1250	UNKNOWN_2
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment					1	2	3		1	2	3				
Ponding Type	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	635.100	633.000	633.000	632.600	630.800			630.000	628.700			628.700	629.400	628.500	629.500
Slope	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000
Impervious Pe	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

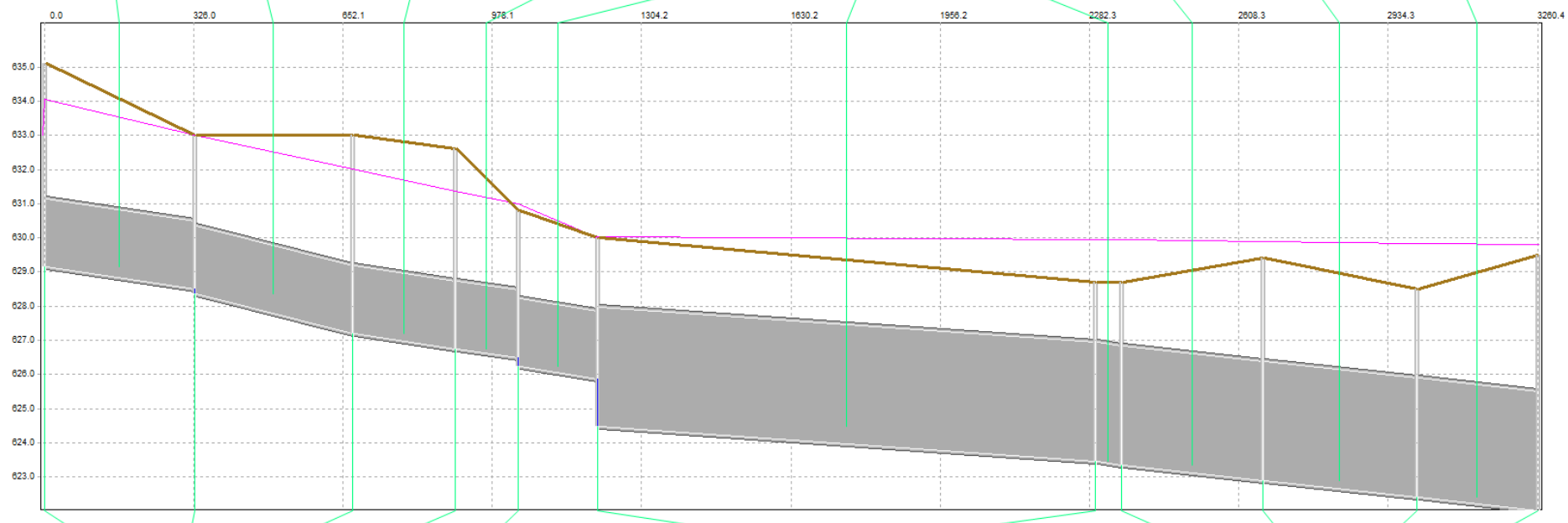
Project SNC-7: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0741	STG-0643	STG-0644	STG-0645	STG-0646	Link959	STG-0651	STG-0653	STG-0652	STG-1266
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	629.170	628.350	627.210	626.760	626.240	624.470	623.470	623.340	622.900	622.400
Downstream I	628.500	627.210	626.760	626.490	625.860	623.470	623.340	622.900	622.400	622.000
Roughness	0.013	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	3.500	3.500	3.500	3.500	3.500

Conduit Link959 from STM-0737 to STM-0733



	STM-0650	STM-0459	STM-0740	STM-0739	STM-0738	STM-0738	STM-0738	STM-0737	STM-0733	STM-0733	STM-0733	STM-0732	STM-0731	STM-1250	UNKNOWN_2
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment					1	2	3		1	2	3				
Ponding Type	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevat	635.100	633.000	633.000	632.600	630.800			630.000	628.700			628.700	629.400	628.500	629.500
Slope	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000
Impervious Pe	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

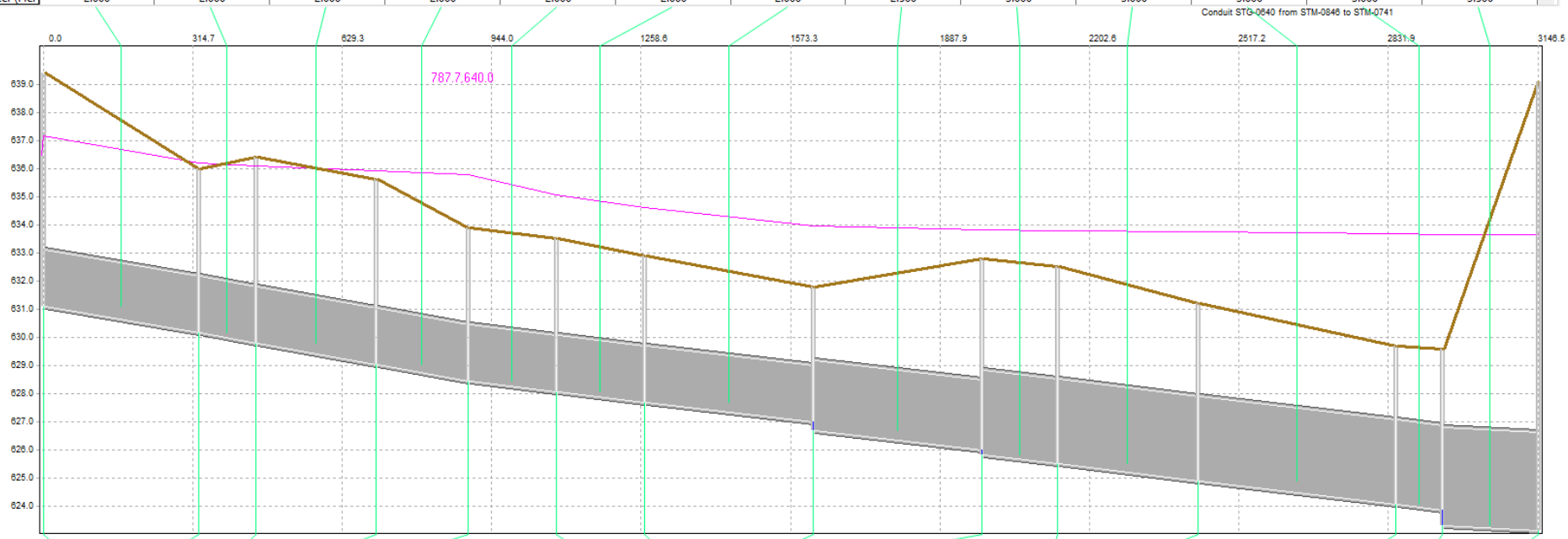
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-8: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0637	STG-0636	STG-0635	STG-0634	STG-0633	STG-0632	STG-0631	STG-0630	STG-0638	STG-0639	STG-0640	STG-0641	STG-0642
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	631.110	630.160	629.780	629.030	628.440	628.070	627.700	626.710	625.840	625.520	624.920	624.100	623.320
Downstream I	630.160	629.780	629.030	628.440	628.070	627.700	627.000	626.000	625.520	624.920	624.100	623.870	623.140
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	3.000	3.000	3.000	3.000	3.500



	STM-0464	STM-0660	STM-0843	STM-0659	STM-0658	STM-0658	STM-0658	STM-0657	STM-0656	STM-0844	STM-0661	STM-0661	STM-0661	STM-0845	STM-0846	STM-0846	STM-0846	STM-0741	STM-0998	Node1166
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment					1	2	3				1	2	3		1	2	3			
Ponding Type	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevati	639.400	636.000	636.400	635.600	633.900			633.500	632.900	631.800	632.800			632.500	631.200			629.700	629.600	639.092
Slope	0.000	0.000	0.000	0.000	0.011	0.011	0.011	0.000	0.000	0.000	0.006	0.006	0.006	0.000	0.011	0.011	0.011	0.000	0.000	0.000
Impervious Pe	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

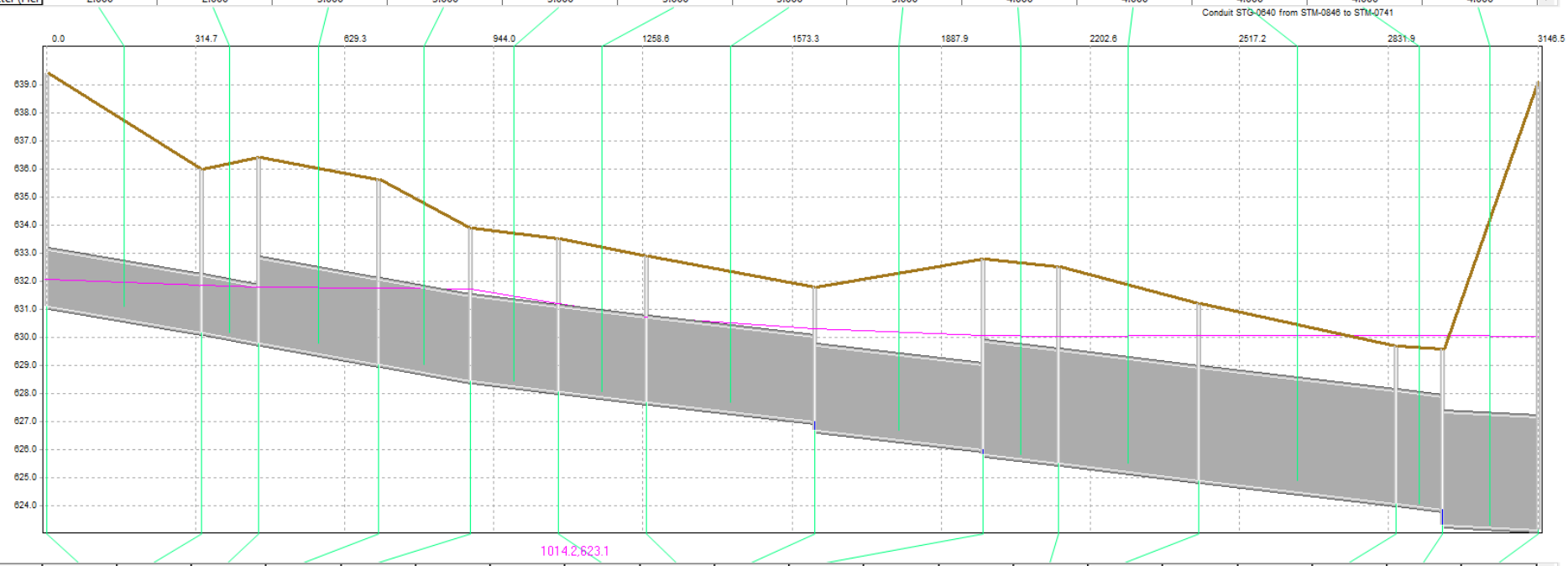
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-8: Proposed (includes storage)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0637	STG-0636	STG-0635	STG-0634	STG-0633	STG-0632	STG-0631	STG-0630	STG-0638	STG-0639	STG-0640	STG-0641	STG-0642
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	631.110	630.160	629.780	629.030	628.440	628.070	627.700	626.710	625.840	625.520	624.920	624.100	623.320
Downstream I	630.160	629.780	629.030	628.440	628.070	627.700	627.000	626.000	625.520	624.920	624.100	623.870	623.140
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Diameter (Hei	2.000	2.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000	4.000	4.000	4.000	4.000



	STM-0464	STM-0660	STM-0843	STM-0659	STM-0658	STM-0658	STM-0658	STM-0657	STM-0656	STM-0844	STM-0661	STM-0661	STM-0661	STM-0845	STM-0846	STM-0846	STM-0846	STM-0741	STM-0998	Node1166
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment					1	2	3				1	2	3		1	2	3			
Ponding Type	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevat	639.400	636.000	636.400	635.600	633.900			633.500	632.900	631.800	632.800			632.500	631.200			629.700	629.600	639.092
Slope	0.000	0.000	0.000	0.000	0.011	0.011	0.011	0.000	0.000	0.000	0.006	0.006	0.006	0.000	0.011	0.011	0.011	0.000	0.000	0.000
Impervious Pe	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

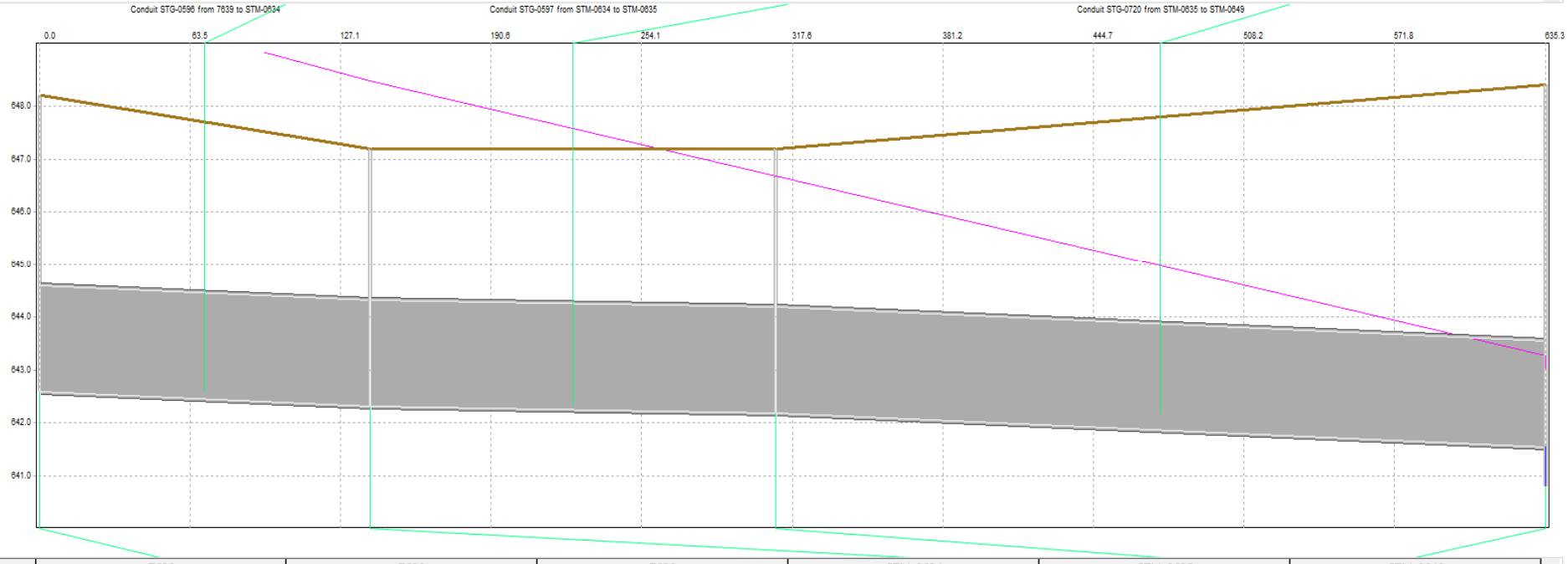
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-9: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0596	STG-0597	STG-0720
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Shape	Circular	Circular	Circular
Diameter (	2.000	2.000	2.000
Length	139.600	170.940	324.740



	7639	7639	7639	STM-0634	STM-0635	STM-0649
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchm	1	2	3			
Ponding Ty	Allowed			Allowed	Allowed	Allowed
Ground Ele	648.200			647.200	647.200	648.400
Slope	0.015	0.015	0.015	0.000	0.000	0.000

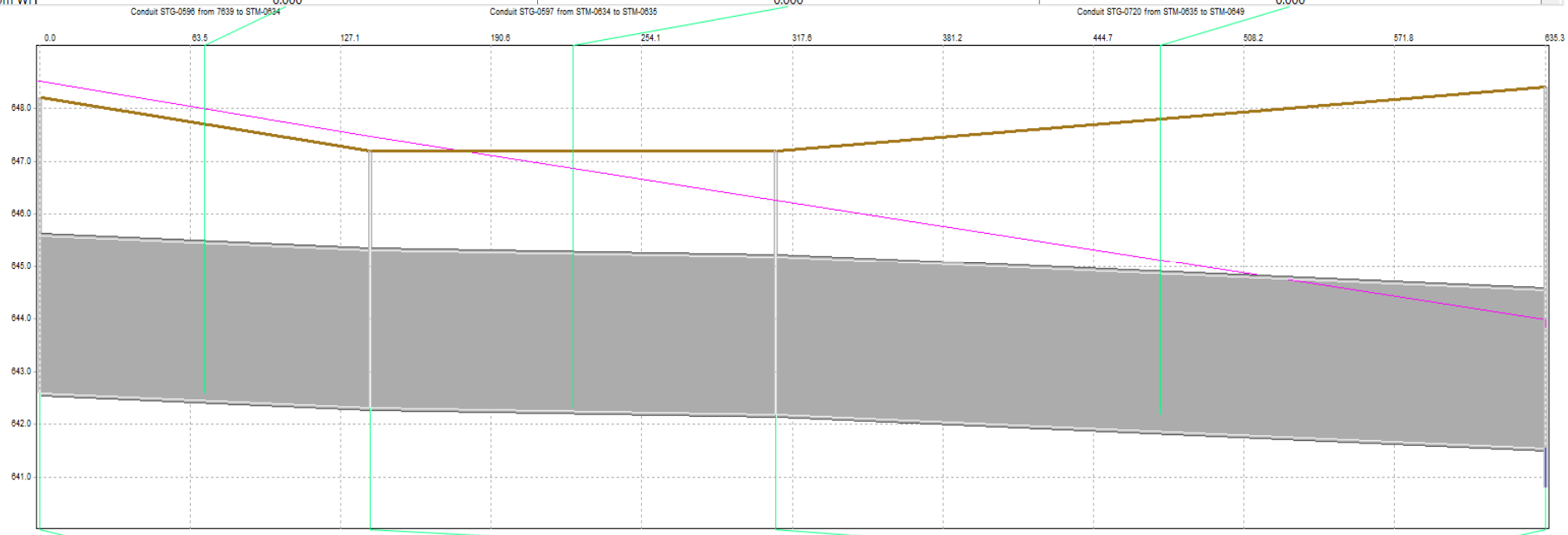
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-9: Proposed (includes storage)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0596	STG-0597	STG-0720
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Roughness	0.013	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (	3.000	3.000	3.000
Bottom Wi	0.000	0.000	0.000



	7639	7639	7639	STM-0634	STM-0635	STM-0649
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchm	1	2	3			
Ponding Ty	Allowed			Allowed	Allowed	Allowed
Ground Ele	648.200			647.200	647.200	648.400
Slope	0.015	0.015	0.015	0.000	0.000	0.000

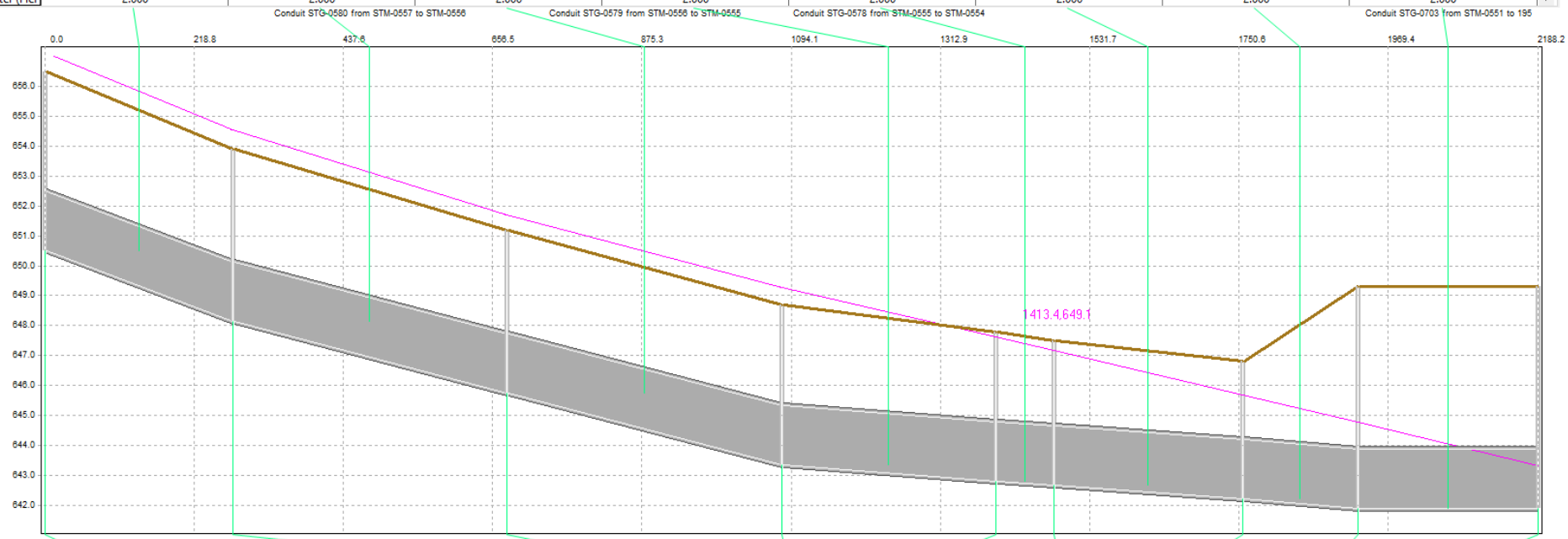
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-10: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0581	STG-0580	STG-0579	STG-0578	STG-0577	STG-0576	STG-0575	STG-0703
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	650.520	648.140	645.740	643.340	642.800	642.660	642.200	641.900
Downstream I	648.140	645.740	643.340	642.800	642.660	642.200	641.900	641.900
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000



