

Prepared by: EOR for the City of Fitchburg  
EOR Project #01052-0009

Final Report – submitted November 2021.

## Cheryl Drive Flooding Analysis



### Cover Images

Street flooding on Cheryl Drive, June 7, 2021 (~1.25" rainfall over two hours). Looking west from the Jacquelyn Drive intersection.

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## VERSION REGISTRY AND CONTRIBUTORS

### Issues and Revisions Registry

Identification	Date	Description of Issue and/or Revision
Draft Report	August 9, 2021	Draft Report for City review
Revised Draft Report	September 10, 2021	Draft Report with revisions based on City comments

### Primary Authors (EOR)

Nick Hayden, MS, PE, GISP

### Significant Contributors

Claudia Guy, PE (City of Fitchburg)

Gabe Lujan, EIT (EOR)

Steve Gaffield, Ph.D, PE (EOR)

## **ACRONYMS**

DEM – Digital Elevation Model

EPA – Environmental Protection Agency

GIS – Geographic Information Systems

NOAA – National Oceanic and Atmospheric Administration

NRCS – National Resources Conservation Service

SSURGO – Soil Survey Geographic Database

SWMM – Storm Water Management Model

## 1. STUDY BACKGROUND

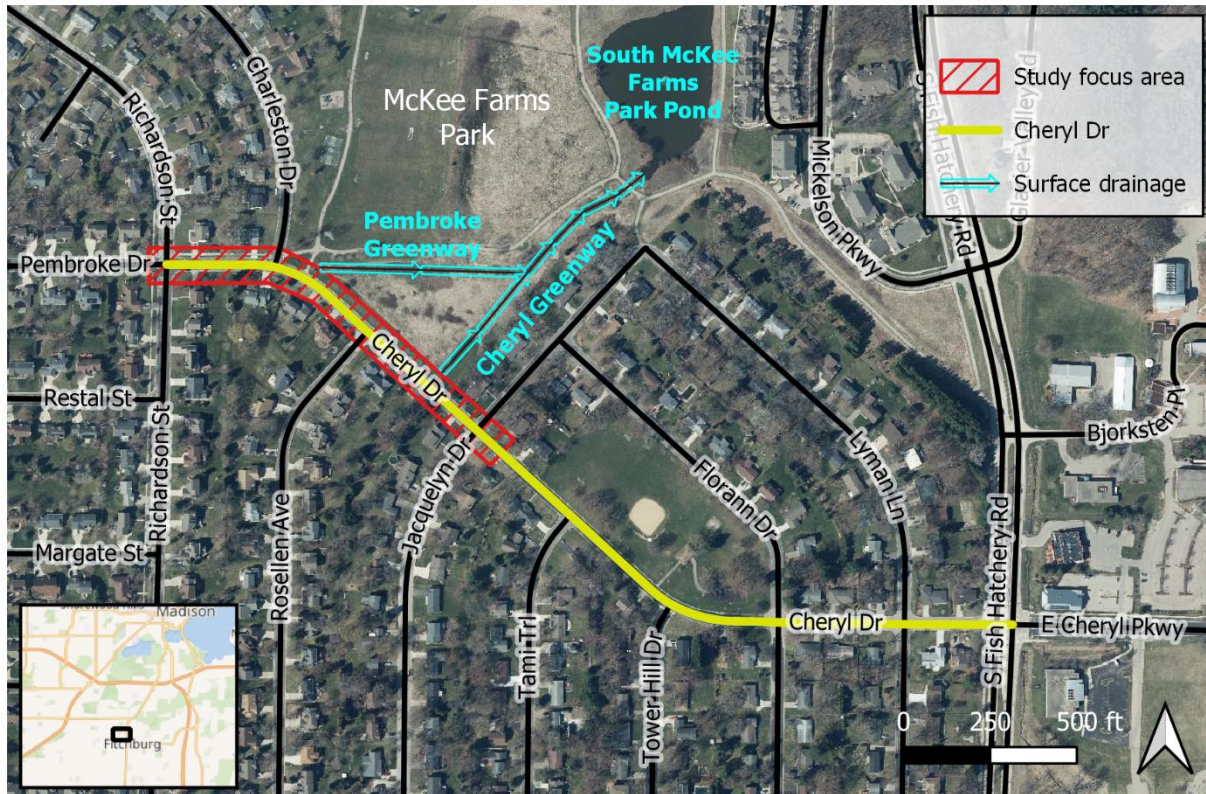
### 1.1. Introduction

Cheryl Drive (**Figure 1**) is an 8-block long residential street in the Tower Hill neighborhood of the City of Fitchburg (City). Street flooding along the western portions of Cheryl Drive from Richardson Street to Jacquelyn Drive is a known issue which has worsened over the last 20 years. Based on resident accounts, the Charleston Drive – Cheryl Drive intersection has typically experienced standing water in the roadway several times per year, which has backed up onto residents' lawns and driveways during heavier rains. The Jacquelyn Drive – Cheryl Drive intersection also experiences street flooding during relatively common rainfall events.

The section of Cheryl Drive between Charleston Drive and Jacquelyn Drive is a topographic low area that receives runoff from three directions (west, south, and east) including relatively steep areas to the south. Once runoff from the drainage area reaches this portion of Cheryl Drive, it drains through the storm sewer network into two surface drainage channels (swales) in McKee Farms Park that carry water northeast to two connected stormwater ponds in the park (see **Figure 1**). These swales, particularly the western one that starts near the Charleston Drive intersection, have partially filled with sediment since construction. This sediment has covered the concrete weirs at the start of each swale, which limits outflow from the storm sewer into the swales during runoff events.

This section of Cheryl Drive roadway has a watershed drainage area of 222 acres (see **Appendix A – Figure 1**), most of which is drained by the storm sewer network (via curb inlets). While the watershed area does not contain large commercial, industrial, or multi-family housing complexes, the streets are wide by current standards and contribute to an impervious cover of over 32% for the drainage area. This amount of runoff-producing imperviousness, combined with the fact that there is no stormwater storage upstream of Cheryl Drive, has contributed to these flooding issues.

This area also has problems with backyard and basement flooding issues, seemingly related to recent high groundwater as well as the designed backyard drainage systems that have subsided, been modified, or otherwise rendered ineffective over time. This report does not cover these private drainage issues but improving the ability of the City stormwater management system to effectively drain water is part of potential solutions for these private issues. A separate, ongoing analysis is being conducted by the City which will assess the feasibility of a City-wide private drainage issue assistance program.