	STM-0558	STM-0558	STM-0558	STM-0557	STM-0556	STM-0555	STM-0554	STM-0553	STM-0552	STM-0551	195
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3								
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	656.500			653.900	651.200	648.700	647.800	647.500	646.800	649.300	649.300
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

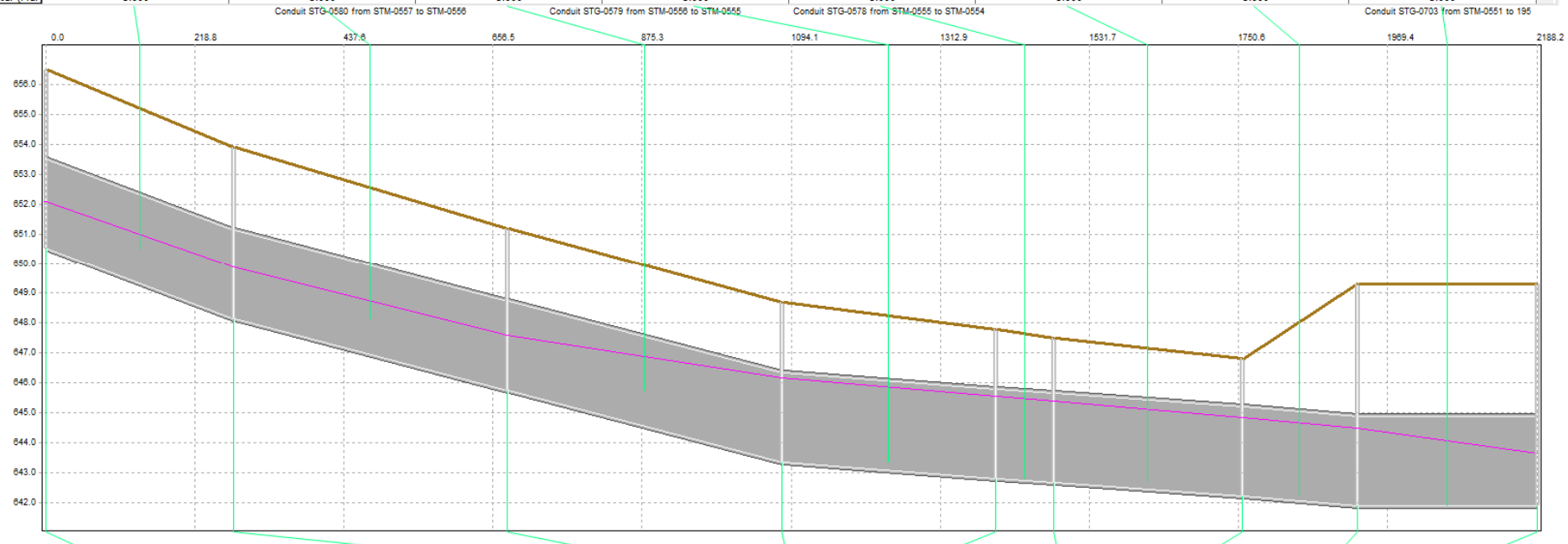
Manhole Parameters | Runoff Info | MH duration and depth

Project SNC-10: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0581	STG-0580	STG-0579	STG-0578	STG-0577	STG-0576	STG-0575	STG-0703
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	650.520	648.140	645.740	643.340	642.800	642.660	642.200	641.900
Downstream I	648.140	645.740	643.340	642.800	642.660	642.200	641.900	641.900
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000



	STM-0558	STM-0558	STM-0558	STM-0557	STM-0556	STM-0555	STM-0554	STM-0553	STM-0552	STM-0551	195
Storm	10-year SCS			10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Subcatchment	1	2	3								
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	656.500			653.900	651.200	648.700	647.800	647.500	646.800	649.300	649.300
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

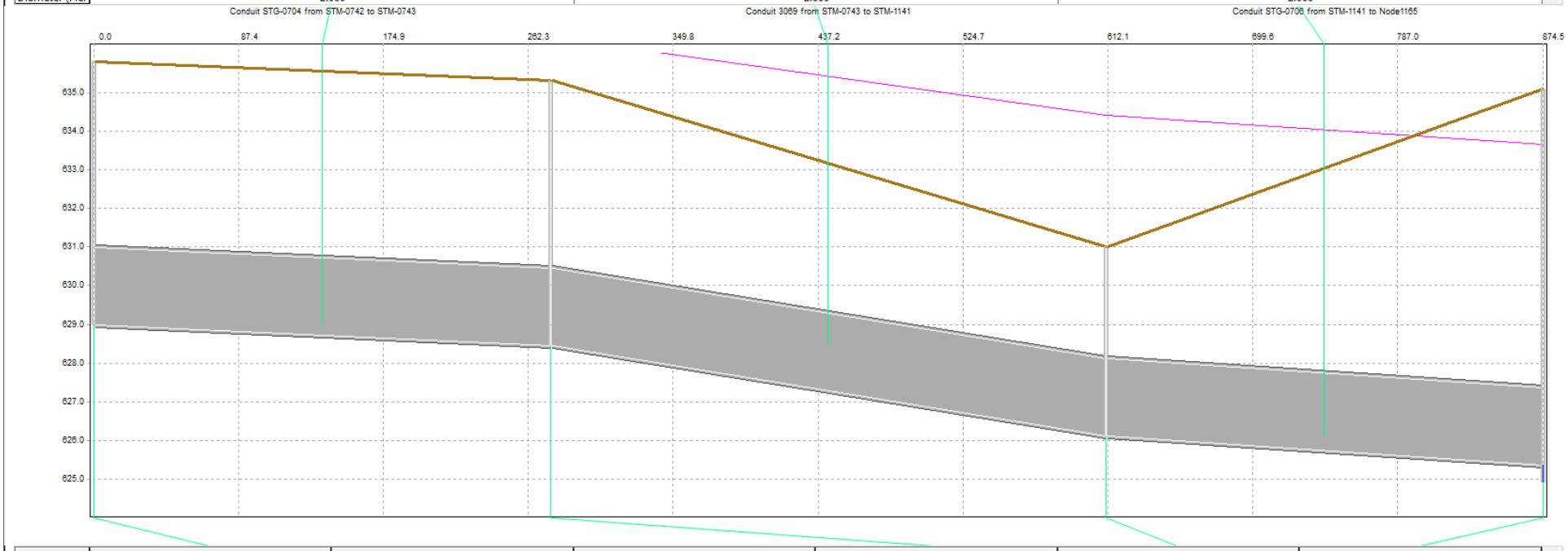
Manhole Parameters | Runoff Info | MH duration and depth

Project SNC-11: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0704	3069	STG-0706
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	629.000	628.460	626.120
Downstream I	628.460	626.120	625.370
Roughness	0.013	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000



	STM-0742	STM-0742	STM-0742	STM-0743	STM-1141	Node1165
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed
Ground Elevati	635.800			635.300	631.000	635.082
Slope	0.006	0.006	0.006	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000

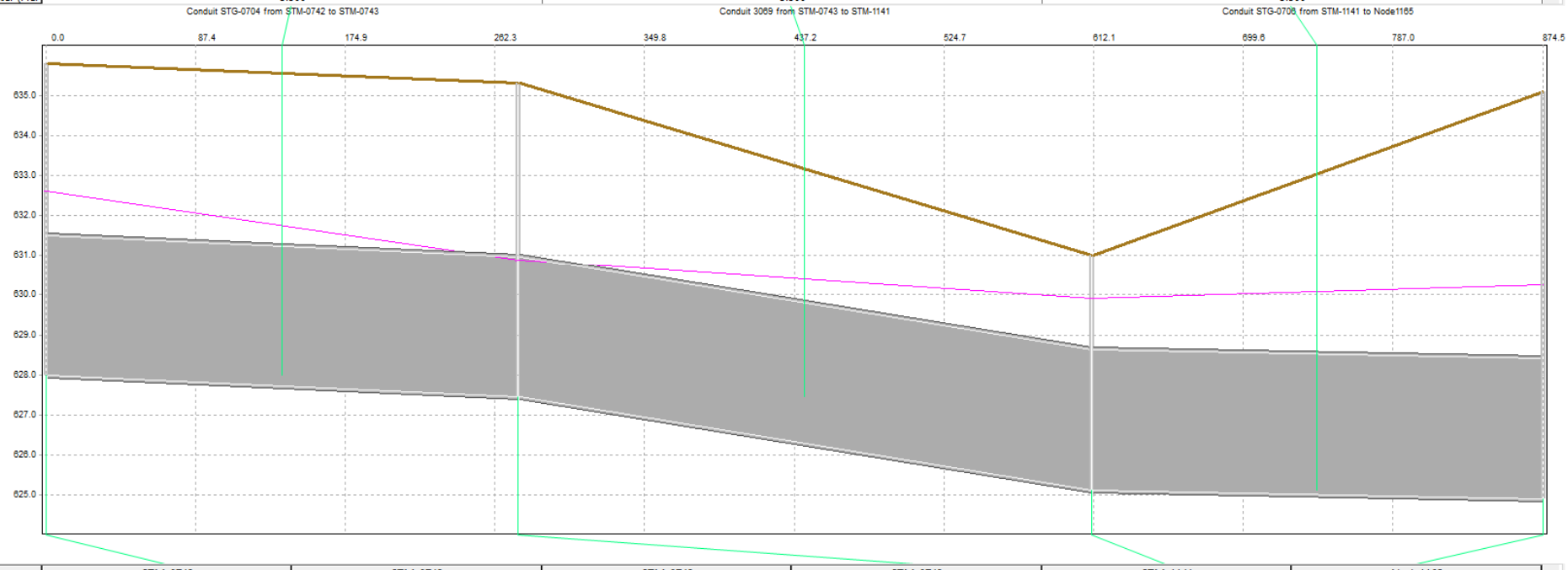
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-11: Proposed (includes storage)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0704	3069	STG-0706
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	628.000	627.460	625.120
Downstream I	627.460	625.120	624.911
Roughness	0.013	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500



	STM-0742	STM-0742	STM-0742	STM-0743	STM-1141	Node1165
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed
Ground Elevat	635.800			635.300	631.000	635.082
Slope	0.006	0.006	0.006	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000

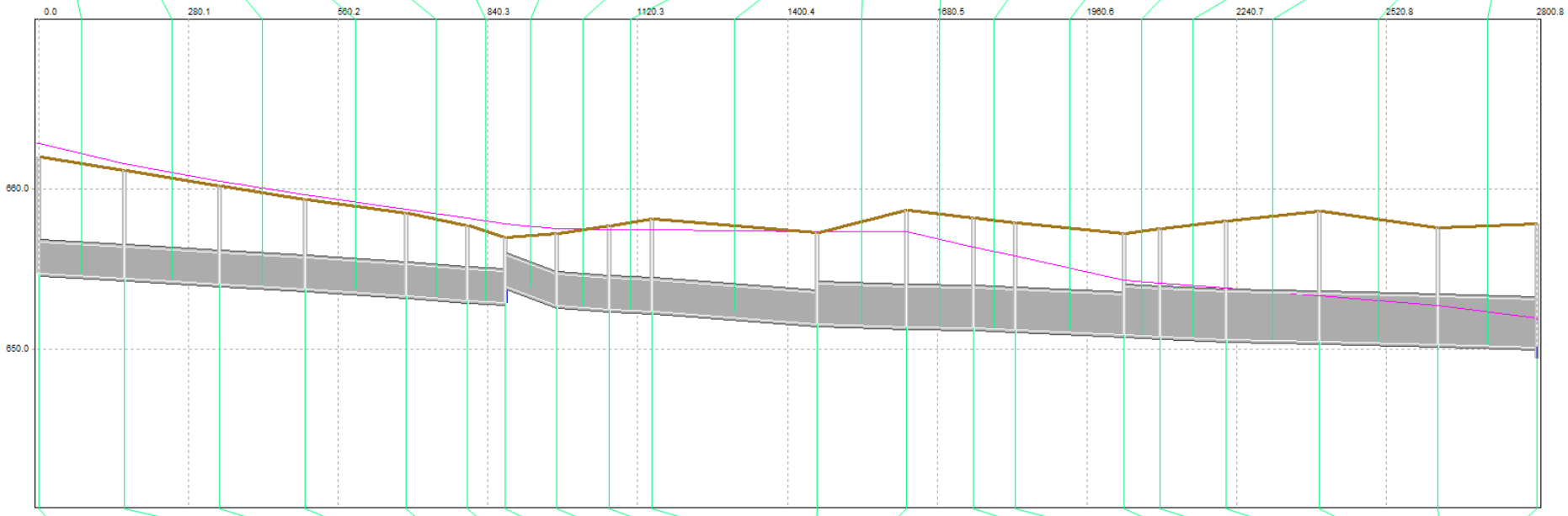
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-13: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1263	STG-1262	STG-1261	STG-1260	STG-1259	STG-1258	STG-1257	STG-1256	STG-1255	STG-1254	STG-1253	STG-0572	STG-0573	STG-0574	STG-0571	STG-1265	STG-1264	STG-0570	STG-0569
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	654.740	654.430	654.070	653.750	653.310	653.050	653.900	652.700	652.500	652.360	651.540	651.400	651.300	651.220	650.900	650.750	650.600	650.480	650.270
Downstream I	654.430	654.070	653.750	653.310	653.050	652.900	652.700	652.500	652.360	651.540	651.400	651.300	651.220	650.900	650.750	650.600	650.480	650.270	650.100
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	2.500	2.500	2.500	3.000	3.000	3.000	3.000	3.000



	STM-1246	STM-1246	STM-1246	STM-1245	STM-1244	STM-1247	STM-1243	STM-1242	STM-1173	STM-1240	STM-1235	STM-1236	STM-1237	STM-0481	STM-0481	STM-0481	STM-0482	STM-0483	STM-0484	STM-0485	STM-1248	STM-0486	STM-0487	STM-0480
Storm	10-year SC			10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS			10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS
Subcatchment	1	2	3											1	2	3								
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	662.000			661.140	660.200	659.320	658.500	657.700	657.000	657.200	657.700	658.100	657.300	658.700			658.200	657.900	657.200	657.500	658.000	658.600	657.600	657.800
Slope	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

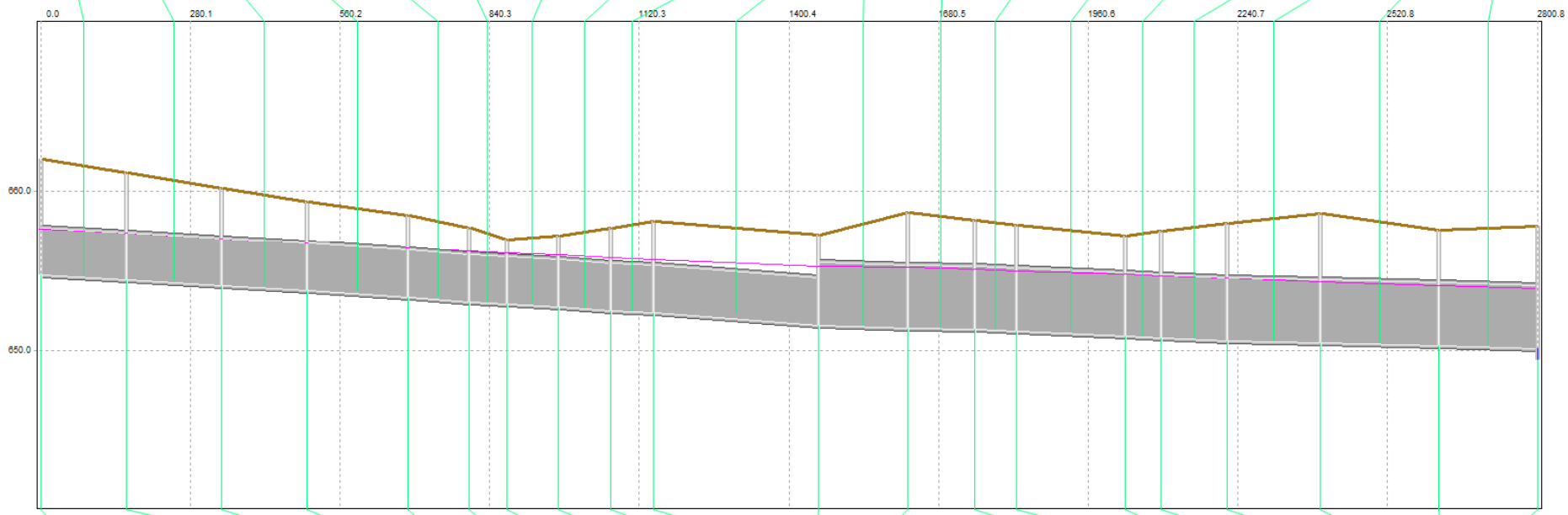
Manhole Parameters | Runoff Info | MH duration and depth

Project SNC-13: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1263	STG-1262	STG-1261	STG-1260	STG-1259	STG-1258	STG-1257	STG-1256	STG-1255	STG-1254	STG-1253	STG-0572	STG-0573	STG-0574	STG-0571	STG-1265	STG-1264	STG-0570	STG-0569
Storm	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS	10-year SCS
Upstream Inve	654.740	654.430	654.070	653.750	653.310	653.050	652.900	652.700	652.500	652.360	651.540	651.400	651.300	651.220	650.900	650.750	650.600	650.480	650.270
Downstream I	654.430	654.070	653.750	653.310	653.050	652.900	652.700	652.500	652.360	651.540	651.400	651.300	651.220	650.900	650.750	650.600	650.480	650.270	650.100
Roughness	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000



	STM-1246	STM-1246	STM-1246	STM-1245	STM-1244	STM-1247	STM-1243	STM-1242	STM-1173	STM-1240	STM-1235	STM-1236	STM-1237	STM-0481	STM-0481	STM-0481	STM-0482	STM-0483	STM-0484	STM-0485	STM-1248	STM-0486	STM-0487	STM-0480
Storm	10-year SC			10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS			10-year SC	10-year SC	10-year SCS	10-year SC	10-year SC	10-year SCS	10-year SC	10-year SCS
Subcatchment	1	2	3											1	2	3								
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevati	662.000			661.140	660.200	659.320	658.500	657.700	657.000	657.200	657.700	658.100	657.300	658.700			658.200	657.900	657.200	657.500	658.000	658.600	657.600	657.800
Slope	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

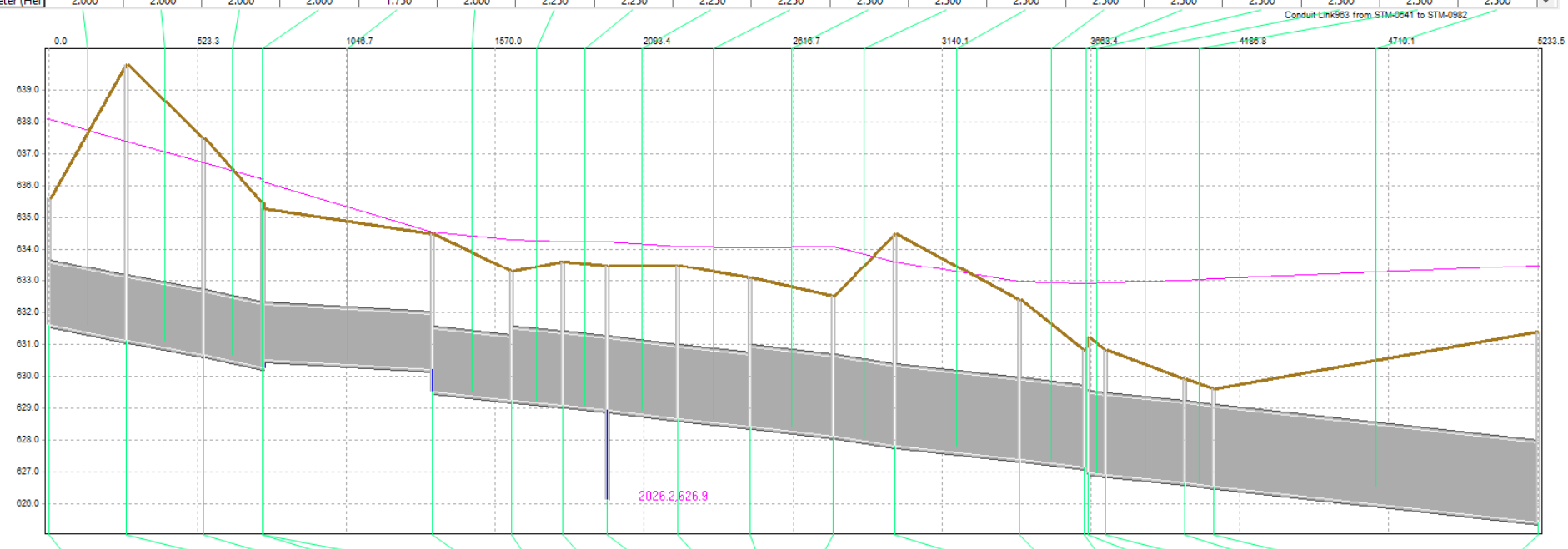
Manhole Parameters | Runoff Info | MH duration and depth

Project SNC-14: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0707	STG-0708	STG-0799	3472	3471	STG-0858	STG-0857	STG-0856	STG-0855	STG-0854	STG-0853	STG-0719	STG-0718	STG-0717	STG-0716	STG-0715	STG-0714	STG-0713	Link963
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	631.590	631.120	630.650	630.280	630.520	629.520	629.250	629.070	628.920	628.670	628.420	628.120	627.820	627.380	627.140	626.960	626.910	626.640	626.540
Downstream I	631.120	630.650	630.280	630.280	630.220	629.250	629.070	628.920	628.670	628.420	628.120	627.820	627.380	627.140	626.960	626.910	626.640	626.540	625.400
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	1.750	2.000	2.250	2.250	2.250	2.250	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500



	STM-0795	STM-0795	STM-0795	STM-0794	STM-0986	STM-1156	STM-0548	STM-0547	STM-0546	STM-0545	STM-0503	STM-0504	STM-0505	STM-0506	STM-0506	STM-0506	STM-0985	STM-0544	STM-0542	STM-0543	STM-0984	STM-0983	STM-0541	STM-0541	STM-0541	STM-0982
Storm	10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H
Subcatchment	1	2	3											1	2	3							1	2	3	
Ponding Type	Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe
Ground Elevati	635.600			639.800	637.500	635.460	635.280	634.500	633.300	633.600	633.500	633.500	633.100	632.500			634.500	632.400	630.800	631.200	630.800	629.900	629.600			631.400
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000

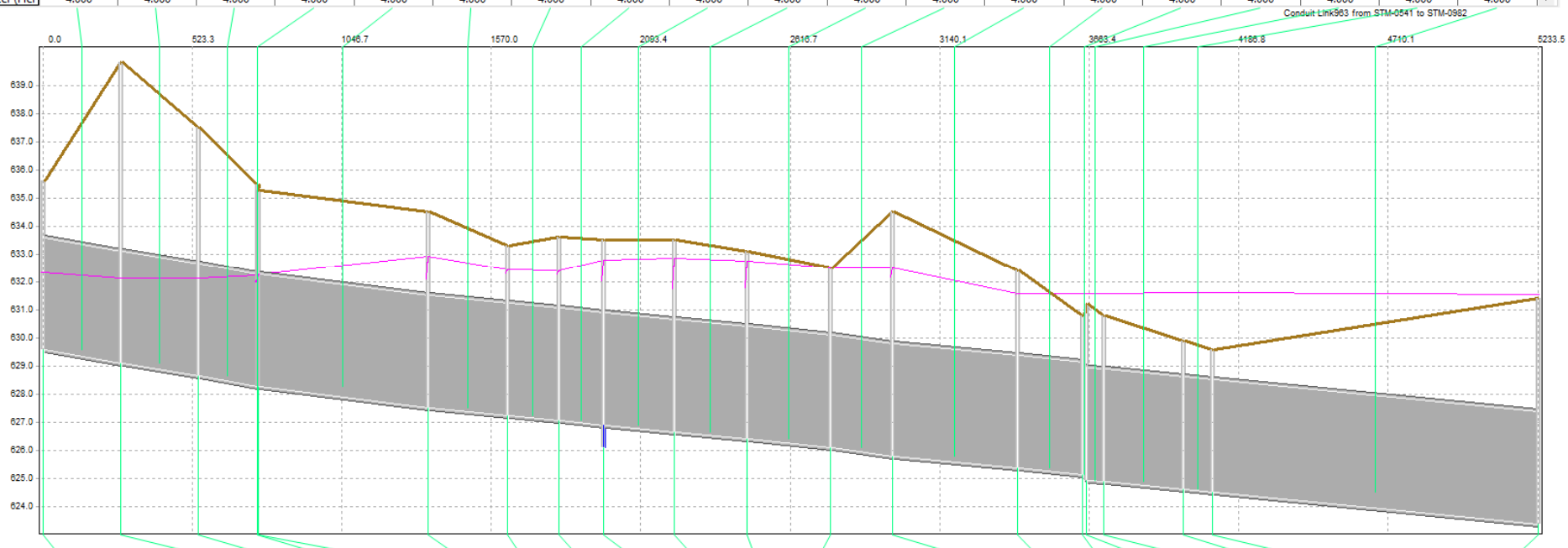
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-14: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0707	STG-0708	STG-0799	3472	3471	STG-0858	STG-0857	STG-0856	STG-0855	STG-0854	STG-0853	STG-0719	STG-0718	STG-0717	STG-0716	STG-0715	STG-0714	STG-0713	Link963
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	629.590	629.120	628.650	628.280	628.280	627.520	627.250	627.070	626.920	626.670	626.420	626.120	625.820	625.380	625.140	624.960	624.910	624.640	624.540
Downstream I	629.120	628.650	628.280	628.280	627.520	627.250	627.070	626.920	626.670	626.420	626.120	625.820	625.380	625.140	624.960	624.910	624.640	624.540	623.400
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000



	STM-0795	STM-0795	STM-0795	STM-0794	STM-0986	STM-1156	STM-0548	STM-0547	STM-0546	STM-0545	STM-0503	STM-0504	STM-0505	STM-0506	STM-0506	STM-0506	STM-0985	STM-0544	STM-0542	STM-0543	STM-0984	STM-0983	STM-0541	STM-0541	STM-0541	STM-0982
Storm	10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H			10 YR 24H
Subcatchment	1	2	3											1	2	3							1	2	3	
Ponding Type	Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe	Allowe	Allowe	Allowe	Allowe	Allowe	Allowe			Allowe
Ground Elevati	635.600			639.800	637.500	635.460	635.280	634.500	633.300	633.600	633.500	633.500	633.100	632.500			634.500	632.400	630.800	631.200	630.800	629.900	629.600			631.400
Slope	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.019	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000

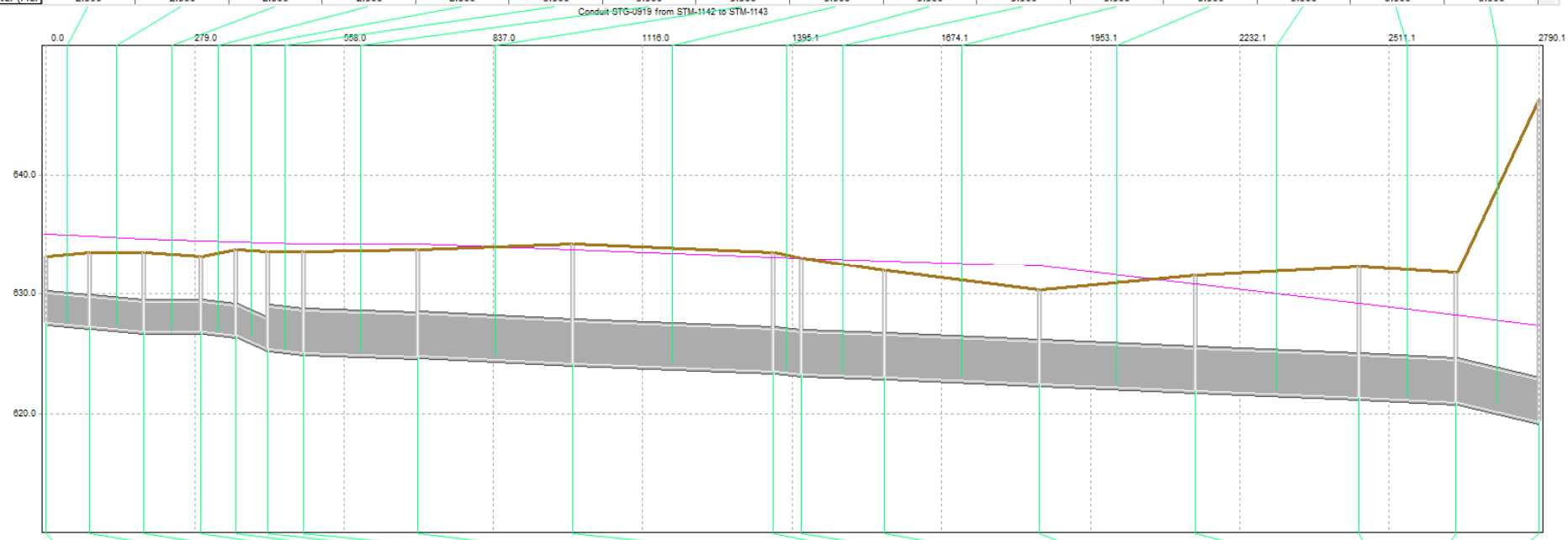
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-15: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1158	STG-1159	STG-1021	STG-1073	STG-1074	STG-0923	STG-1075	STG-0918	STG-0919	STG-0920	STG-0921	STG-0922	STG-0917	STG-0916	3888	STG-0915
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	627.640	627.280	626.920	626.890	626.590	625.400	625.100	624.830	624.230	623.550	623.330	623.100	622.540	621.940	621.340	620.970
Downstream I	627.280	626.920	626.890	626.590	625.400	625.100	624.800	624.230	623.550	623.330	623.100	622.540	621.940	621.340	620.970	619.340
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.500	2.500	2.500	2.500	2.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500



	STM-1165	STM-1165	STM-1165	STM-1166	STM-1164	STM-1069	STM-0354	STM-0982	STM-0536	STM-0981	STM-0981	STM-0981	STM-1142	STM-1143	STM-1144	STM-0744	STM-0745	STM-0745	STM-0745	STM-1087	STM-0781	STM-0954	Node1183
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3							1	2	3					1	2	3				
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	633.200			633.500	633.500	633.200	633.800	633.600	633.600	633.800			634.250	633.490	633.000	632.000	630.400			631.600	632.300	631.800	646.285
Slope	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.015	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

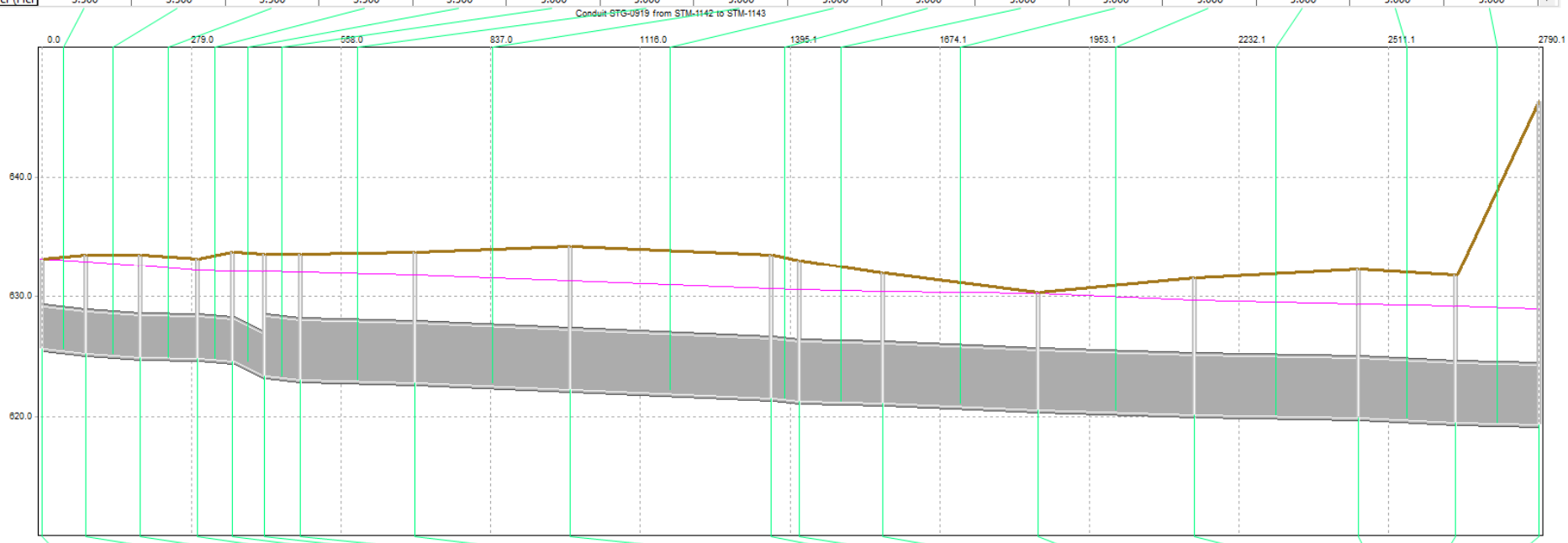
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-15: Proposed (includes storage)

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1158	STG-1159	STG-1021	STG-1073	STG-1074	STG-0923	STG-1075	STG-0918	STG-0919	STG-0920	STG-0921	STG-0922	STG-0917	STG-0916	3888	STG-0915
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	625.640	625.280	624.920	624.890	624.590	623.400	623.100	622.830	622.230	621.550	621.330	621.100	620.540	620.140	619.940	619.540
Downstream I	625.280	624.920	624.890	624.590	623.400	623.100	622.800	622.230	621.550	621.330	621.100	620.540	620.140	619.940	619.540	619.340
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500	3.500	3.500	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000



	STM-1165	STM-1165	STM-1165	STM-1166	STM-1164	STM-1069	STM-0354	STM-0982	STM-0536	STM-0981	STM-0981	STM-0981	STM-1142	STM-1143	STM-1144	STM-0744	STM-0745	STM-0745	STM-0745	STM-1087	STM-0781	STM-0954	Node1183
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3							1	2	3					1	2	3				
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed
Ground Elevati	633.200			633.500	633.500	633.200	633.800	633.600	633.600	633.800			634.250	633.490	633.000	632.000	630.400			631.600	632.300	631.800	646.285
Slope	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.015	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

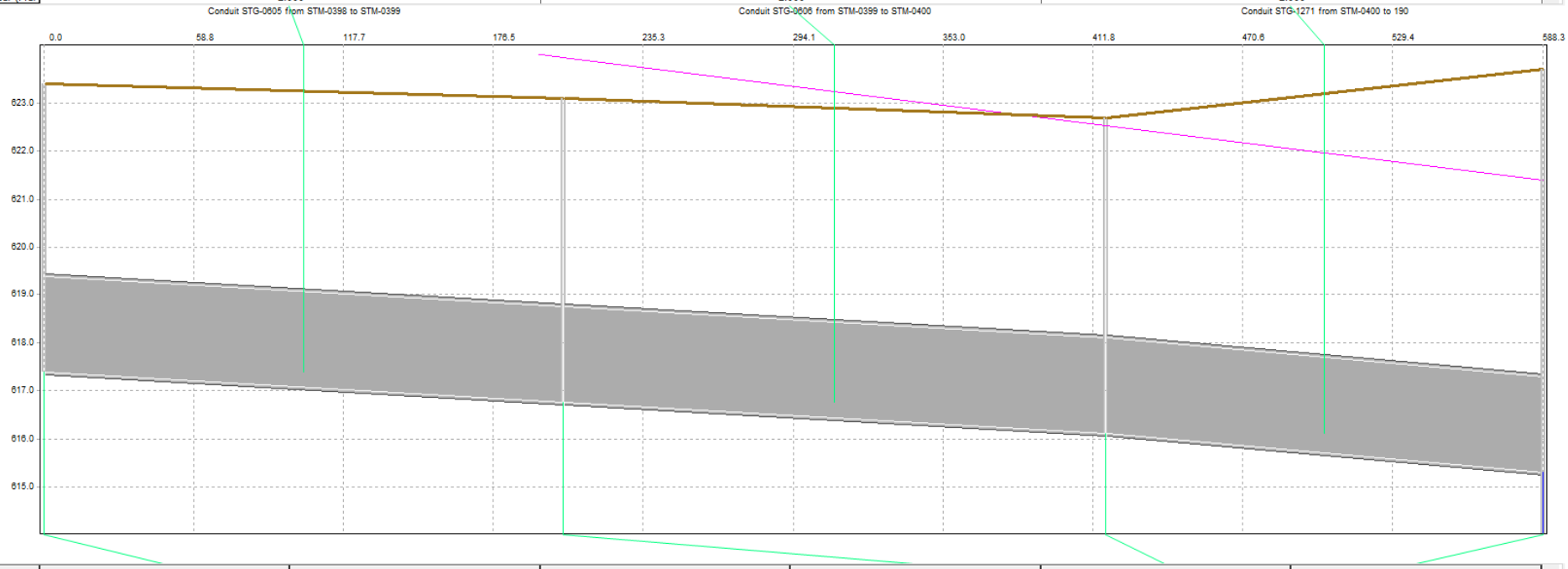
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-16: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0605	STG-0606	STG-1271
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	617.390	616.760	616.120
Downstream I	616.760	616.120	615.310
Roughness	0.013	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000



	STM-0398	STM-0398	STM-0398	STM-0399	STM-0400	190
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed
Ground Elevati	623.400			623.100	622.700	623.700
Slope	0.009	0.009	0.009	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000

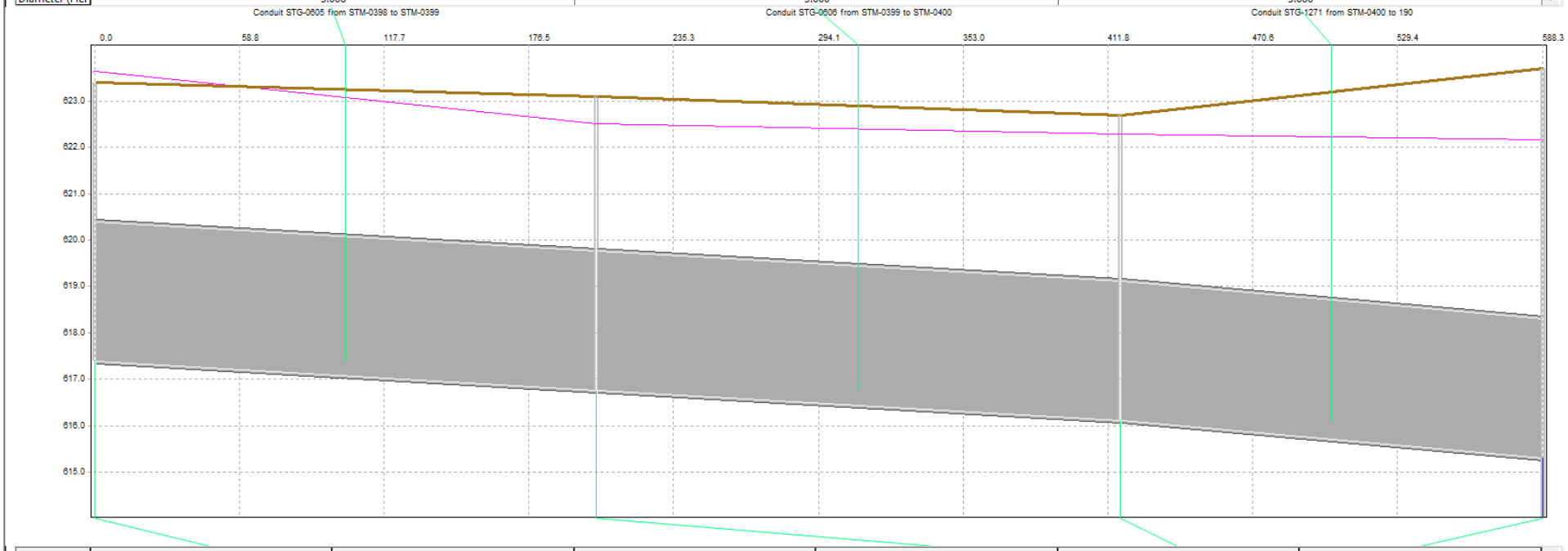
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-16: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0605	STG-0606	STG-1271
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	617.390	616.760	616.120
Downstream I	616.760	616.120	615.310
Roughness	0.013	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000



	STM-0398	STM-0398	STM-0398	STM-0399	STM-0400	190
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed
Ground Elevat	623.400			623.100	622.700	623.700
Slope	0.009	0.009	0.009	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000