**Figure 1. Project area overview.**

## 1.2. Study Purpose

The City hired Emmons & Olivier Resources, Inc. (EOR) in Spring 2021 to conduct an analysis of flooding along Cheryl Drive. This study has been a collaborative effort between the City and EOR and included interactions with residents via surveys and public information meetings. The key study outcomes were:

- Develop an urban stormwater computer model capable of simulating flooding during rain events.
- Determine the main causes of existing street flooding in the Cheryl Drive area, including potential impacts from downstream stormwater management systems.
- Identify potential solutions and test their efficacy using the stormwater model.
- Create preliminary figures and cost estimates for proposed solutions.
- Present all findings to local residents during a final public information meeting and recommend solutions to the City.

This report describes these outcomes and the steps that led to them, including data collection, model development and testing, designing solutions, estimating solution costs, and our final conclusions and recommendations.

## 2. BACKGROUND INFORMATION

### 2.1. Data Compilation

The following background information on the study area was provided by the City (or other sources as indicated):

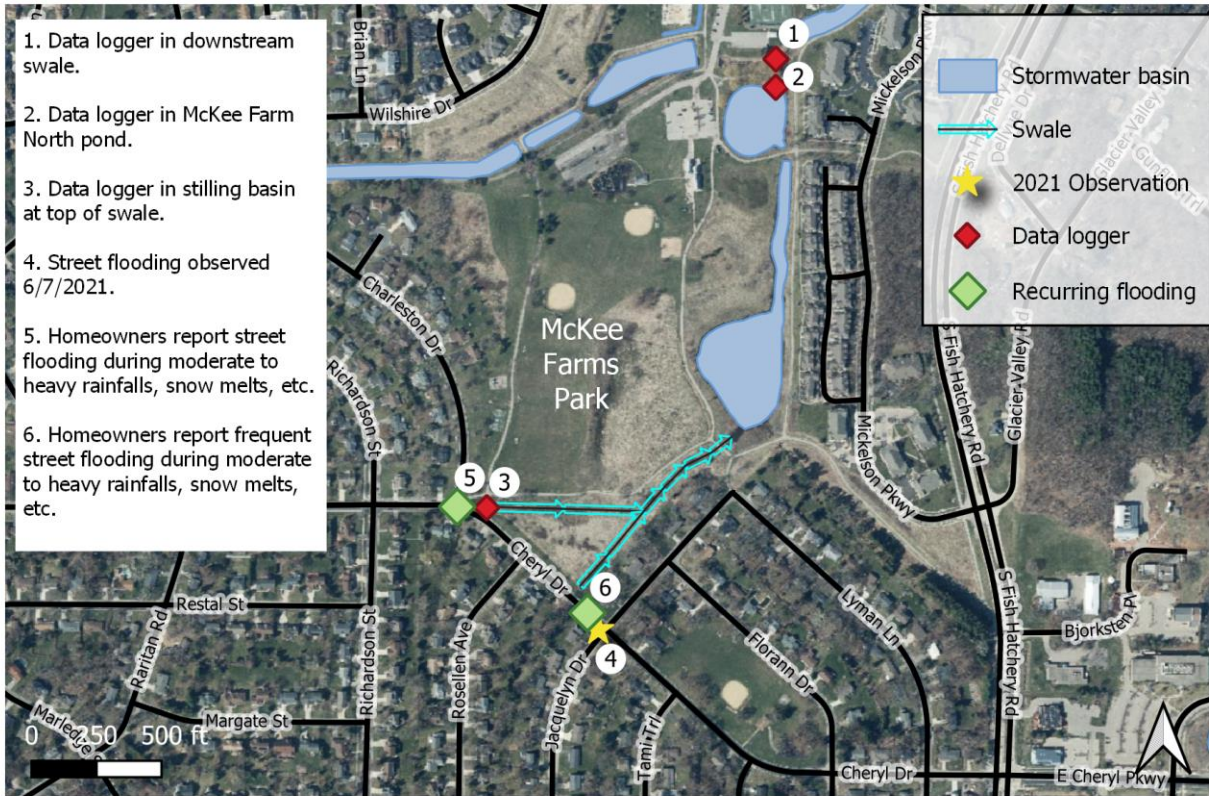
- Storm sewer design drawings, as-built records, calculations, and survey
- Photos from historical events including July 21, 2016
- Summaries of resident concerns and comments from previous meetings and other interactions
- GIS vector data, including:
  - Storm sewer and sanitary sewer data, including pipes, structures, and outfalls
  - Storm sewer basin footprints
  - Roads (Dane County)
  - Building footprints (Dane County)
  - Soils (NRCS)
  - Parcels (Dane County)
- 2020 6" leaf-off aerial imagery (Dane County)
- 2017 2 ft resolution LiDAR DEM (Dane County)
- Rainfall data from unofficial citizen data (from Weather Underground) and from NOAA

### 2.2. Field Data Collection and Observations

Observing storm sewer system response during rain events was considered crucial to understanding the problem along Cheryl Drive. The following qualitative and quantitative data were collected, which are summarized on **Figure 2**:

- Observations and photos during 1.25" of rainfall in two hours on June 6<sup>th</sup>, 2021. This storm, which was highly localized over the City and Tower Hill neighborhood, resulted in street flooding at the intersection of Cheryl Drive and Jacquelyn Drive including stormwater surcharging from the inlets at the southwest corner of that intersection. The McKee Farms swales and culverts were nearly full during this event, but there was no street flooding observed at the intersection of Cheryl Drive and Charleston Drive. Unfortunately, there were no additional intense rainfall events directly observed by City staff during the project, as summer 2021 was dry and intense rainfalls tended to occur only at night and/or on weekends.
- Photographs and a video provided by a resident during 0.75" of rainfall over 45 minutes on Saturday, August 7, 2021. The video and photographs showed street flooding at the intersection of Cheryl Drive and Charleston Drive. It should be noted that there was a significant storm the night prior (1.3"), so it is likely that the upstream watershed was saturated and unable to absorb water at the time of this event.
- Historical observations from landowners and City photographs and other records helped to identify the locations and frequency of street flooding in the project area. An online survey was created and