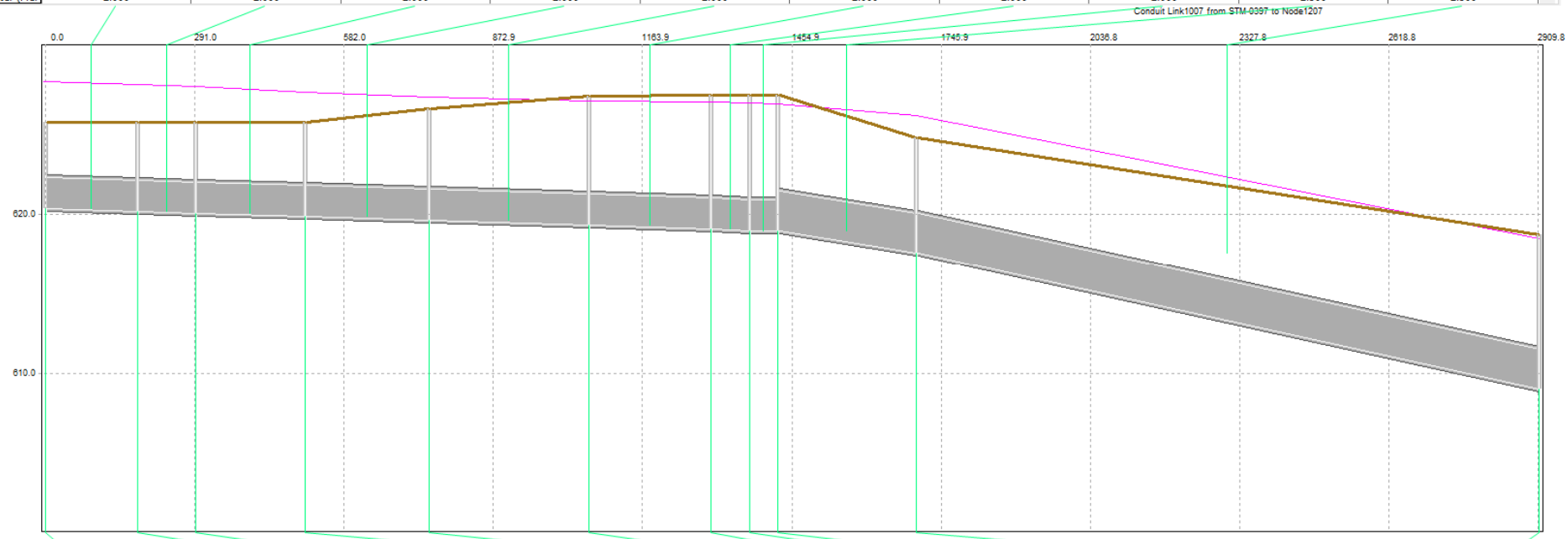
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-17: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0604	STG-0603	STG-0602	STG-0601	STG-0847	STG-0848	STG-0843	STG-0846	STG-0841	Link1007
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	620.390	620.200	620.090	619.870	619.630	619.320	619.080	619.000	619.000	617.570
Downstream I	620.200	620.090	619.870	619.630	619.320	619.080	619.000	619.000	617.570	609.000
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.500	2.500



	STM-0394	STM-0394	STM-0394	STM-0395	STM-0393	STM-0393	STM-0393	STM-0392	STM-0391	STM-1150	STM-0437	STM-0430	STM-0431	STM-0431	STM-0431	STM-0397	STM-0397	STM-0397	Node1207
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR			10 YR 24HR
Subcatchment	1	2	3		1	2	3						1	2	3	1	2	3	
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed			Allowed
Ground Elevat	625.800			625.800	625.800			625.800	626.600	627.400	627.500	627.500	627.500			624.800			618.713
Slope	0.004	0.004	0.004	0.000	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.010	0.010	0.010	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000

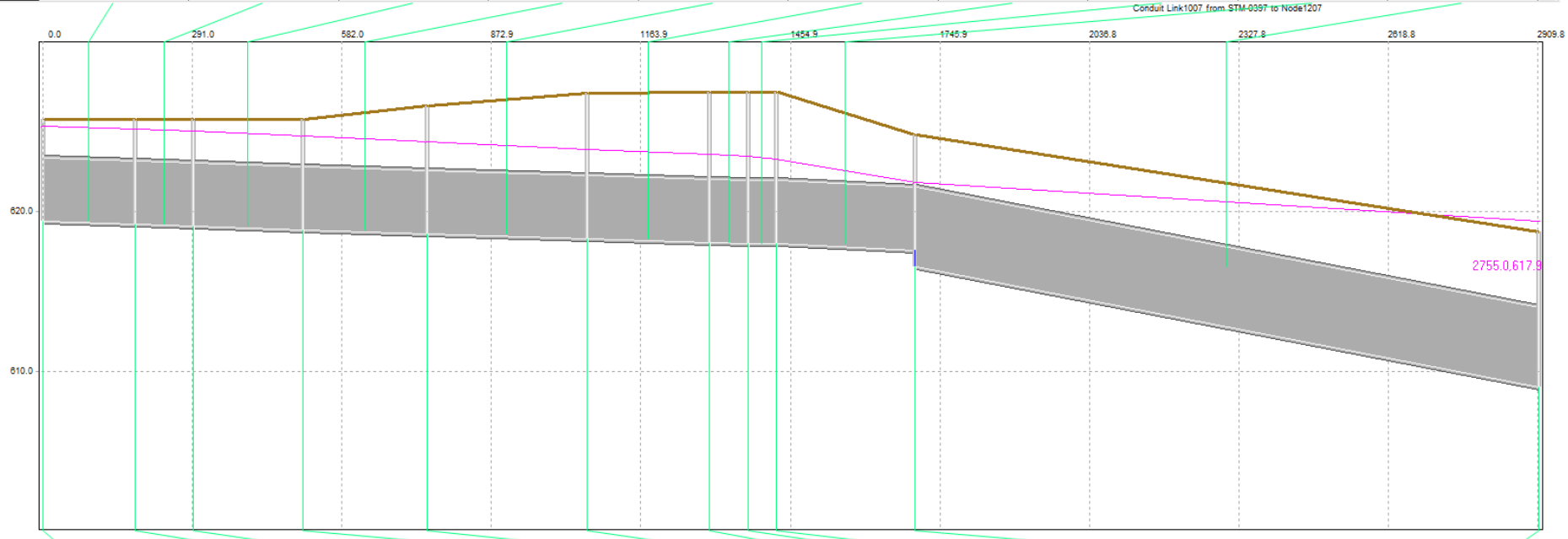
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project SNC-17: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0604	STG-0603	STG-0602	STG-0601	STG-0847	STG-0848	STG-0843	STG-0846	STG-0841	Link1007
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	619.390	619.200	619.090	618.870	618.630	618.320	618.080	618.000	618.000	616.570
Downstream I	619.200	619.090	618.870	618.630	618.320	618.080	618.000	618.000	617.570	609.000
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	5.000



	STM-0394	STM-0394	STM-0394	STM-0395	STM-0393	STM-0393	STM-0393	STM-0392	STM-0391	STM-1150	STM-0437	STM-0430	STM-0431	STM-0431	STM-0431	STM-0397	STM-0397	STM-0397	Node1207
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR			10 YR 24HR
Subcatchment	1	2	3		1	2	3						1	2	3	1	2	3	
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed			Allowed
Ground Elevati	625.800			625.800	625.800			625.800	626.600	627.400	627.500	627.500	627.500			624.800			618.713
Slope	0.004	0.004	0.004	0.000	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.010	0.010	0.010	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000

Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

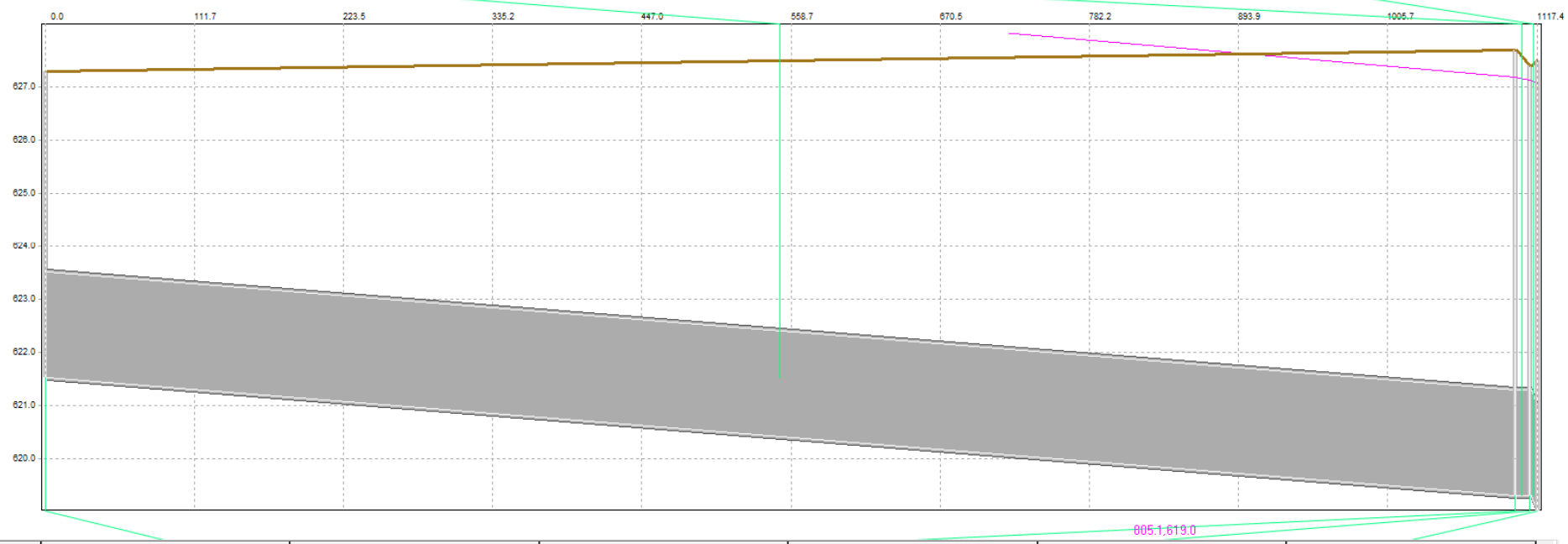
Project SNC-18: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	Link1002	STG-0844	STG-0845
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	621.520	619.300	619.300
Downstream I	619.300	619.300	619.000
Roughness	0.014	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000

Conduit Link1002 from STM-0436 to STM-0429



	STM-0436	STM-0436	STM-0436	STM-0429	STM-0428	STM-0430
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed
Ground Elevat	627.300			627.700	627.400	627.500
Slope	0.012	0.012	0.012	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000

Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

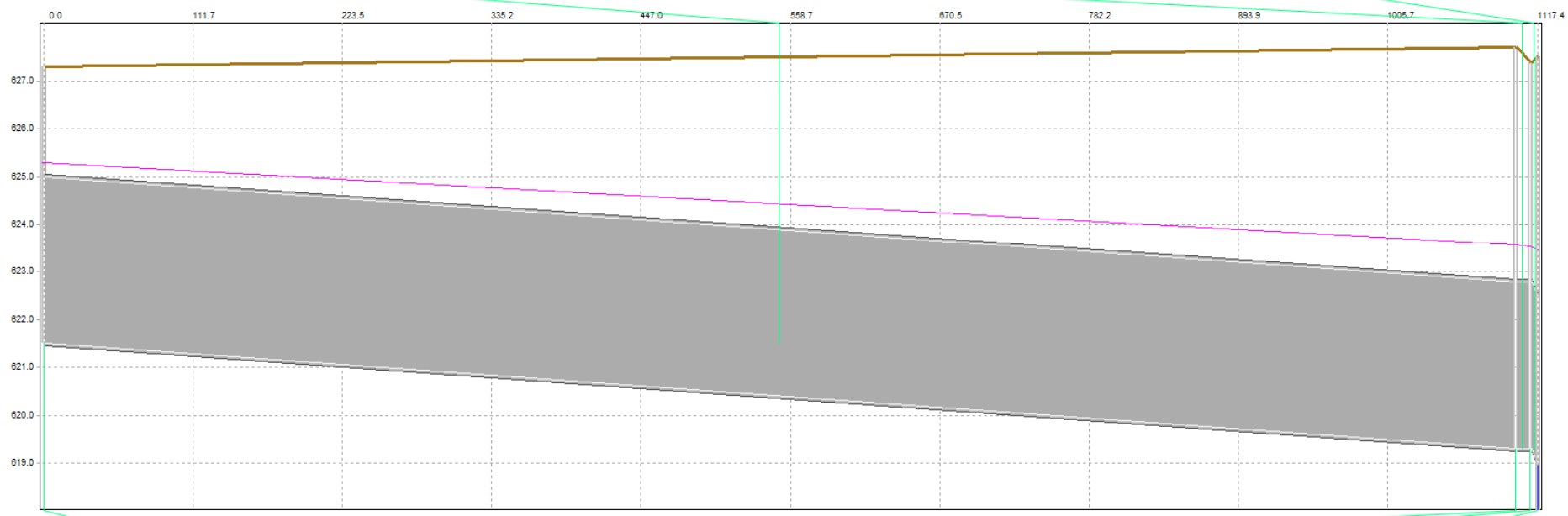
Project SNC-18: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	Link1002	STG-0844	STG-0845
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	621.520	619.300	619.300
Downstream I	619.300	619.300	619.000
Roughness	0.014	0.013	0.013
Shape	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500

Conduit Link1002 from STM-0436 to STM-0429

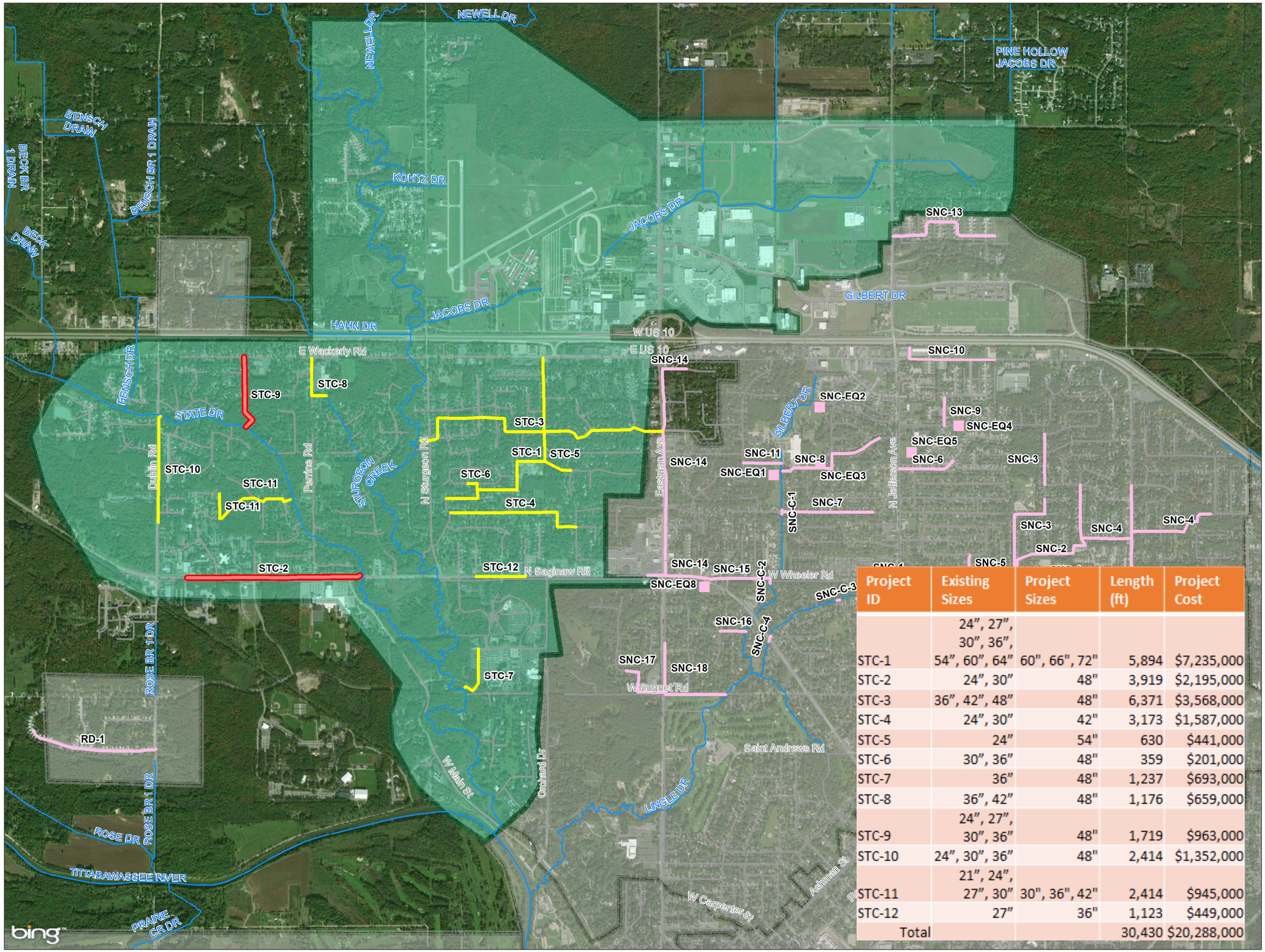


	STM-0436	STM-0436	STM-0436	STM-0429	STM-0428	STM-0430
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed
Ground Elevati	627.300			627.700	627.400	627.500
Slope	0.012	0.012	0.012	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000

Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

City of Midland Sturgeon Creek Watershed

Recommended Storm Sewer Improvements



Project ID	Existing Sizes	Project Sizes	Length (ft)	Project Cost
STC-1	24", 27", 30", 36", 54", 60", 64"	60", 66", 72"	5,894	$7,235,000
STC-2	24", 30"	48"	3,919	$2,195,000
STC-3	36", 42", 48"	48"	6,371	$3,568,000
STC-4	24", 30"	42"	3,173	$1,587,000
STC-5	24"	54"	630	$441,000
STC-6	30", 36"	48"	359	$201,000
STC-7	36"	48"	1,237	$693,000
STC-8	36", 42"	48"	1,176	$659,000
STC-9	24", 27", 30", 36"	48"	1,719	$963,000
STC-10	24", 30", 36"	48"	2,414	$1,352,000
STC-11	21", 24", 27", 30"	30", 36", 42"	2,414	$945,000
STC-12	27"	36"	1,123	$449,000
Total			30,430	$20,288,000

Storm Sewer Improvements

- Improvements Outside of Watershed
- High Priority Improvements
- Low Priority Improvements

Culvert Improvements

- Improvements Outside of Watershed

EQ Basins

- EQ Basins Outside of Watershed
- Storm Sewer Gravity Main
- Drains

N

0 4,000

Feet

1" = 2,100'

Source: Data provided by City of Midland and ESRI. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: June 7, 2018

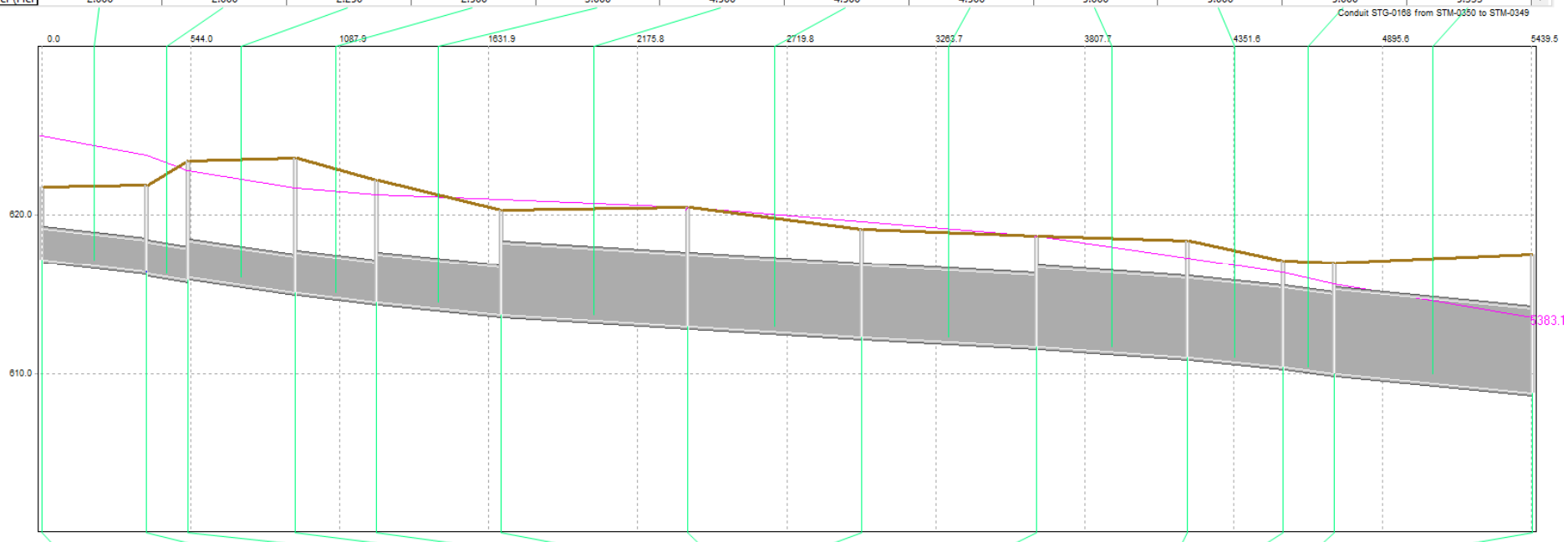
OHM

Project STC-1: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0164	STG-0163	STG-0162	STG-0161	Link994	STG-0979	STG-0996	STG-0183	STG-1303	STG-0999	STG-0167	STG-0168
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	617.180	616.300	616.090	615.120	614.510	613.700	612.940	612.310	611.670	611.000	610.400	610.020
Downstream I	616.420	615.910	615.120	614.510	613.700	612.940	612.310	611.670	611.000	610.400	610.020	608.800
Roughness	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.250	2.500	3.000	4.500	4.500	4.500	5.000	5.000	5.000	5.333



	STM-0305	STM-0305	STM-0305	STM-0292	STM-0292	STM-0292	STM-1018	STM-0893	STM-0293	STM-1022	STM-0898	STM-0351	STM-0351	STM-0351	STM-0896	STM-0896	STM-0896	STM-1013	STM-1009	STM-0350	STM-0349	STM-0349	STM-0349
Storm	10 YR 24HR			10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3	1	2	3						1	2	3	1	2	3				1	2	3
Ponding Type	Allowed			Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed			Allowed	Allowed	Allowed	Allowed		
Ground Elevat	621.800			621.900			623.440	623.600	622.200	620.300	620.500	619.100			618.700			618.400	617.100	617.000	617.500		
Slope	0.006	0.006	0.006	0.006	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.006	0.016	0.016	0.016	0.000	0.000	0.000	0.008	0.008	0.008
Impervious Pe	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000

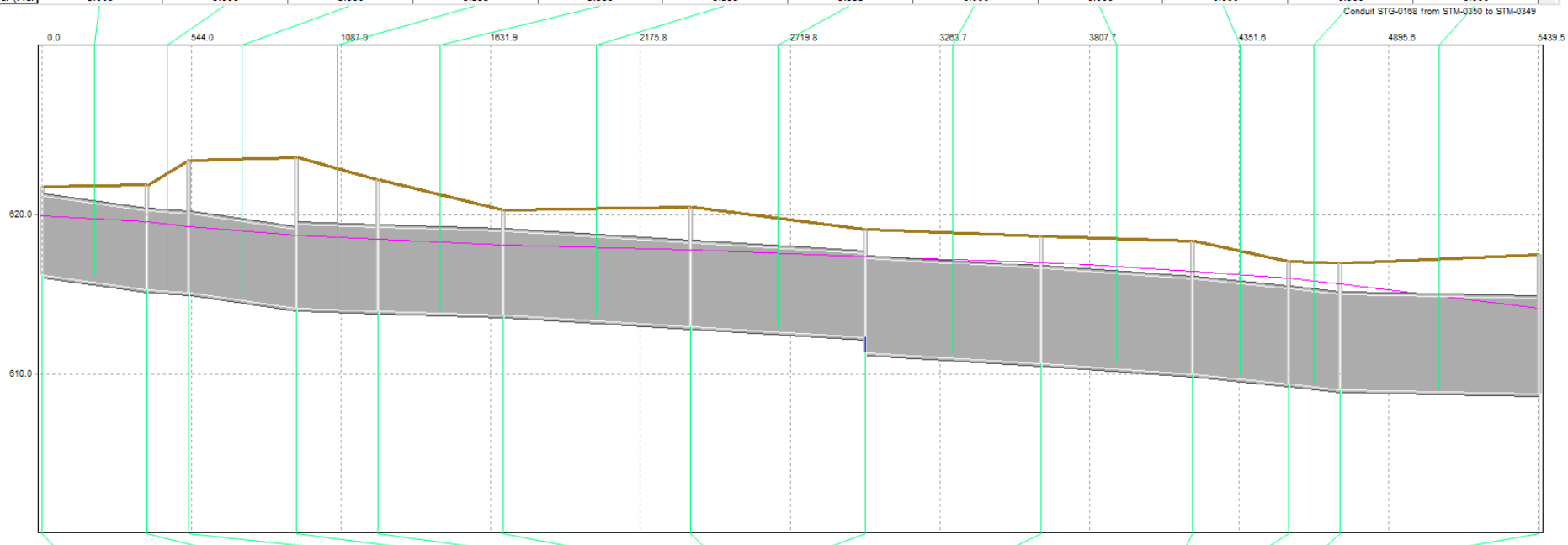
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-1: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0164	STG-0163	STG-0162	STG-0161	Link994	STG-0979	STG-0996	STG-0183	STG-1303	STG-0999	STG-0167	STG-0168
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	616.180	615.300	615.090	614.120	613.910	613.700	612.940	611.310	610.670	610.000	609.400	609.020
Downstream I	615.300	615.090	614.120	613.910	613.700	612.940	612.310	610.670	610.000	609.400	609.020	608.800
Roughness	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	5.000	5.000	5.000	5.333	5.333	5.333	5.333	6.000	6.000	6.000	6.000	6.000



	STM-0305	STM-0305	STM-0305	STM-0292	STM-0292	STM-0292	STM-1018	STM-0893	STM-0293	STM-1022	STM-0898	STM-0351	STM-0351	STM-0351	STM-0896	STM-0896	STM-0896	STM-1013	STM-1009	STM-0350	STM-0349	STM-0349	STM-0349
Storm	10 YR 24HR			10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR		
Subcatchment	1	2	3	1	2	3						1	2	3	1	2	3				1	2	3
Ponding Type	Allowed			Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed			Allowed	Allowed	Allowed	Allowed		
Ground Elevati	621.800			621.900			623.440	623.600	622.200	620.300	620.500	619.100			618.700			618.400	617.100	617.000	617.500		
Slope	0.006	0.006	0.006	0.006	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.006	0.016	0.016	0.016	0.000	0.000	0.000	0.008	0.008	0.008
Impervious Pe	100.000	100.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000

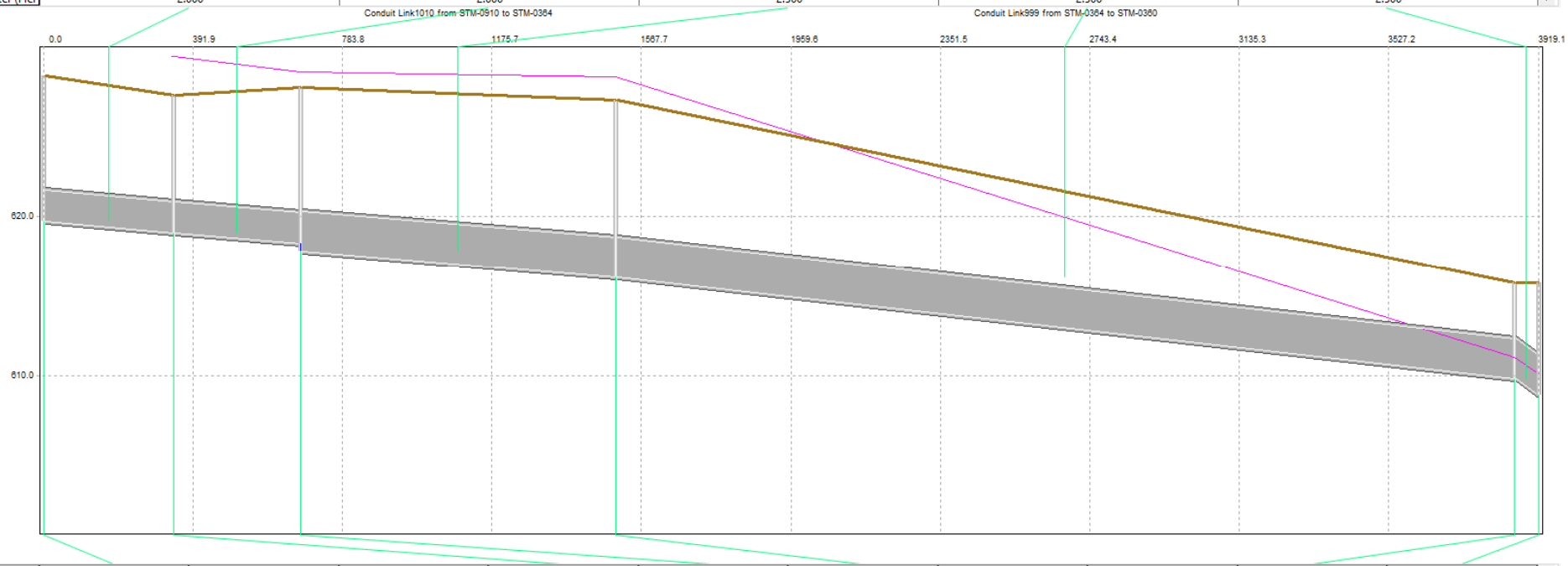
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-2: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0124	STG-0125	Link1010	Link999	STG-0494
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	619.680	618.980	617.830	616.180	609.800
Downstream I	618.980	618.330	616.180	609.800	608.800
Roughness	0.013	0.013	0.014	0.014	0.013
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.500	2.500	2.500



	STM-0368	STM-0368	STM-0368	STM-0367	STM-0910	STM-0364	STM-0364	STM-0364	STM-0360	113
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	628.800			627.600	628.100	627.300			615.800	615.800
Slope	0.003	0.003	0.003	0.000	0.000	0.007	0.007	0.007	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

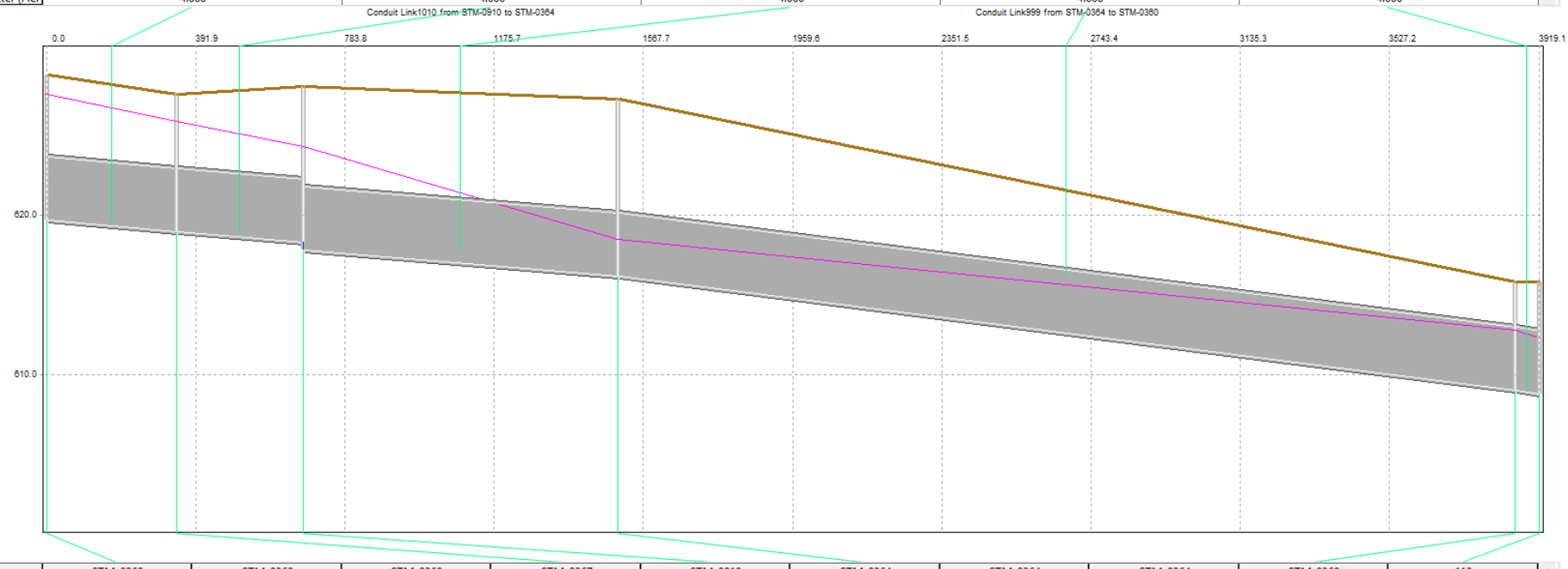
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-2: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0124	STG-0125	Link1010	Link999	STG-0494
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	619.680	618.980	617.830	616.180	609.000
Downstream I	618.980	618.330	616.180	609.000	608.800
Roughness	0.013	0.013	0.014	0.014	0.013
Shape	Circular	Circular	Circular	Rectangular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000



	STM-0368	STM-0368	STM-0368	STM-0367	STM-0910	STM-0364	STM-0364	STM-0364	STM-0360	113
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevati	628.800			627.600	628.100	627.300			615.800	615.800
Slope	0.003	0.003	0.003	0.000	0.000	0.007	0.007	0.007	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

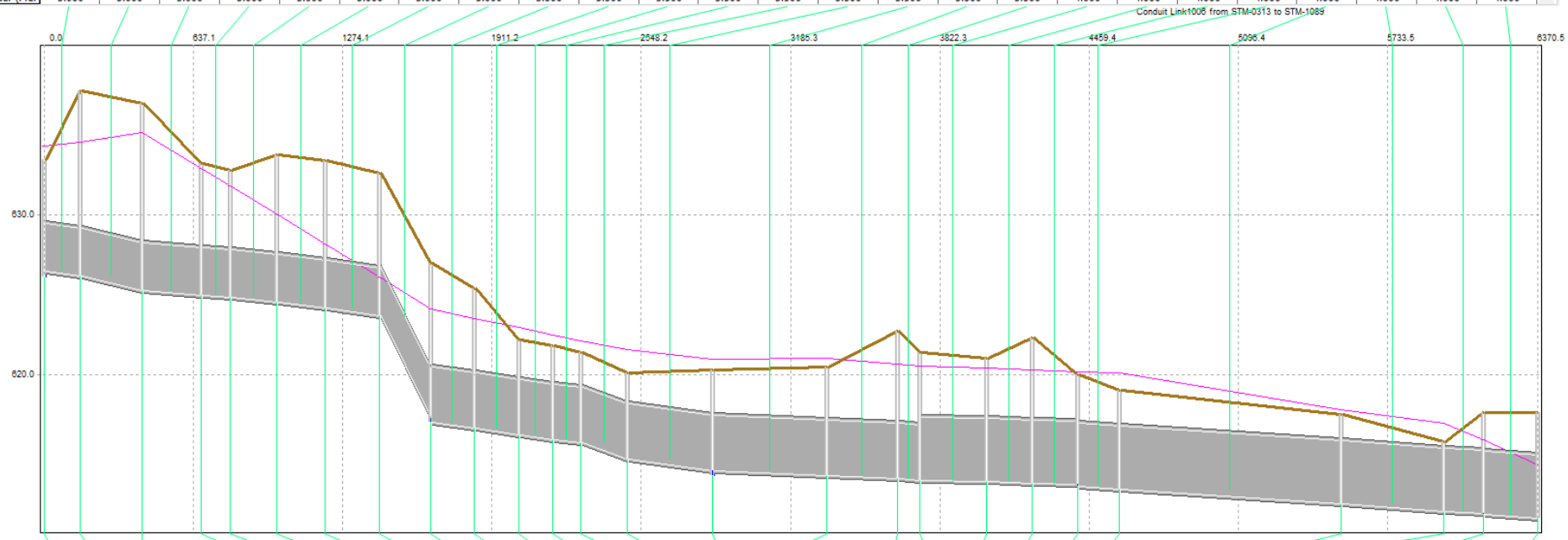
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-3: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1142	STG-1143	STG-1144	STG-0158	STG-0157	STG-0156	STG-0155	STG-0154	STG-0152	STG-0153	STG-0151	STG-0150	STG-0149	STG-0148	STG-0147	STG-0146	STG-0975	STG-0976	STG-0977	STG-0997	STG-0998	Link1006	STG-1062	STG-0165	STG-1058
Storm	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H
Upstream Inve	626.500	626.190	625.260	624.970	624.820	624.570	624.170	623.720	617.000	616.630	616.230	615.940	615.710	614.730	614.000	613.700	613.510	613.400	613.300	613.170	613.000	612.850	611.900	611.440	611.240
Downstream I	626.190	625.260	624.970	624.820	624.570	624.170	623.720	617.400	616.630	616.230	615.940	615.710	614.730	614.000	613.700	613.510	613.400	613.300	613.170	613.100	612.850	611.900	611.440	611.280	611.010
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000



	STM-0	STM-1	STM-1	STM-1	STM-1	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-1	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-1	STM-0	STM-0	STM-0	STM-1	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	129
Storm	10 YR 2	10 YR 2	10 YR 2			10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2			10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2			10 YR 2	10 YR 2			10 YR 2			10 YR 2
Subcatchment			1	2	3													1	2	3						1	2	3		1	2	3	1	2	3	
Ponding Type	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo			Allo			Allo
Ground Elevati	633.500	637.800	637.000			633.200	632.800	633.800	633.400	632.600	627.000	625.400	622.200	621.800	621.400	620.100	620.300	620.500			622.700	621.400	621.000	622.300	620.000	619.000			617.500	615.800			617.600			617.600
Slope	0.000	0.000	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.019	0.019	0.019	0.023	0.023	0.023	0.000
Impervious Pe	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000

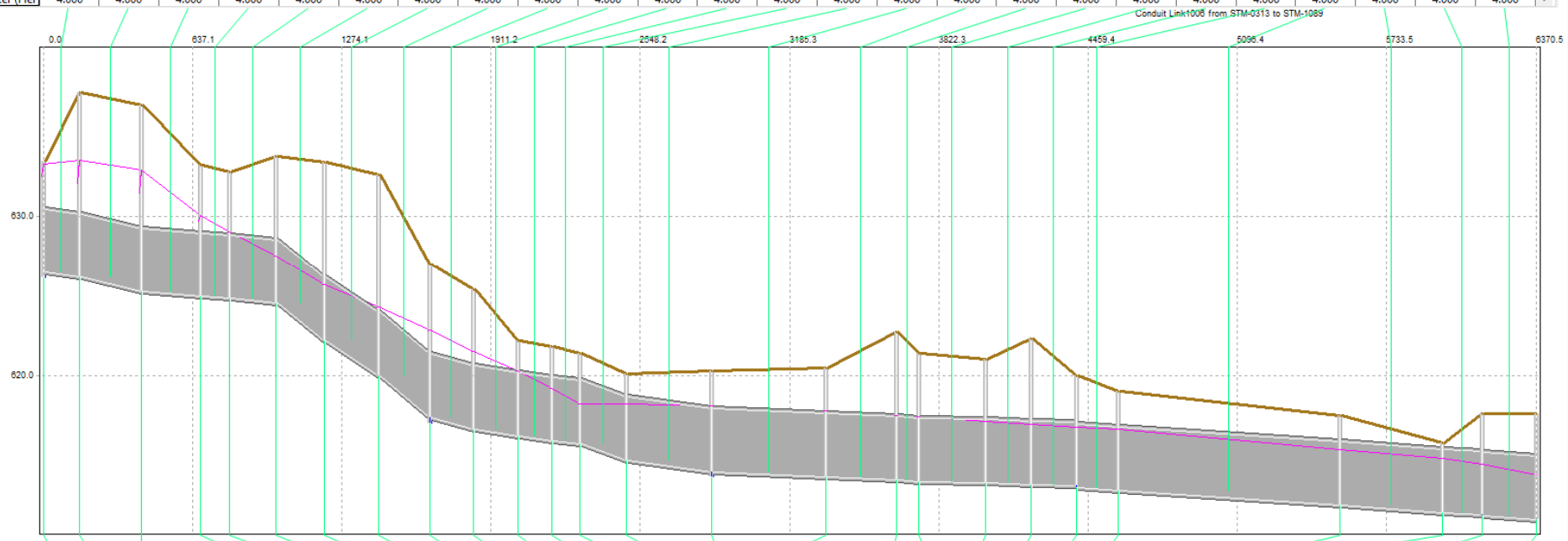
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-3: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1142	STG-1143	STG-1144	STG-0158	STG-0157	STG-0156	STG-0155	STG-0154	STG-0152	STG-0153	STG-0151	STG-0150	STG-0149	STG-0148	STG-0147	STG-0146	STG-0975	STG-0976	STG-0977	STG-0997	STG-0998	Link1006	STG-1062	STG-0165	STG-1058
Storm	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H	10 YR 24H
Upstream Inve	626.500	626.190	625.260	624.970	624.820	624.570	622.170	620.000	617.400	616.630	616.230	615.940	615.710	614.730	614.000	613.700	613.510	613.400	613.300	613.170	613.000	612.850	611.900	611.440	611.240
Downstream I	626.190	625.260	624.970	624.820	624.570	622.170	620.000	617.400	616.630	616.230	615.940	615.710	614.730	614.000	613.700	613.510	613.400	613.300	613.170	613.100	612.850	611.900	611.440	611.280	611.010
Roughness	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang	Rectang
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000



	STM-0	STM-1	STM-1	STM-1	STM-1	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-1	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	STM-1	STM-0	STM-0	STM-0	STM-1	STM-0	STM-0	STM-0	STM-0	STM-0	STM-0	129
Storm	10 YR 2	10 YR 2	10 YR 2			10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2			10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2	10 YR 2			10 YR 2	10 YR 2			10 YR 2			10 YR 2
Subcatchment			1	2	3													1	2	3						1	2	3		1	2	3	1	2	3	
Ponding Type	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo	Allo	Allo	Allo	Allo			Allo	Allo			Allo			Allo
Ground Elevati	633.500	637.800	637.000			633.200	632.800	633.800	633.400	632.600	627.000	625.400	622.200	621.800	621.400	620.100	620.300	620.500			622.700	621.400	621.000	622.300	620.000	619.000			617.500	615.800			617.600			617.600
Slope	0.000	0.000	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.019	0.019	0.019	0.023	0.023	0.023	0.000
Impervious Pe	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	100.000	100.000	0.000	0.000