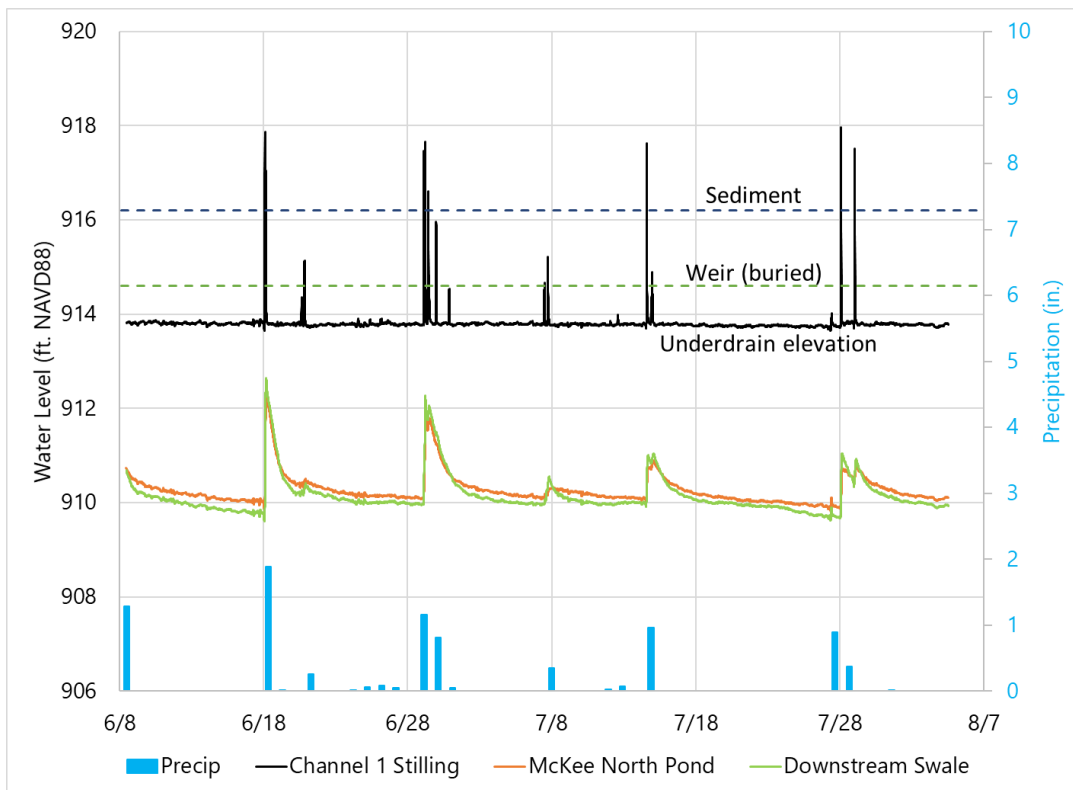
distributed to nearby homeowners prior to the first public information meeting. These various data suggested that the Cheryl Drive – Charleston Drive intersection was frequently flooded (five or more time per year) including over-the-curb intersection flooding and hazardous driving lane conditions shown in photographs from 7/21/2016, when approximately 2.8" of rain fell over two hours at the nearest hourly precipitation gage (MSN airport). Homeowners also identified the section of Cheryl Drive to the east near Jacquelyn Drive as having frequent street flooding.



**Figure 2. Field data collection and Cheryl Drive street flooding reports / observations.**

- The City collected GPS survey of storm sewer and surface drainage features within the project focus area on several dates.
- Water level loggers were installed in three stormwater management features on June 8<sup>th</sup>, 2021. These automated pressure sensors collected water level readings every 5 minutes until the end of the monitoring period (August 4<sup>th</sup>, 2021). The three locations selected for monitoring were:
  - Location 1: The swale (“Nine Springs Creek” headwaters) downstream of the culverts that drain the McKee Farm Park North Pond.
  - Location 2: The connected two-pond system (McKee Farm Park “North” and “South” ponds), placed near the North Pond outlet.

- Location 3: The stilling basin at the upstream end of the swale that drains the Cheryl Drive – Charleston Drive intersection (Channel 1).
- The water level logger data and daily rainfall from the nearest NOAA weather station (UW Arboretum) are shown in **Figure 2**. Key observations / interpretations are briefly described below:
  - The monitoring period was relatively dry compared to a typical summer, with only 4 events over 0.8" and one over 1" (1.89" on 6/18).
  - Water levels in the ponds only rose more than one ft on two occasions and water levels receded fairly quickly (within a few days).
  - The stilling basins for Channels 1 and 2 each consist of a storm sewer pipe outfall, an 18" underdrain pipe that carries low flows underground towards the South Pond, and a higher concrete weir section that forms the start of the swale that carries higher flows downstream. For most of the period, water levels were even with the invert of the underdrain. On five separate occasions, the water levels in the Channel 1 stilling basin rose higher than the sediment deposited over the buried weir and flowed down the channel. As shown in **Figure 2**, if the weir and upstream end of the channel was not buried with sediment, water levels in the stilling basin likely would not have reached these levels. The upstream (storm sewer) implications of this are explored in later report sections.



**Figure 3. Water level and rainfall data.**

### 2.3. Design Criteria

The City generally follows Wisconsin Department of Transportation (WisDOT) guidance for storm sewer design criteria. City requirements for new storm sewer design in residential areas include:

- For the 10-yr design storm, storm sewer pipes should be designed to carry the 10-year storm and inlets should be spaced so that there is a driveable lane in the center of the street.
- For the 25-yr design storm, storm sewer structures should not surcharge and flow should be within the banks of any roadside ditches.
- For the 100-yr design storm, flooding should be contained within the street right-of-way.

The 24-hour design storms assessed during this project are those typically used in Dane County, which are based on NOAA Atlas 14 rainfall depths and use the prescribed MSE4 temporal distribution. These totals are shown in **Table 1**.

**Table 1. Design storm rainfall depths.**

<b>Design Storm (Recurrence Interval)</b>	<b>24-hr Rainfall Depth (MSE4 Distribution)</b>
2-yr	2.84"
5-yr	3.49"
10-yr	4.09"
25-yr	5.01"
50-yr	5.80"
100-yr	6.66"

For this project the 24-hr, 10-yr design storm (4.09") was the main assessment rainfall during model diagnostics and scenario testing, but larger storms were also checked. The new construction design standards were considered for reference but achieving the new construction targets was typically not possible in this area. Even though much of the contributing watershed area was constructed prior to current stormwater detention and infiltration standards, there are several stormwater management features present nearby (i.e. McKee Farms Park ponds). But these features are all just downstream of the problem areas being analyzed by this project (along Cheryl Drive), so there is essentially no designed stormwater detention or infiltration upstream of the problem area. Additionally, southern WI has become wetter and experienced more intense storms in the past few decades, which means that older storm sewer systems are typically undersized to handle modern design storms.

### 3. WATERSHED AND STORM SEWER MODEL CONSTRUCTION

A combined hydrology and hydraulics (H&H) model of the area including Cheryl Drive was constructed and used to assess current storm sewer performance and flooding issues. The EPA's Storm Water Management Model (EPA SWMM) and related proprietary software are considered the gold standard for modeling storm sewer systems in the U.S., and EPA SWMM version 5.1.015 was used as the basis for the Cheryl Drive model. A proprietary software (CHI's "PCSWMM") was used to assemble the one-dimensional (1-D) EPA SWMM model; using PCSWMM also allowed EOR to implement two-dimensional (2-D) mapping routines in specific model areas. 2-D mapping is beneficial for urban and storm sewer modeling because it better represents overland flow routes, including determining the fate of "excess" runoff that cannot be conveyed with the storm sewer and instead travels downhill along roadways and other paths (over curbs, through backyards, etc.). The model was constructed mainly based on the data sources identified in **Section 2.1**, with the key data layers being the City's storm sewer GIS layers (pipes, structures, and inlets) and the county-wide 2017 digital elevation mode. **Figure A1 (Appendix A)** shows the resulting model schematic including the storm sewer network, downstream surface water drainage, 2-D flow areas, and subcatchments.

SWMM models have multiple rainfall infiltration method options and dozens of parameters that need to be estimated; for consistency's sake, the Cheryl Drive model was constructed and parameterized based on methods developed by the City of Madison in their ongoing, city-wide SWMM modeling efforts that followed the 2018 storms. Key model options are briefly summarized below:

- Infiltration method: Modified Horton, using City of Madison maximum and minimum infiltration rates based on Hydrologic Soil Groups mapped in the current NRCS SSURGO soils GIS data.
- Subcatchment hydrology:
  - Impervious fraction based on the Dane County impervious GIS layer which contain building footprints and roof overhangs, augmented by digitizing missing impervious surfaces (roads and driveways).
  - Impervious depression storage and Manning's n "roughness": 0.05" and 0.016, based on standard literature values for impervious ground surfaces.
  - Pervious depression storage and Manning's n "roughness": 0.15" and 0.2, based on standard literature values for the dominant pervious land use (turf grass and other landscaping).
  - Slope based on resampling the County 2017 DEM from 2 ft resolution to 50 ft to remove vertical exaggerations, then averaging the slope of the 50 ft layer over each subcatchment.
- 1-D Storm sewer network:
  - Pipes – the City GIS layer contained sizes for all pipes, and most of the pipes had elevation information for both upstream and downstream ends. Pipes in the problem areas along Cheryl Drive were resurveyed by the City at the start of the project. Standard roughness values and junction loss coefficients were added based on pipe material and junction geometry.

- Structures – the City GIS layers provided the location of manholes and inlets, and rim and bottom elevations were resurveyed for structures in the problem areas. Inlet type was identified for the key inlets along Cheryl Drive, and capacity curves provided by Neenah Foundry were applied to the appropriate inlets. Curb inlets farther from the problem areas that were not identified by type were assumed to have a common grate geometry (~18" x 36") and behave as orifice with a discharge coefficient of 0.6.
- 1-D surface water drainage (McKee Farms Park):
  - The downstream area in McKee Farms Park was modeled in 1-D, as flow directions were more predictable there than in the residential area, and because it was much easier to assess the impacts of changes (dredging swales, adding offline storage areas) by modifying 1-D hydraulics layers.
  - The swale geometries were based on a series of survey lines collected by the City, which were typically spaced every 100 ft but were collected with much closer spacing at the upstream ends of each swale. The elevations of the weirs and underdrain pipes at the upstream end of both swales, and the six culverts at the entrance of the southern pond, were confirmed by City survey crew.
- 2-D flow areas:
  - The roadways and backyard drainage paths upstream of Cheryl Drive were modeled using an "adaptive" shaped grid, with a 50 ft grid resolution, which was considered adequate for modeling ponding near the storm sewer inlets and transporting overland flow downhill to Cheryl Drive.
  - A more detailed and smaller (20 ft resolution) "adaptive" grid was used along Cheryl Drive. The smaller cell spacing allowed for more detail in modeling storm sewer inlet hydraulics and calculating road flooding and overflows.
  - The 2-D mesh cells were connected to the 1-D network using bottom orifice elements at storm sewer inlets and at areas where the 2-D network transitioned back to 1-D at the upstream ends of the swales.
- Simulation options:
  - Dynamic Wave routing with inertial terms set to "Ignore"
  - One-second hydraulic routing time step
  - Variable time steps adjusted by up to 75%, with a minimum variable time step of 0.5 seconds
  - Five-minute reporting time step
  - Minimum node surface area of one SF
  - Head convergence tolerance of 0.0005 ft

The constructed model was tested and refined until it met typical model standards, including checking that water was not erroneously lost from the system ("Flooding Loss" = 0.0 acre-feet) and that continuity errors for both the runoff generation and flow routing modules was less than one percent.

## 4. DIAGNOSTICS AND SOLUTIONS TESTING

### 4.1. Existing Conditions Diagnostics

#### 4.1.1. Focused Analysis Locations

The existing conditions model was assessed, primarily with the 10-yr design storm, to determine how the storm sewer and downstream surface drainage was functioning. The diagnostics focused on six model areas which are shown on **Figure 4** and described below.