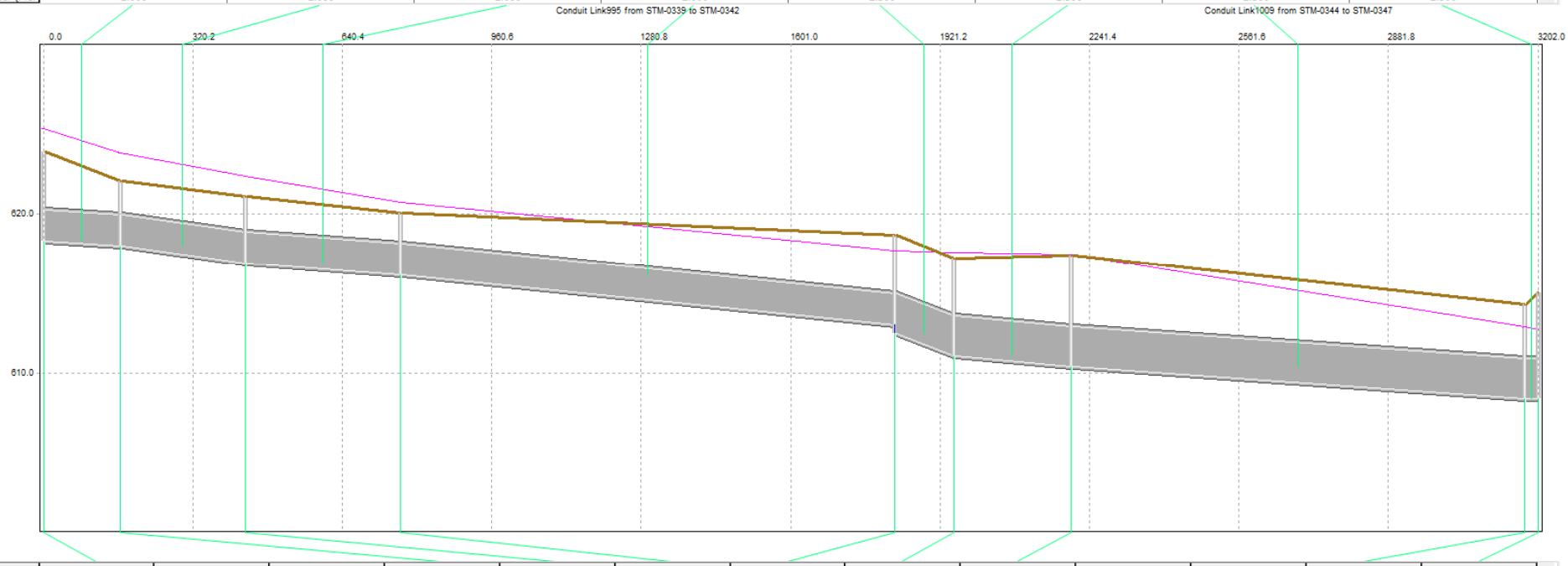
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-4: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0182	STG-0181	STG-0180	Link995	STG-0176	STG-0175	Link1009	STG-0171
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	618.300	618.000	616.930	616.210	612.500	611.110	610.400	608.440
Downstream I	618.000	616.930	616.210	613.000	611.110	610.400	608.440	608.400
Roughness	0.013	0.013	0.013	0.014	0.013	0.013	0.014	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.000	2.000	2.500	2.500	2.500	2.500



	STM-0336	STM-0336	STM-0336	STM-0337	STM-0338	STM-0339	STM-0342	STM-0343	STM-0344	STM-0344	STM-0344	STM-0347	STM-0348
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3						1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	623.900			622.100	621.100	620.100	618.700	617.200	617.400			614.300	615.000
Slope	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

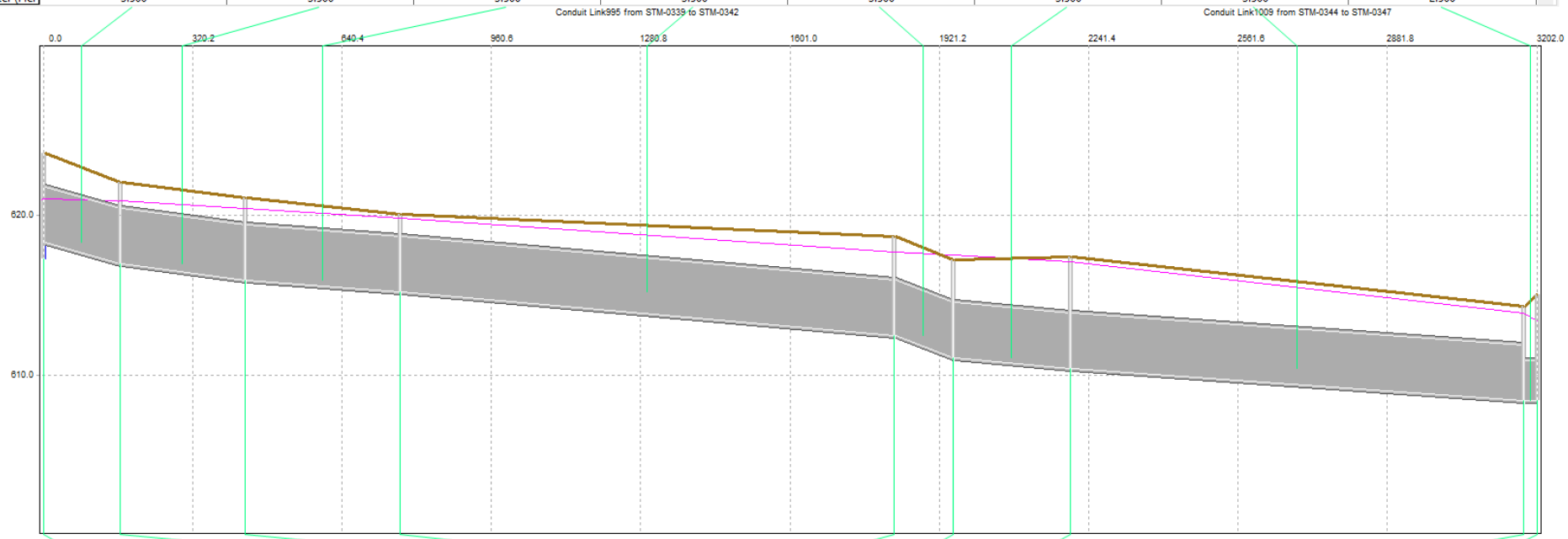
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-4: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0182	STG-0181	STG-0180	Link995	STG-0176	STG-0175	Link1009	STG-0171
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	618.300	617.000	615.930	615.210	612.500	611.110	610.400	608.440
Downstream I	617.000	615.930	615.210	612.500	611.110	610.400	608.440	608.400
Roughness	0.013	0.013	0.013	0.014	0.013	0.013	0.014	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500	3.500	3.500	3.500	3.500	2.500



	STM-0336	STM-0336	STM-0336	STM-0337	STM-0338	STM-0339	STM-0342	STM-0343	STM-0344	STM-0344	STM-0344	STM-0347	STM-0348
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3						1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	623.900			622.100	621.100	620.100	618.700	617.200	617.400			614.300	615.000
Slope	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

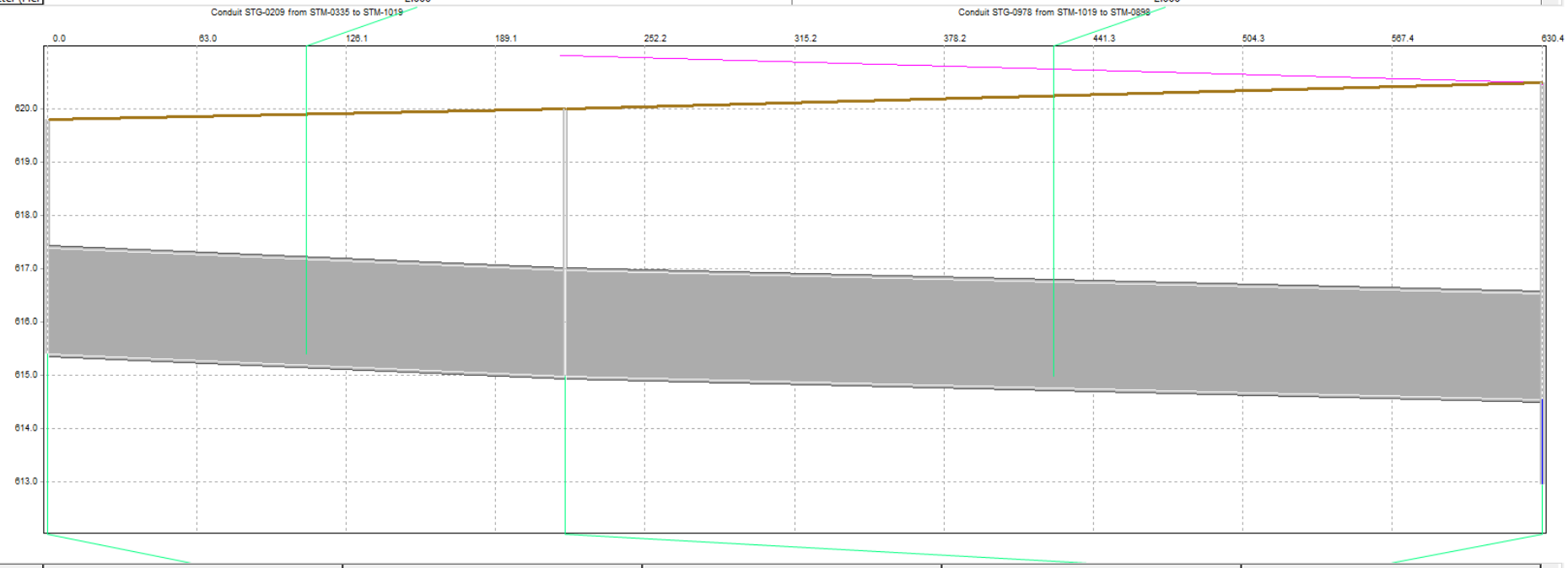
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-5: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0209	STG-0978
Storm	10 YR 24HR	10 YR 24HR
Upstream Inve	615.400	614.980
Downstream I	614.980	614.540
Roughness	0.013	0.013
Shape	Circular	Circular
Diameter (Hei	2.000	2.000



	STM-0335	STM-0335	STM-0335	STM-1019	STM-0898
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		
Ponding Type	Allowed			Allowed	Allowed
Ground Elevati	619.800			620.000	620.500
Slope	0.012	0.012	0.012	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000

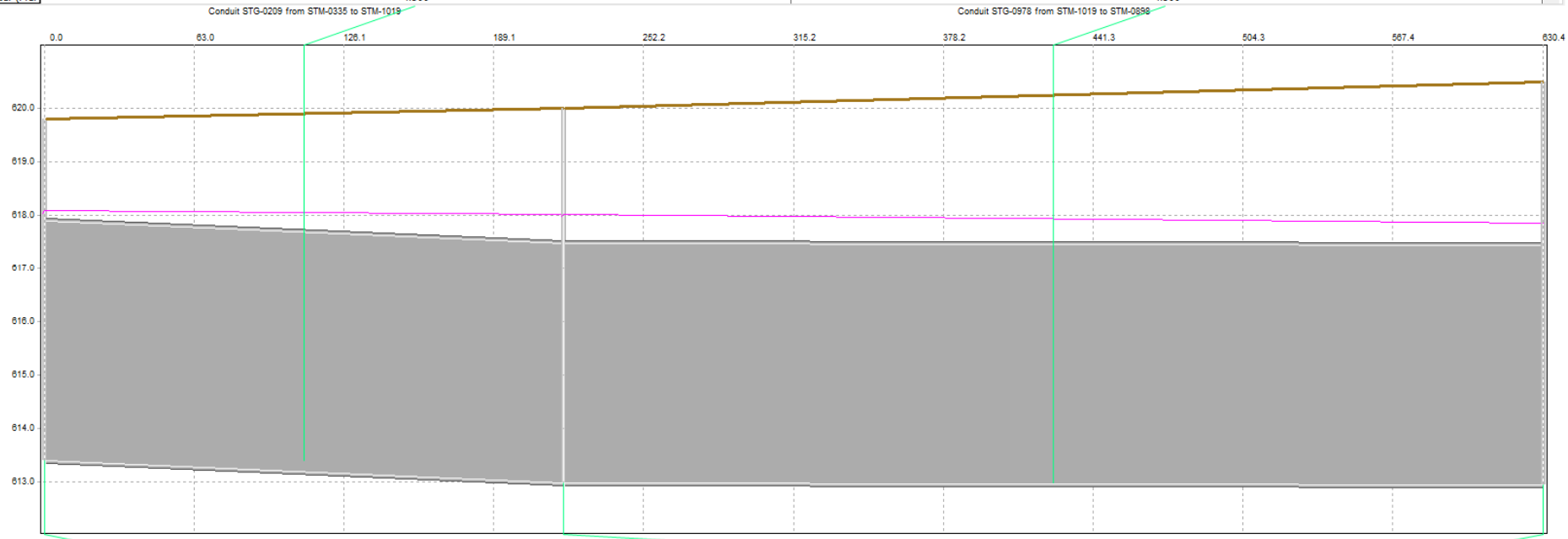
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-5: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0209	STG-0978
Storm	10 YR 24HR	10 YR 24HR
Upstream Inve	613.400	612.980
Downstream I	612.980	612.940
Roughness	0.013	0.013
Shape	Circular	Circular
Diameter (Hei	4.500	4.500



	STM-0335	STM-0335	STM-0335	STM-1019	STM-0898
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		
Ponding Type	Allowed			Allowed	Allowed
Ground Elevati	619.800			620.000	620.500
Slope	0.012	0.012	0.012	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000

Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-6: Existing

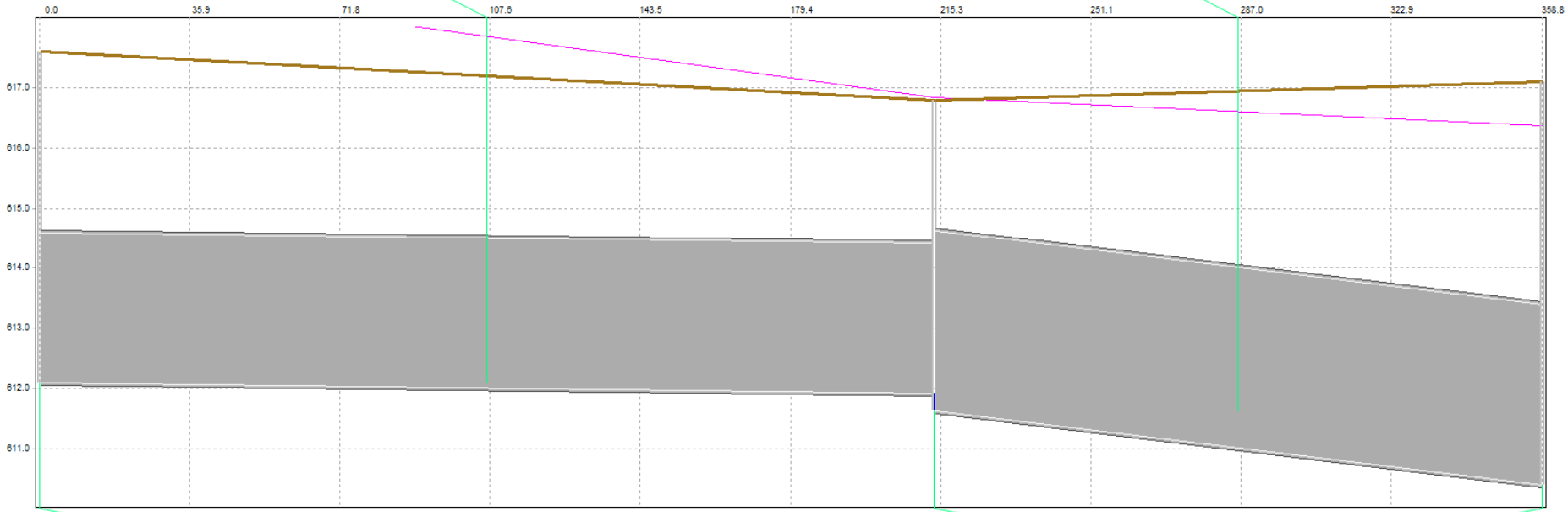
Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0166	STG-0981
Storm	10 YR 24HR	10 YR 24HR
Upstream Inve	612.100	611.620
Downstream I	611.920	610.400
Roughness	0.013	0.013
Shape	Circular	Circular
Diameter (Hei	2.500	3.000

Conduit STG-0166 from STM-0353 to STM-0352

Conduit STG-0981 from STM-0352 to STM-1009



	STM-0353	STM-0353	STM-0353	STM-0352	STM-1009
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		
Ponding Type	Allowed			Allowed	Allowed
Ground Elevati	617.600			616.800	617.100
Slope	0.007	0.007	0.007	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000

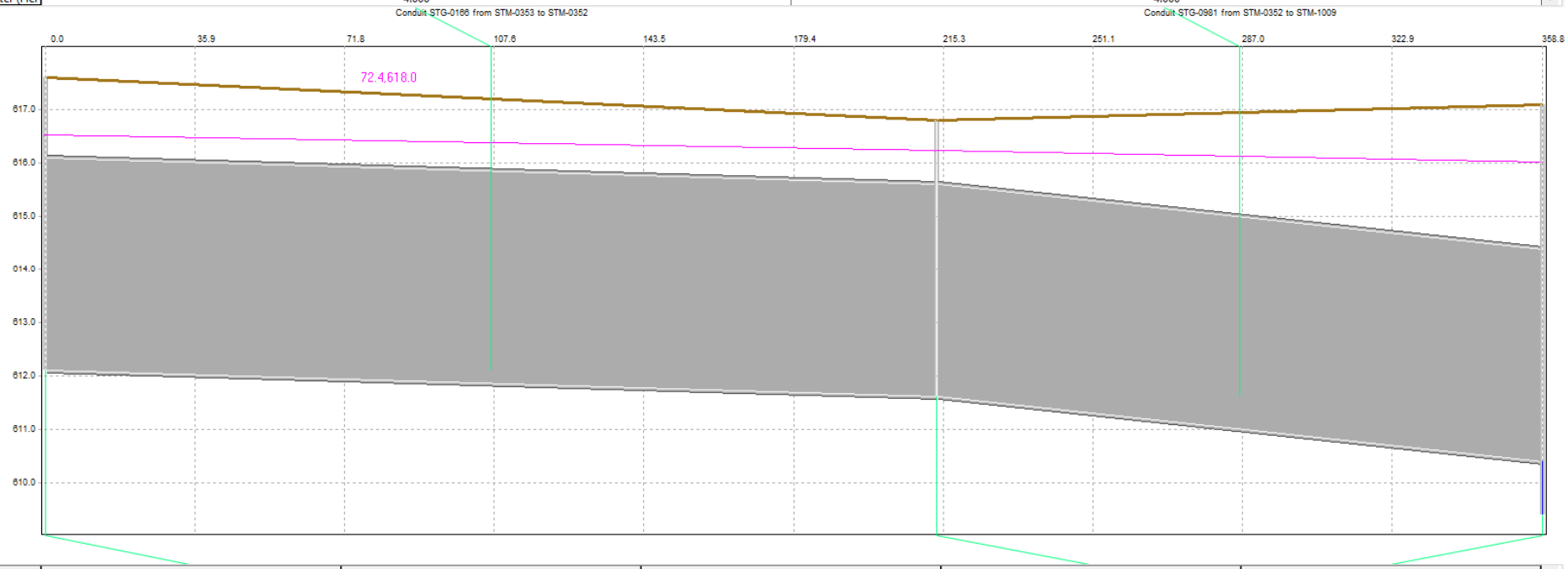
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-6: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0166	STG-0981
Storm	10 YR 24HR	10 YR 24HR
Upstream Inve	612.100	611.620
Downstream I	611.620	610.400
Roughness	0.013	0.013
Shape	Circular	Circular
Diameter (Hei	4.000	4.000



	STM-0353	STM-0353	STM-0353	STM-0352	STM-1009
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		
Ponding Type	Allowed			Allowed	Allowed
Ground Elevati	617.600			616.800	617.100
Slope	0.007	0.007	0.007	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000