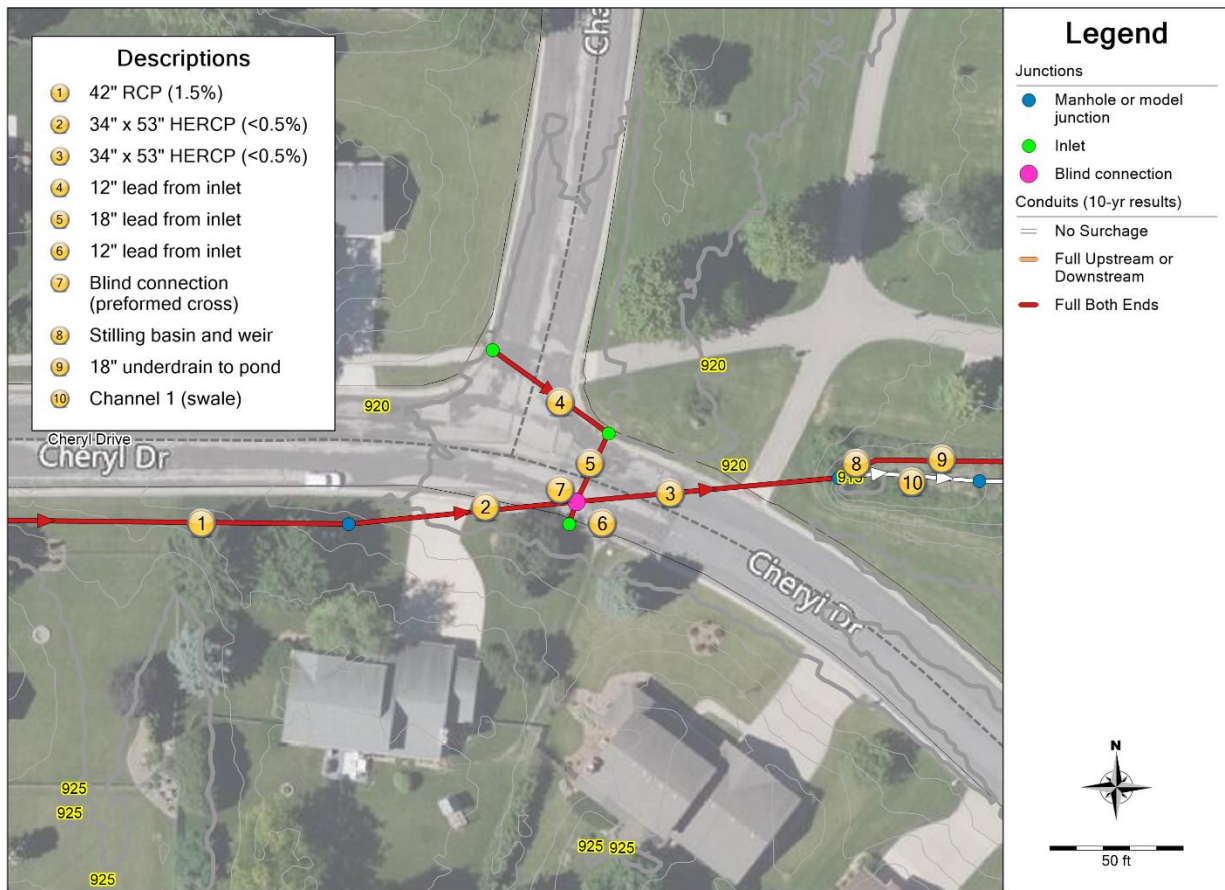


**Figure 4. Focused analysis locations.**

1. Cheryl-Pembroke-Richardson intersection. This location, where Richardson Street intersects with Pembroke Drive to the west and Cheryl Drive to the east, is along a section of roadway that flows downhill at a steeper slope (~2%) than other sections of Cheryl Drive. There are six inlets at this intersection. Stormwater that is not captured by these inlets flows downhill along Cheryl Drive towards the Cheryl-Charleston intersection, potentially exacerbating the known flooding problems there.
2. Cheryl-Charleston intersection. This location is shown in greater detail in **Figure 5**. Flooding problems at this specific intersection prompted this project. The storm sewer here transitions from a 42" diameter circular pipe at 1.5% slope to the west to a 34" x 53" elliptical pipe at a much lower

slope (<0.5%) at a location in the terrace approximately 60 ft to the west of the intersection, and this same size elliptical pipe continues to the stilling basin at the upstream end of the western swale in McKee Farms Park. The low slope and elliptical design of the sewer here suggests that the original designers wanted to ensure there was adequate cover between the tops of the pipes and the roadway.

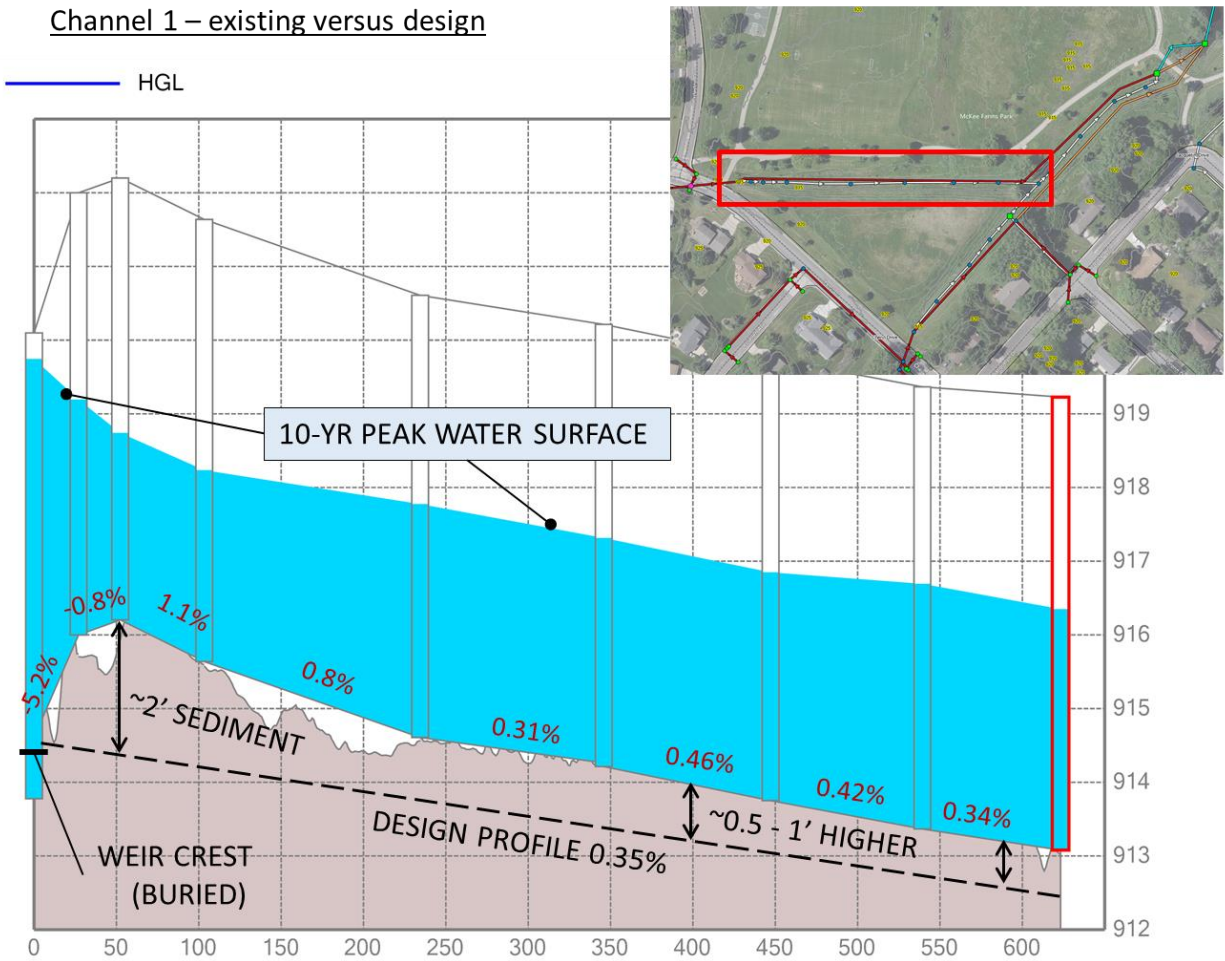
There is also a “blind connection” (no manhole) along the elliptical pipe in the intersection where pipes from the three intersection inlets connect to the elliptical pipe at 90 degree angles. This connection is described in the original plans as a “preformed cross”, which appears to be failing (slipped joints) when viewed from the available vantage point from the southern intersection inlet. This slipped connection is likely limiting drainage from the intersection and could possibly create sinkhole conditions due to excessive leakage.



**Figure 5. Storm sewer and start of Channel 1 near Cheryl-Charleston intersection.**

3. “Channel 1” (western swale). The original McKee Farms Park drainage plan identifies the western swale as “Channel No. 1,” now referred to as Pembroke Greenway. This channel starts at a very shallow stilling basin at the outfall of the elliptical pipe coming from the Cheryl-Charleston

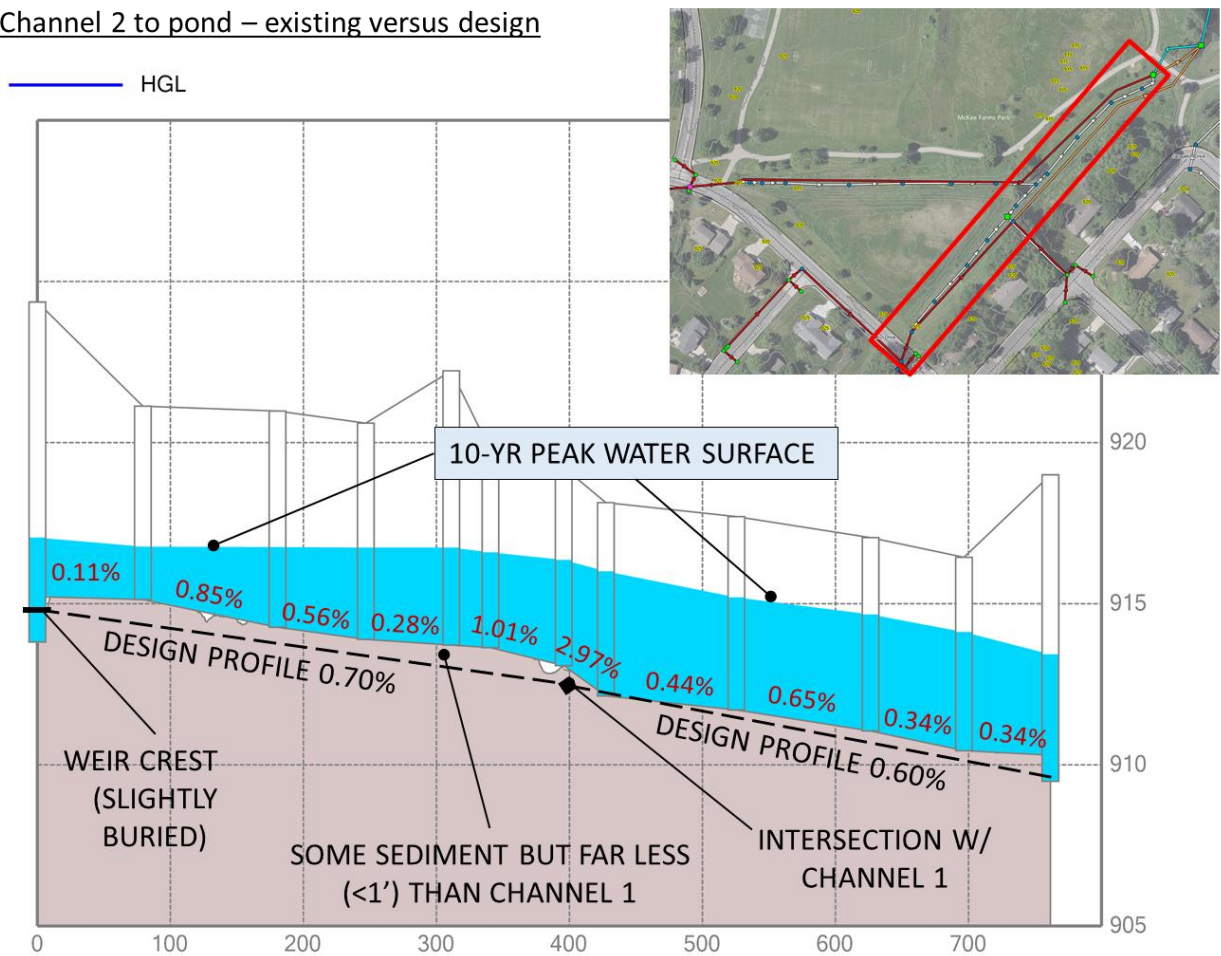
intersection. There is an 18" underdrain pipe that captures lower flows from the stilling basin and daylights just upstream of the six culverts that drain the swales into the McKee Farms Park South Pond. When the water level in the stilling basin is higher, such as during runoff events, the water enters Channel 1 by flowing over a concrete trapezoidal weir that was designed to be 4" higher than the invert of the underdrain. However, the weir has a significant amount of sediment and what appears to be fine-grained asphalt or chip-sealing debris. This mound of sediment continues downstream approximately 100 ft, with a maximum elevation approximately 2.0 ft higher than the designed elevation of Channel 1. This sediment is also heavily vegetated with thistles and nettles which are likely to inhibit water flow. The deposited sediment and vegetation thins out downstream of the mound at the upper end, but the channel is still generally 0.5 – 1.0 ft higher than designed throughout its length. The sediment deposit just downstream of the weir, as well as a comparison of the current channel profile and slopes to the designed slope (0.35%) and profile, is shown on Figure 6.