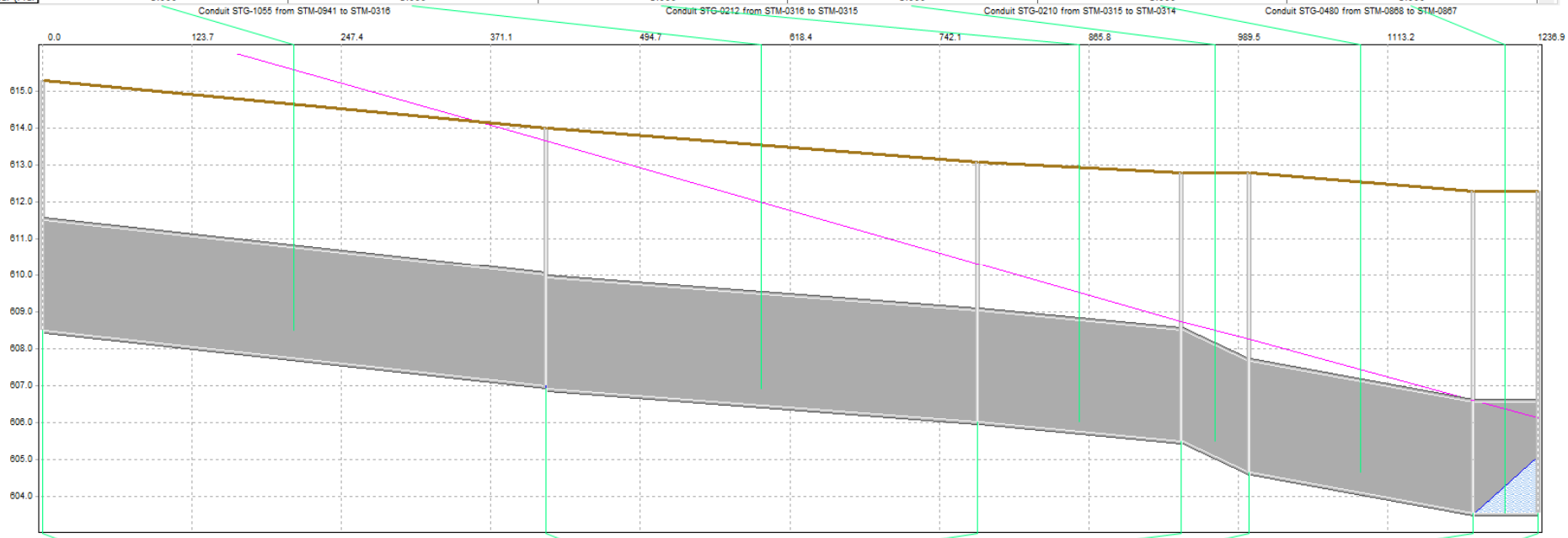
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-7: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1055	STG-0212	STG-0210	STG-0211	STG-0480	Link813
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	608.500	606.930	606.030	605.520	604.680	603.560
Downstream I	607.000	606.030	605.520	604.680	603.560	603.560
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.000	3.000



	STM-0941	STM-0941	STM-0941	STM-0316	STM-0315	STM-0314	STM-0868	STM-0867	136
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3						
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	615.300			614.000	613.100	612.800	612.800	612.300	612.300
Slope	0.018	0.018	0.018	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000

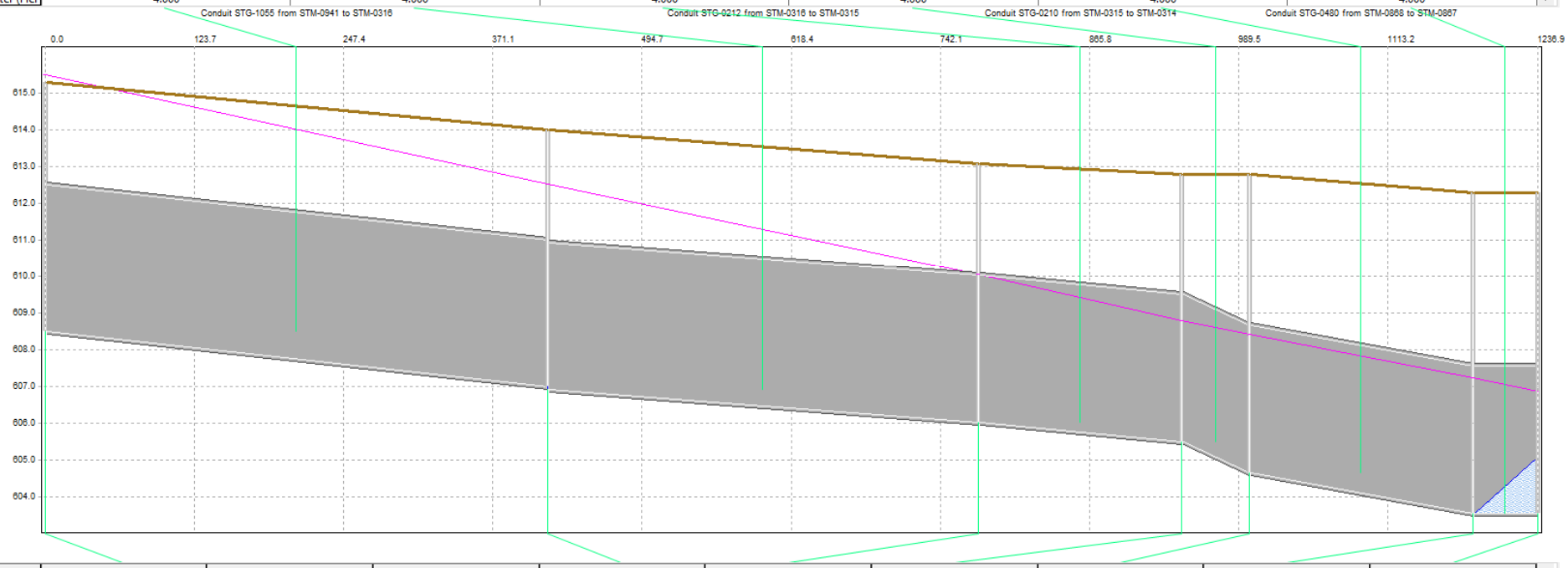
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-7: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1055	STG-0212	STG-0210	STG-0211	STG-0480	Link813
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	608.500	606.930	606.030	605.520	604.680	603.560
Downstream I	607.000	606.030	605.520	604.680	603.560	603.560
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000



	STM-0941	STM-0941	STM-0941	STM-0316	STM-0315	STM-0314	STM-0868	STM-0867	136
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3						
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	615.300			614.000	613.100	612.800	612.800	612.300	612.300
Slope	0.018	0.018	0.018	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000

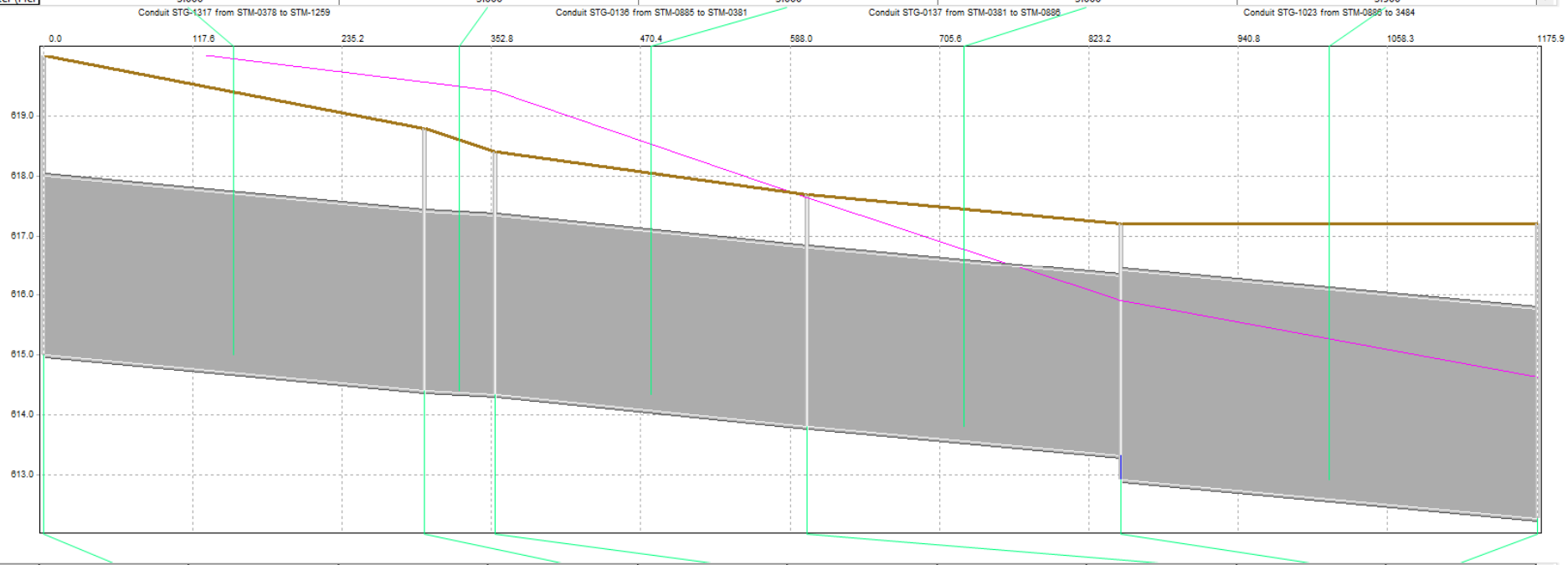
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-8: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1317	STG-1318	STG-0136	STG-0137	STG-1023
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	615.000	614.400	614.340	613.800	612.910
Downstream I	614.400	614.340	613.800	613.320	612.260
Roughness	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.000	3.000	3.000	3.000	3.500



	STM-0378	STM-0378	STM-0378	STM-1259	STM-0885	STM-0885	STM-0885	STM-0381	STM-0886	3484
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		1	2	3			
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevat	620.000			618.800	618.400			617.700	617.200	617.200
Slope	0.009	0.009	0.009	0.000	0.017	0.017	0.017	0.000	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

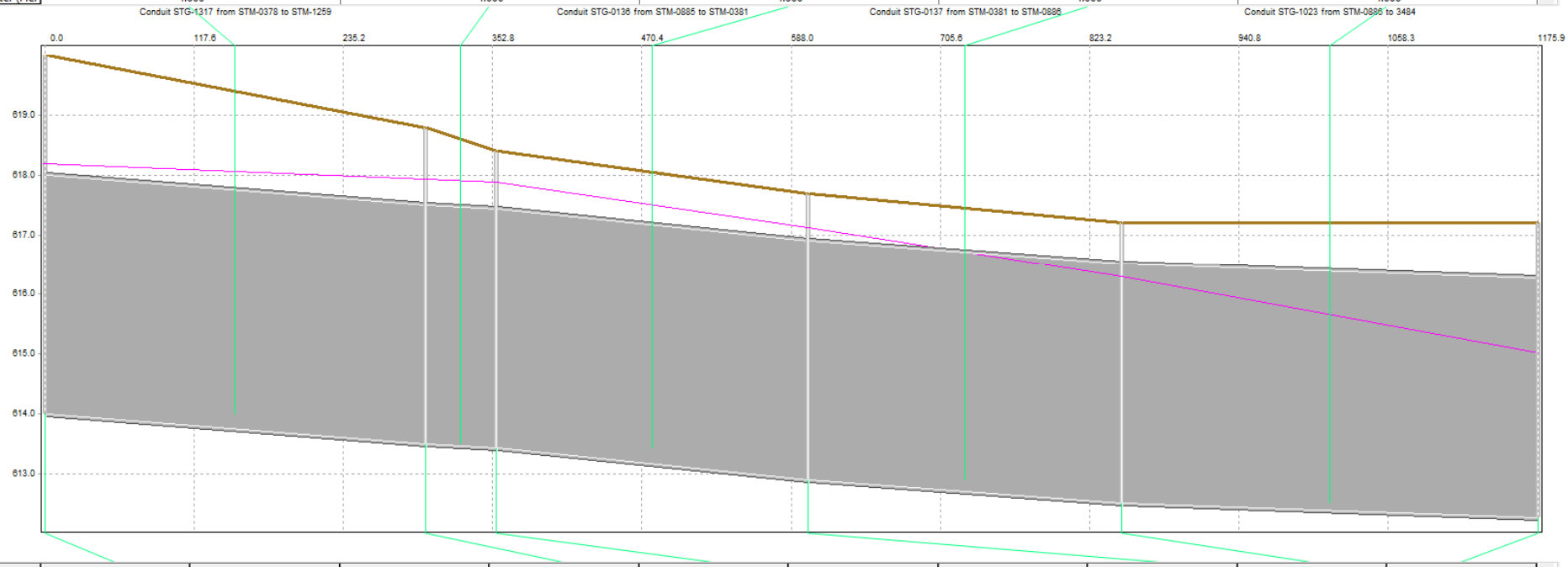
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-8: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1317	STG-1318	STG-0136	STG-0137	STG-1023
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	614.000	613.500	613.440	612.900	612.510
Downstream I	613.500	613.440	612.900	612.510	612.260
Roughness	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000



	STM-0378	STM-0378	STM-0378	STM-1259	STM-0885	STM-0885	STM-0885	STM-0381	STM-0886	3484
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		1	2	3			
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevat	620.000			618.800	618.400			617.700	617.200	617.200
Slope	0.009	0.009	0.009	0.000	0.017	0.017	0.017	0.000	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

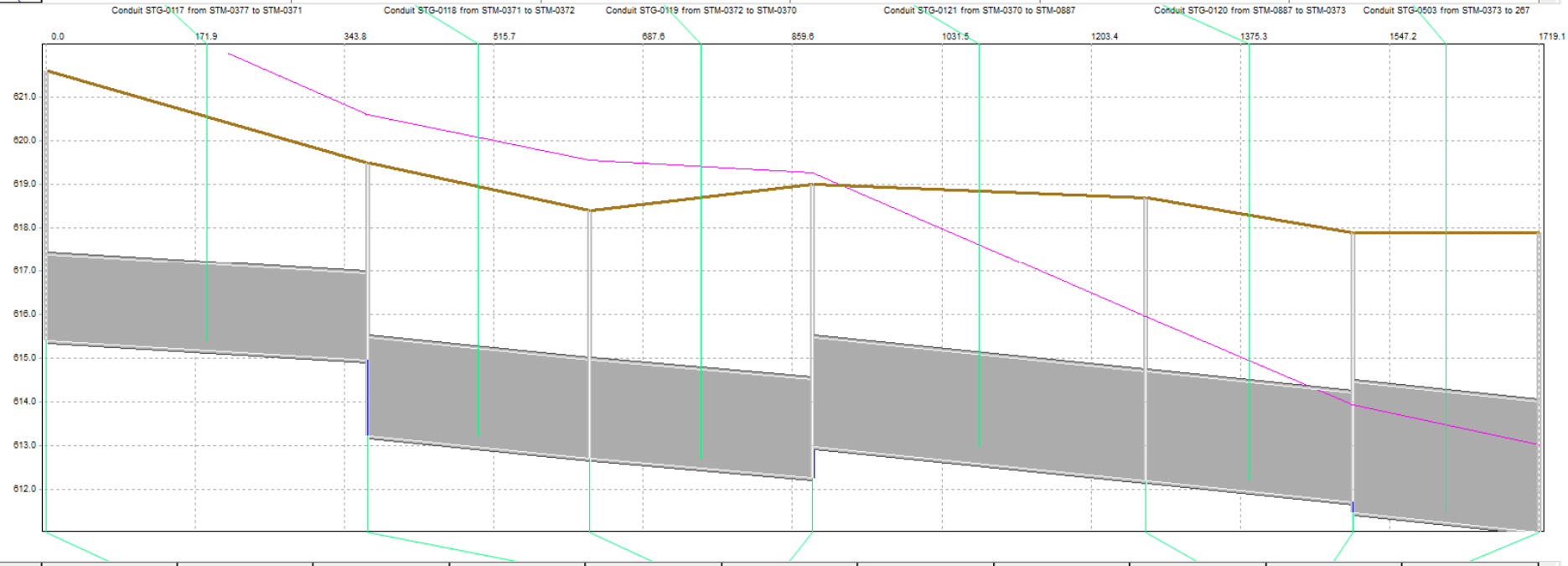
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-9: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0117	STG-0118	STG-0119	STG-0121	STG-0120	STG-0503
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	615.400	613.210	612.710	612.960	612.190	611.450
Downstream I	614.960	612.710	612.260	612.190	611.700	611.000
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.250	2.250	2.500	2.500	3.000



	STM-0377	STM-0377	STM-0377	STM-0371	STM-0372	STM-0370	STM-0370	STM-0370	STM-0887	STM-0373	267
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevati	621.600			619.500	618.400	619.000			618.700	617.900	617.900
Slope	0.013	0.013	0.013	0.000	0.000	0.014	0.014	0.014	0.000	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

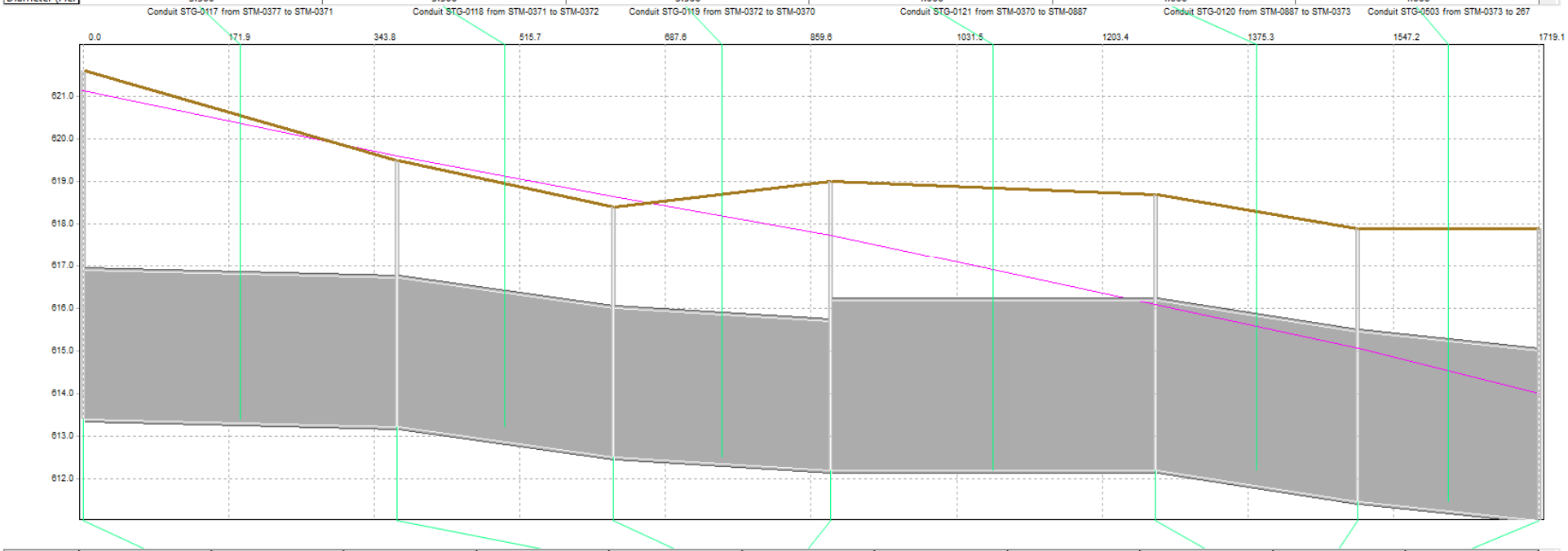
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-9: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0117	STG-0118	STG-0119	STG-0121	STG-0120	STG-0503
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	613.400	613.210	612.510	612.200	612.190	611.450
Downstream I	613.210	612.510	612.200	612.190	611.450	611.000
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	3.500	3.500	3.500	4.000	4.000	4.000



	STM-0377	STM-0377	STM-0377	STM-0371	STM-0372	STM-0370	STM-0370	STM-0370	STM-0887	STM-0373	267
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3			1	2	3			
Ponding Type	Allowed			Allowed	Allowed	Allowed			Allowed	Allowed	Allowed
Ground Elevati	621.600			619.500	618.400	619.000			618.700	617.900	617.900
Slope	0.013	0.013	0.013	0.000	0.000	0.014	0.014	0.014	0.000	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000

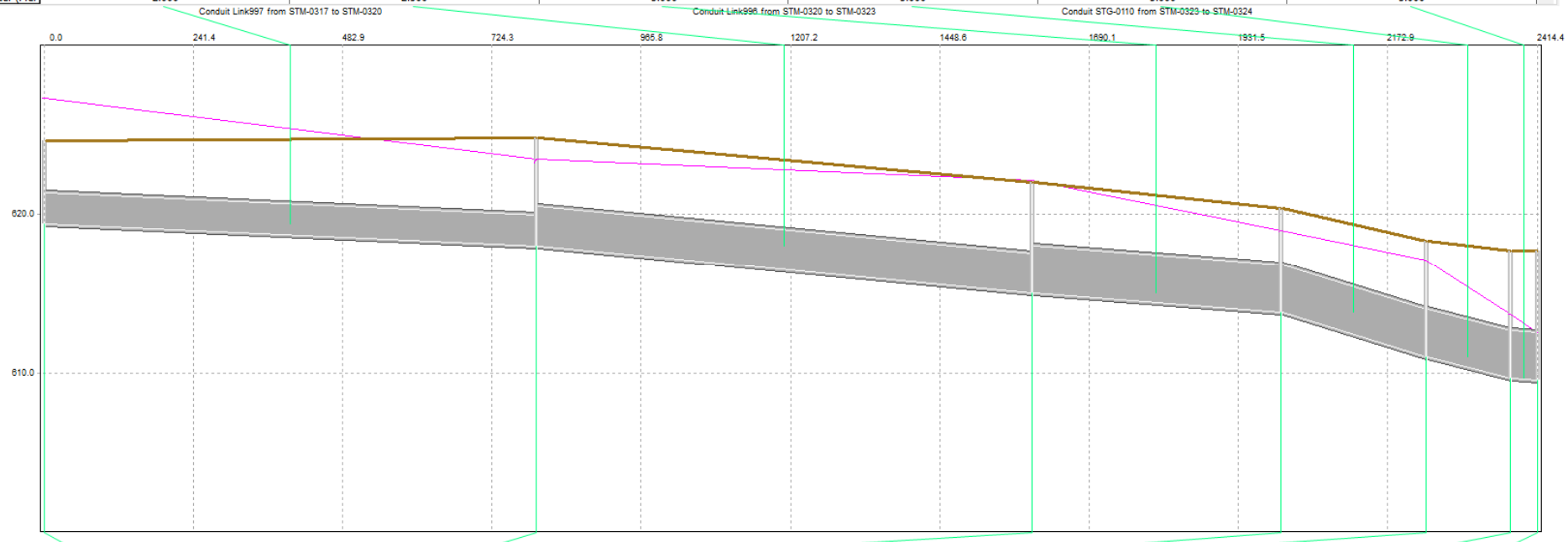
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-10: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	Link997	Link996	STG-0110	STG-0109	STG-0108	Link795
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	619.380	618.010	615.000	613.800	611.050	609.700
Downstream I	618.010	615.000	613.800	611.050	609.700	609.560
Roughness	0.014	0.014	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.500	3.000	3.000	3.000	3.000



	STM-0317	STM-0317	STM-0317	STM-0320	STM-0323	STM-0323	STM-0323	STM-0324	STM-0325	STM-0325	STM-0325	STM-0326	271
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		1	2	3		1	2	3		
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed			Allowed	Allowed
Ground Elevati	624.600			624.800	622.000			620.400	618.300			617.700	617.700
Slope	0.011	0.011	0.011	0.000	0.006	0.006	0.006	0.000	0.007	0.007	0.007	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

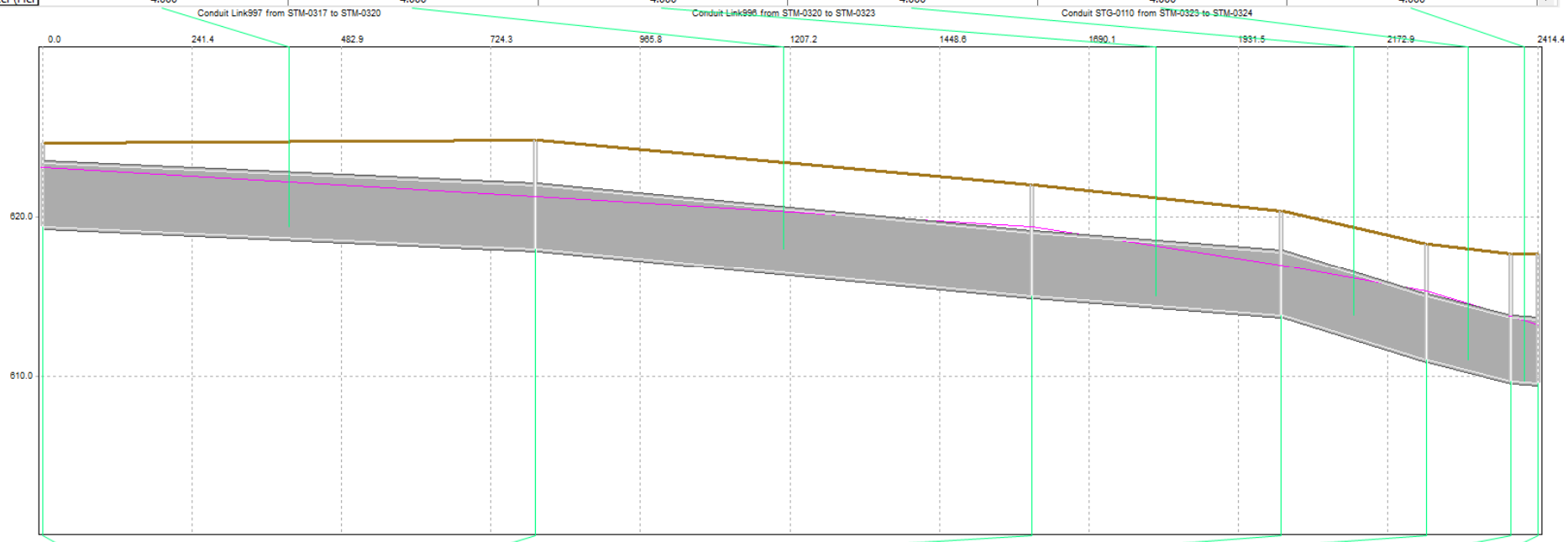
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-10: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	Link997	Link996	STG-0110	STG-0109	STG-0108	Link795
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	619.380	618.010	615.000	613.800	611.050	609.700
Downstream I	618.010	615.000	613.800	611.050	609.700	609.560
Roughness	0.014	0.014	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	4.000	4.000	4.000	4.000	4.000	4.000



	STM-0317	STM-0317	STM-0317	STM-0320	STM-0323	STM-0323	STM-0323	STM-0324	STM-0325	STM-0325	STM-0325	STM-0326	271
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3		1	2	3		1	2	3		
Ponding Type	Allowed			Allowed	Allowed			Allowed	Allowed			Allowed	Allowed
Ground Elevati	624.600			624.800	622.000			620.400	618.300			617.700	617.700
Slope	0.011	0.011	0.011	0.000	0.006	0.006	0.006	0.000	0.007	0.007	0.007	0.000	0.000
Impervious Pe	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

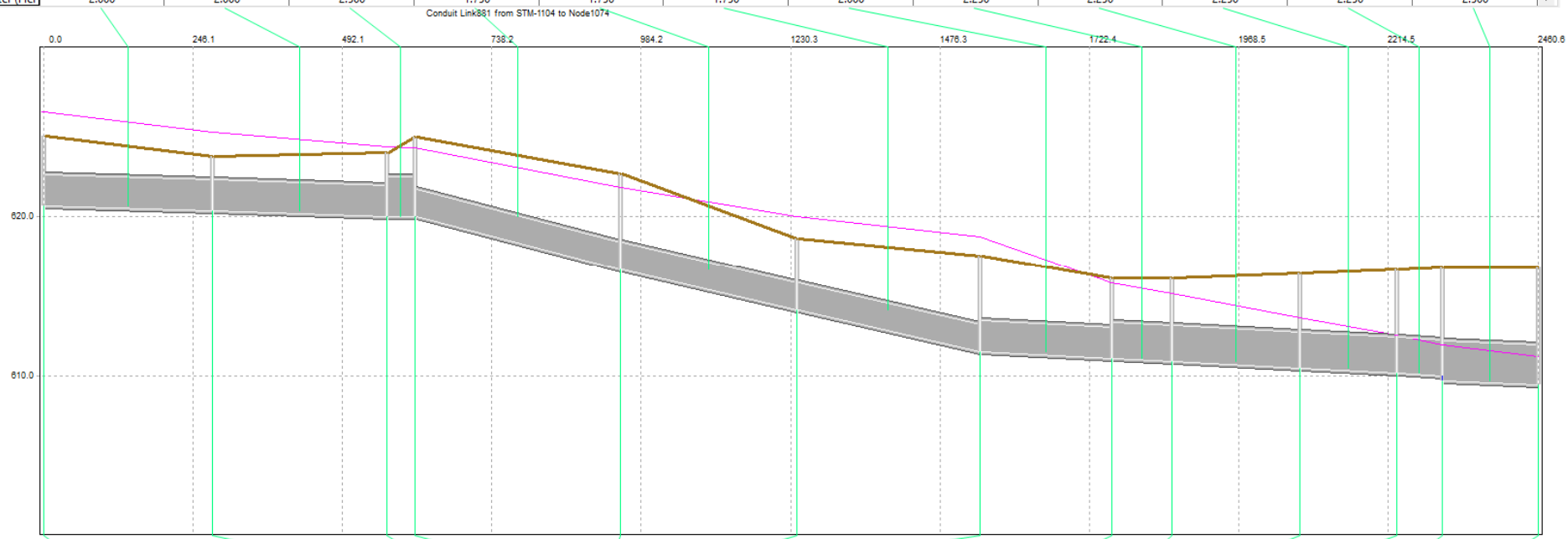
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-11: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1155	STG-1154	STG-1153	Link881	Link882	Link883	STG-1152	STG-0138	STG-0139	STG-0140	STG-0141	Link798
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	620.700	620.400	620.040	620.000	616.700	614.100	611.500	611.080	610.890	610.470	610.150	609.700
Downstream I	620.400	620.040	620.000	616.700	614.100	611.500	611.080	610.890	610.470	610.150	610.000	609.470
Roughness	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.500	1.750	1.750	1.750	2.000	2.250	2.250	2.250	2.250	2.500



	STM-1107	STM-1107	STM-1107	STM-1106	STM-1105	STM-1104	Node1074	Node1075	STM-0891	STM-0891	STM-0891	STM-0379	STM-1017	STM-0890	STM-0889	STM-0380	115
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3						1	2	3						
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	625.030			623.800	624.000	625.000	622.700	618.600	617.500			616.100	616.100	616.400	616.700	616.800	616.800
Slope	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000

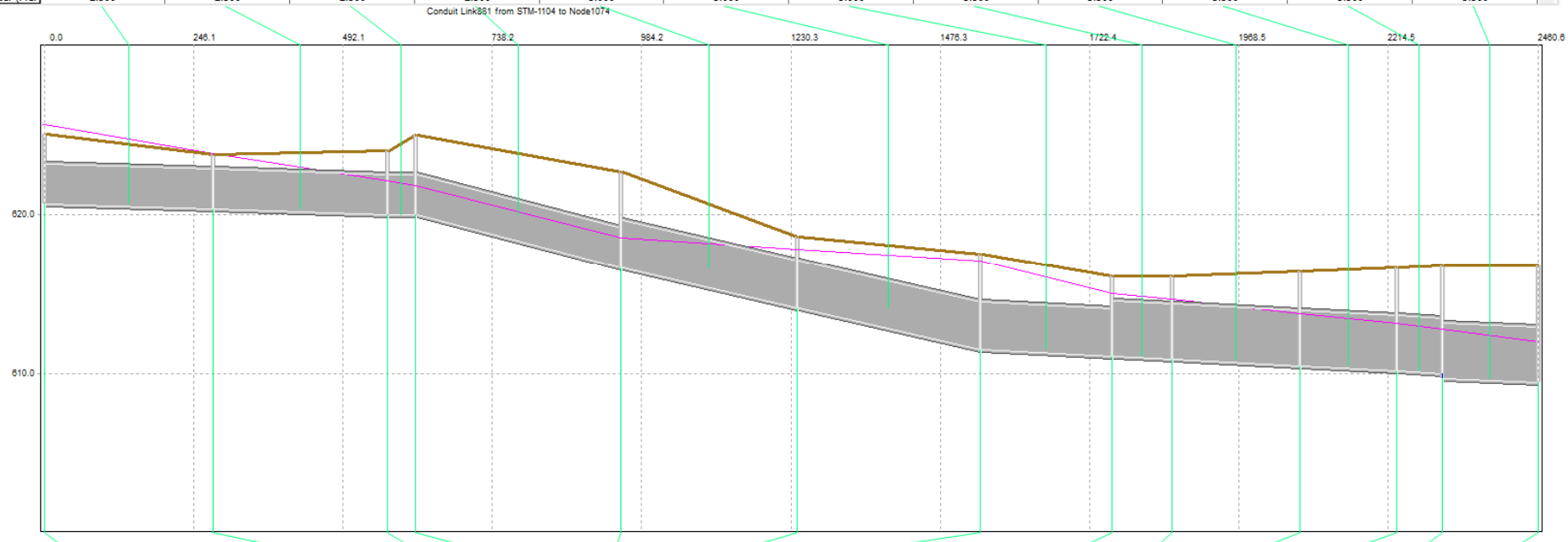
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-11: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-1155	STG-1154	STG-1153	Link881	Link882	Link883	STG-1152	STG-0138	STG-0139	STG-0140	STG-0141	Link798
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	620.700	620.400	620.040	620.000	616.700	614.100	611.500	611.080	610.890	610.470	610.150	609.700
Downstream I	620.400	620.040	620.000	616.700	614.100	611.500	611.080	610.890	610.470	610.150	610.000	609.470
Roughness	0.013	0.013	0.013	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.500	2.500	2.500	2.500	3.000	3.000	3.000	3.500	3.500	3.500	3.500	3.500



	STM-1107	STM-1107	STM-1107	STM-1106	STM-1105	STM-1104	Node1074	Node1075	STM-0891	STM-0891	STM-0891	STM-0379	STM-1017	STM-0890	STM-0889	STM-0380	115
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3						1	2	3						
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed			Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Ground Elevat	625.030			623.800	624.000	625.000	622.700	618.600	617.500			616.100	616.100	616.400	616.700	616.800	616.800
Slope	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000

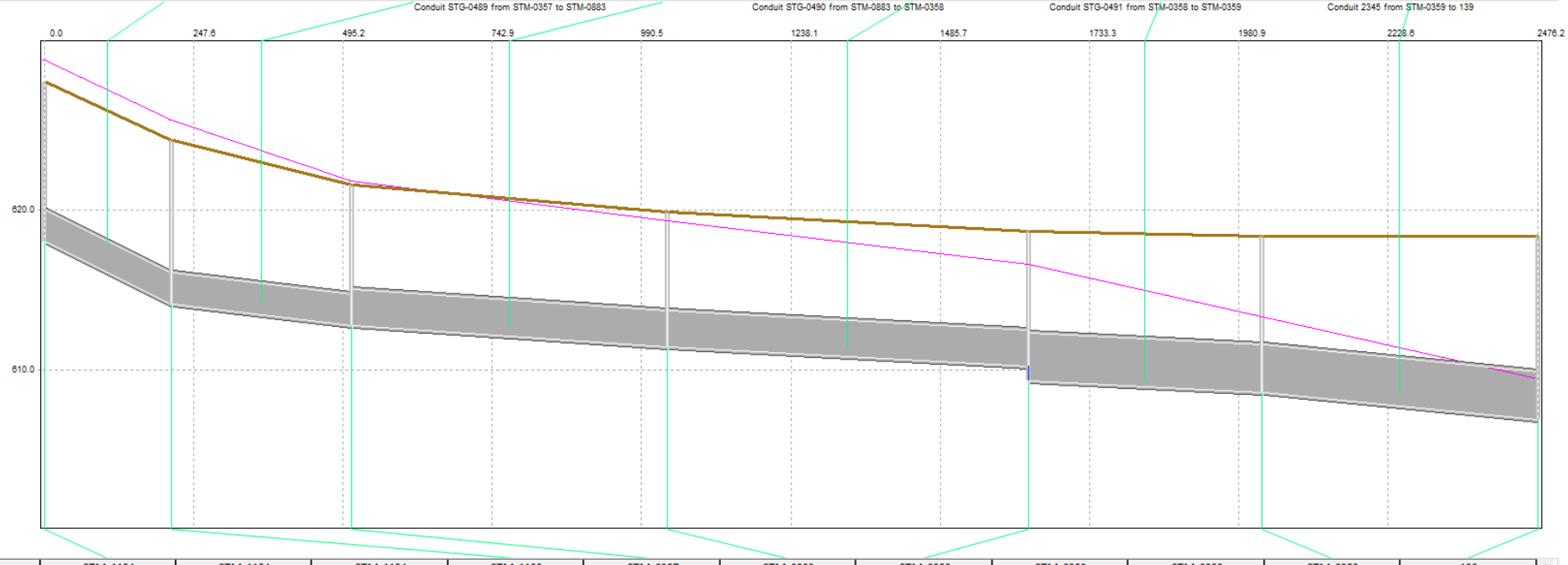
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-12: Existing

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0487	STG-0488	STG-0489	STG-0490	STG-0491	2345
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	618.000	614.100	612.760	611.450	609.350	608.580
Downstream I	614.100	612.760	611.450	610.260	608.580	606.880
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	2.250	2.250	3.000	3.000



	STM-1154	STM-1154	STM-1154	STM-1155	STM-0357	STM-0883	STM-0358	STM-0358	STM-0358	STM-0359	139
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3				1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevat	628.000			624.400	621.600	619.900	618.700			618.400	618.400
Slope	0.008	0.008	0.008	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

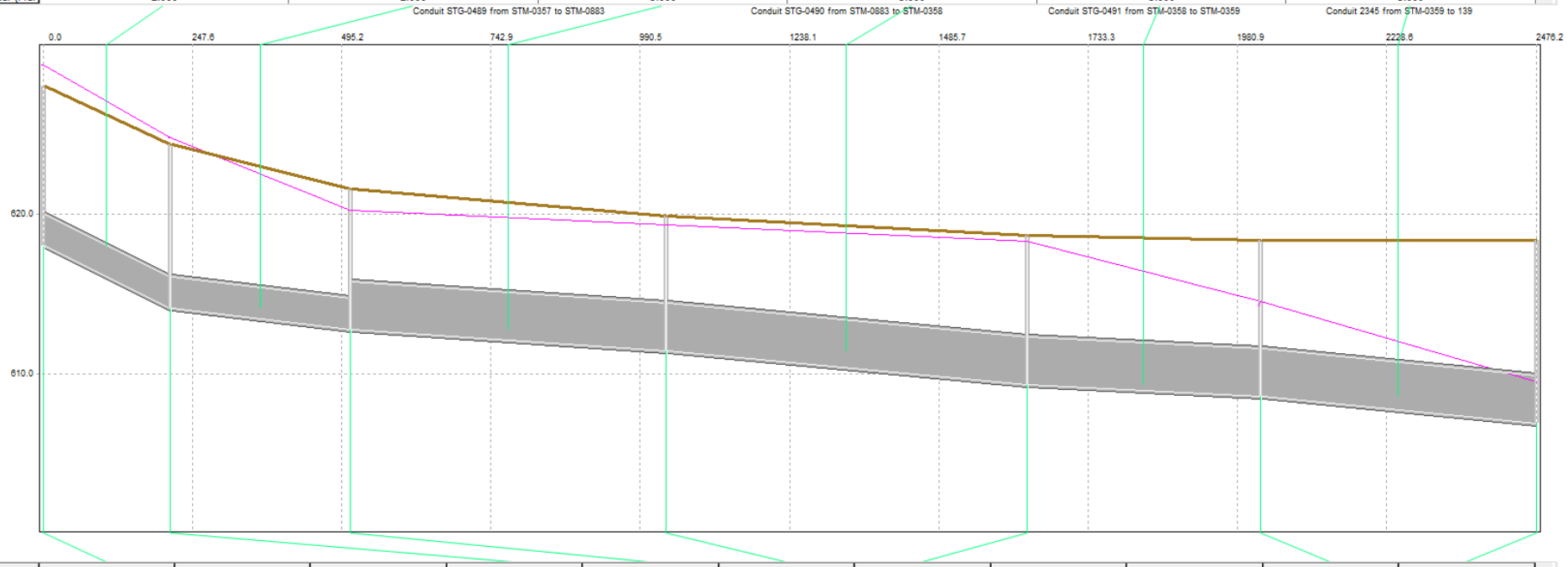
Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration

Project STC-12: Proposed

Untitled
Day [0]Time 00:00:00 Step 0

Pipe Parameters

	STG-0487	STG-0488	STG-0489	STG-0490	STG-0491	2345
Storm	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR
Upstream Inve	618.000	614.100	612.760	611.450	609.350	608.580
Downstream I	614.100	612.760	611.450	609.350	608.580	606.880
Roughness	0.013	0.013	0.013	0.013	0.013	0.013
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Diameter (Hei	2.000	2.000	3.000	3.000	3.000	3.000



	STM-1154	STM-1154	STM-1154	STM-1155	STM-0357	STM-0883	STM-0358	STM-0358	STM-0358	STM-0359	139
Storm	10 YR 24HR			10 YR 24HR	10 YR 24HR	10 YR 24HR	10 YR 24HR			10 YR 24HR	10 YR 24HR
Subcatchment	1	2	3				1	2	3		
Ponding Type	Allowed			Allowed	Allowed	Allowed	Allowed			Allowed	Allowed
Ground Elevati	628.000			624.400	621.600	619.900	618.700			618.400	618.400
Slope	0.008	0.008	0.008	0.000	0.000	0.000	0.008	0.008	0.008	0.000	0.000
Impervious Pe	0.000	100.000	100.000	0.000	0.000	0.000	100.000	100.000	0.000	0.000	0.000

Manhole Parameters | Runoff Parameters | Node Assumptions | Manhole Depth/Duration