**Figure 6. Existing Channel 1 swale profile compared to design.**

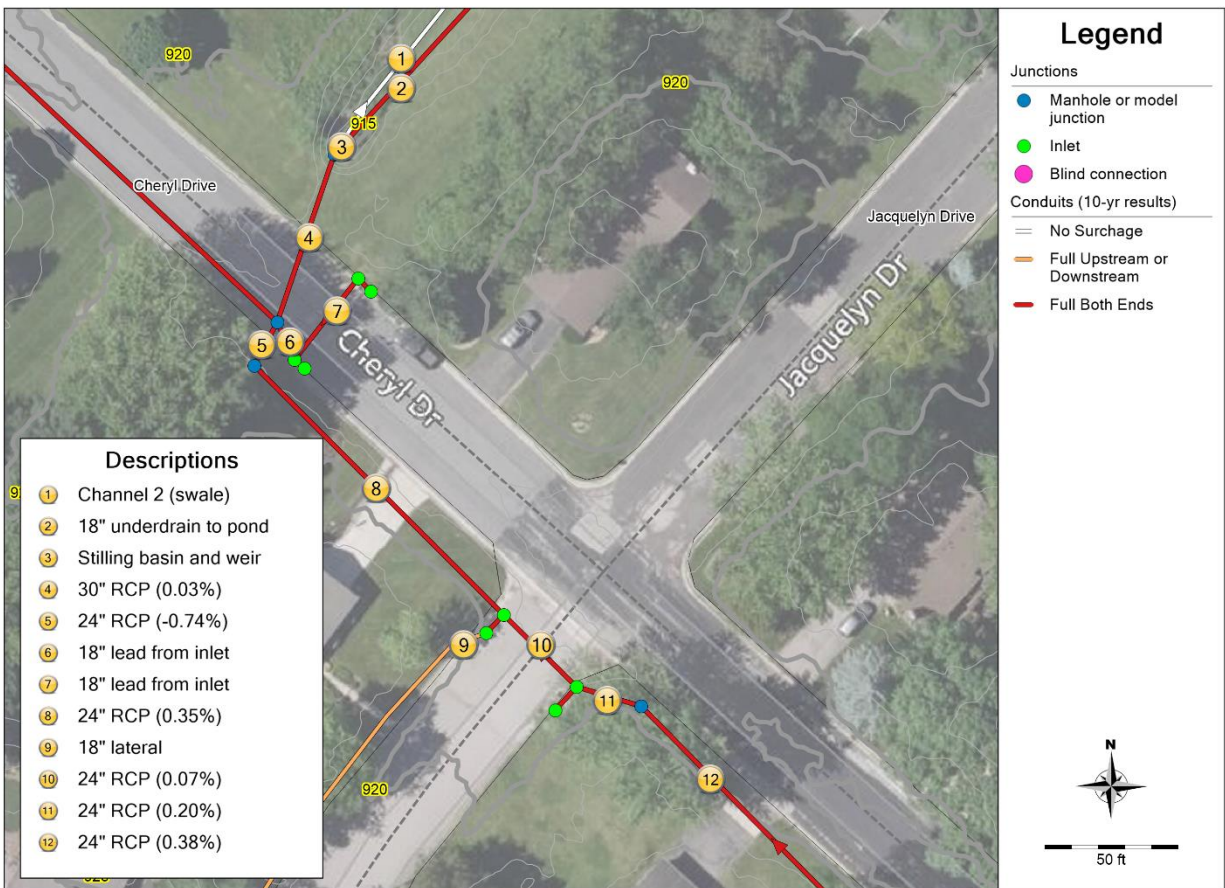
4. "Channel 2" (eastern and combined swale). "Channel No. 2," now referred to as Cheryl Greenway, starts with an almost identical configuration as Channel 1: a shallow stilling basin, an underdrain that outlets to the north near the southern pond, and an overflow weir which carries higher flows into the upper end of Channel 2 and down the swale to the pond culverts. This swale was designed with higher slopes than Channel 1, ranging from 0.6% to 0.7%, but the upper portion is much narrower than Channel 1 with a designed bottom width of only 5 ft (compared to 14 ft for Channel 1). Channel 2 does not have any distinct mounds of sediment and has generally only filled in by 0.75 ft or less, as shown on **Figure 7**. The vegetation cover along the bottom of the swale is generally less dense than Channel 1.

Channel 2 to pond – existing versus design



**Figure 7. Existing Channel 2 swale profile compared to design.**

5. Cheryl-Jacquelyn intersection. The area west of the Cheryl Drive – Jacquelyn Drive intersection near the Channel 1 stilling basin, as well as the intersection itself, was reported to have street flooding problems (as seen in the photo on the cover of this report). This location is shown in greater detail in **Figure 8**. There are several curb inlets at these locations, which drain to the Channel 2 stilling basin via 24" and 30" circular pipes. These pipes are generally very low slope (<0.5%), including one short length of adverse (negative) slope 24" pipe that connects the 24" pipe in the terrace to the 30" pipe at the street manhole.



**Figure 8. Storm sewer and start of Channel 2 near Cheryl-Jacquelyn intersection.**

6. Eastern Cheryl Drive. The storm sewer along Cheryl Drive east of Jacquelyn Drive was assessed for general capacity and street flooding likelihood. Many residents felt that street flooding was worse here and at the Jacquelyn intersection than to the west at the Charleston intersection. The storm sewer pipes in this area are generally small: 18" to the east of Tami Trail, and 24" west of Tami Trail to Jacquelyn.

#### 4.1.2. Diagnostic Results

Diagnostic results for each of the focused analysis areas are summarized in **Table 2**. Each storm sewer area has been assessed in terms of "level of service"; that is, for what design storm is the storm sewer able to meet the design criteria of no pipe surcharge. Looking at the hydraulic grade line (HGL) for different events provides a visual summary of existing pipe capacity; **Figure A2** shows the HGL of the run of storm sewer along Pembroke Drive and Cheryl Drive from Raritan Road to McKee Farms Park (top of Channel 1), and **Figure A3** shows the HGL along Cheryl Drive from Lyman Lane to McKee Farms Park (top of Channel 2).

**Table 2. Diagnostic results by analysis area.**

Analysis Area	Level of Service	General assessment
1. Cheryl-Pembroke-Richardson intersection	<p>Pipe surcharge: <b>2-yr</b></p> <p>HGL below rim for 10-yr: <b>NO</b></p> <p>Flooding limited to ROW for 100-yr: <b>NO</b></p> <p>Structures Impacted for 100-year: <b>NO</b></p>	<ul style="list-style-type: none"> <li>• The storm sewer here has sufficient capacity for the 2-yr event but starts to surcharge during the 5-yr event. Some of this is due to downstream conditions related to the problems at Cheryl-Charleston.</li> <li>• The 18" lateral pipe that connects the northern inlets to the main is currently undersized and would need upsizing to handle the 10-yr flow</li> <li>• The 42" circular pipe along the main that crosses the intersection from west to east is currently undersized and would need either upsizing or increased slope to handle the 10-yr flow</li> <li>• The HGL is above the rims of structures for the 10-yr storm and larger, and street flooding extends beyond the ROW into lawns and driveways during the 100-yr event but does appear to impact structures</li> </ul>
2. Cheryl-Charleston intersection.	<p>Pipe surcharge: <b>&lt; 2-yr</b></p> <p>HGL below rim for 10-yr: <b>NO</b></p> <p>Flooding limited to ROW for 100-yr: <b>NO</b></p> <p>Structures Impacted for 100-year: <b>NO</b></p>	<ul style="list-style-type: none"> <li>• The storm sewer here is severely limited by capacity, particularly the low-slope (&lt;0.5%) elliptical 34" x 53" pipes</li> <li>• The lack of pipe capacity is magnified by the downstream conditions at the upstream end of Channel 1 (sediment blockage)</li> <li>• Street flooding here appears to be primarily caused by the surcharged conditions in the main storm sewer system, not inlet capacity. Nevertheless, doubling or over-sizing inlet grates and upsizing catch basin lead sizes would help address street flooding once other system changes are made.</li> <li>• The failing "preformed cross" connection between the inlet leads and the elliptical pipe is not explicitly modeled but is likely further restricting flows. The connection should be replaced with a structure that allows maintenance access.</li> <li>• Running the north side inlets directly to the stilling basin of Channel 1 should be considered during repair to limit junction energy losses and simply the structure.</li> <li>• Due to topography and the large watershed draining here, even with significant upsizing and downstream improvements it will likely be difficult to bring the storm sewer to new design standards (10-yr)</li> <li>• The HGL is above the rims of any structures at the 2-yr storm and larger, and street flooding extends beyond the ROW for 5-</li> </ul>

Analysis Area	Level of Service	General assessment
		<p>yr and larger events. Lawns and driveways are impacted during these larger events, but even the 100-yr event does not appear to impact structures.</p>
<p>3. "Channel 1" (western swale).</p>	<p>N/A for pipes 100-yr flow within banks of designed drainage way: <b>NO</b></p>	<ul style="list-style-type: none"> <li>• The sediment mound covering the weir and the first 100 ft of Channel 1 is severely restricting flow into Channel 1 and impacting the upstream storm sewer (note – see slope of HGL in <b>Figure 6</b>), and should be removed ASAP</li> <li>• The vegetation in the upper 100 ft is also thick and likely restricting flows</li> <li>• The "stilling basin" lacks a permanent water pool normally seen at this type of outfall, which means there is no mechanism for energy dissipation or for sediment to drop out prior to entering the swale. In addition to adding a permanent pool, extending the length of the basin to be much longer would bring it in line with design standards and further help the energy / sedimentation issue.</li> <li>• As discussed in 4.1.1, the slopes and profile of the channel do not match the design even downstream of the large sediment mound</li> <li>• Further downstream there is flow outside of the banks for the 100-yr event; however, the area is surrounding by park land (no structures), and the 100-year flood elevation was noted on the original design, so this area appears to be functioning as designed. This may be beneficial in terms of overall stormwater management.</li> </ul>
<p>4. "Channel 2" (eastern and combined swale).</p>	<p>N/A for pipes 100-yr flow within banks of designed drainage way: <b>NO</b></p>	<ul style="list-style-type: none"> <li>• Sediment accumulation is lower here than Channel 1, but the portion upstream of the junction with Channel 1 still shows some accumulation compared to design and would benefit from dredging</li> <li>• There appears to be minimal to no accumulation of sediments in Channel 2 between the Channel 1 junction and McKee Farms Park southern pond, but there are considerable sediment deposits on both the upstream and downstream ends of the six culverts leading to the pond</li> <li>• The comments for the Channel 1 stilling basin also apply here – adding a pool and/or lengthening the basin would allow for better sediment trapping and removal</li> <li>• There is flow outside of the banks for the 100-yr event; however, the area is surrounded by park land (no structures), and the 100-year flood elevation was noted on the original design, so this area appears to be functioning as designed. This may be beneficial in terms of overall stormwater management.</li> </ul>
<p>5. Cheryl-Jacquelyn intersection.</p>	<p>Pipe surcharge: &lt; 2-yr</p>	<ul style="list-style-type: none"> <li>• The storm sewer here does not have capacity to handle even the 2-yr event</li> </ul>

Analysis Area	Level of Service	General assessment
	<p>HGL below rim for 10-yr: <b>NO</b></p> <p>Flooding limited to ROW for 100-yr: <b>NO</b></p> <p>Structures Impacted for 100-year: <b>NO</b></p>	<ul style="list-style-type: none"> <li>In Area 2 the elliptical pipes were a clear constriction compared to other pipes; in this area, the <u>entire storm system</u> appears to be undersized</li> <li>There are some impacts here related to downstream conditions in Channel 2, though it's not as pronounced as in Area 2 because Channel 2 is higher slope than Channel 1 and does not have the same sediment mounding</li> <li>Running the north side inlets directly to the stilling basin of Channel 2 should be considered during repair to limit junction energy losses and simply the connections.</li> </ul> <p>The HGL is above the rims of any structures at the 2-yr storm and larger, and street flooding extends beyond the ROW for 5-yr and larger events. Lawns and driveways are impacted during these larger events, but even the 100-yr event does not appear to impact structures.</p>
6. Eastern Cheryl Drive	<p>Pipe surcharge: &lt;2-yr</p> <p>HGL below rim for 10-yr: <b>NO</b></p> <p>Flooding limited to ROW for 100-yr: <b>NO</b></p> <p>Structures Impacted for 100-year: <b>NO</b></p>	<ul style="list-style-type: none"> <li>The storm sewer has capacity for the 2-yr event only at the upper end of this section (between Lyman Lane and Florann Drive). Everywhere else the pipes are surcharged for even the 2-yr event.</li> <li>There are tailwater impacts related to the downstream areas at Jacquelyn Drive and Channel 2, but overall capacity and pipe sizes is the dominant issue here</li> <li>Most of the main pipes appear to have adequate slope (close to 1%) and may be able to meet the 10-yr design criteria if properly upsized. <u>However, upsizing this entire run of pipe would have downstream consequences</u> near the Jacquelyn intersection, so future upsizing may need to be accompanied by added storage to minimize this impact.</li> <li>The HGL is above the rims of several structures at the 2-yr storm and for all structures for larger storms, and street flooding extends beyond the ROW for 5-yr and larger events. Lawns and driveways are impacted during these larger events, but even the 100-yr event does not appear to impact structures.</li> </ul>

**4.2. Alternatives Testing**

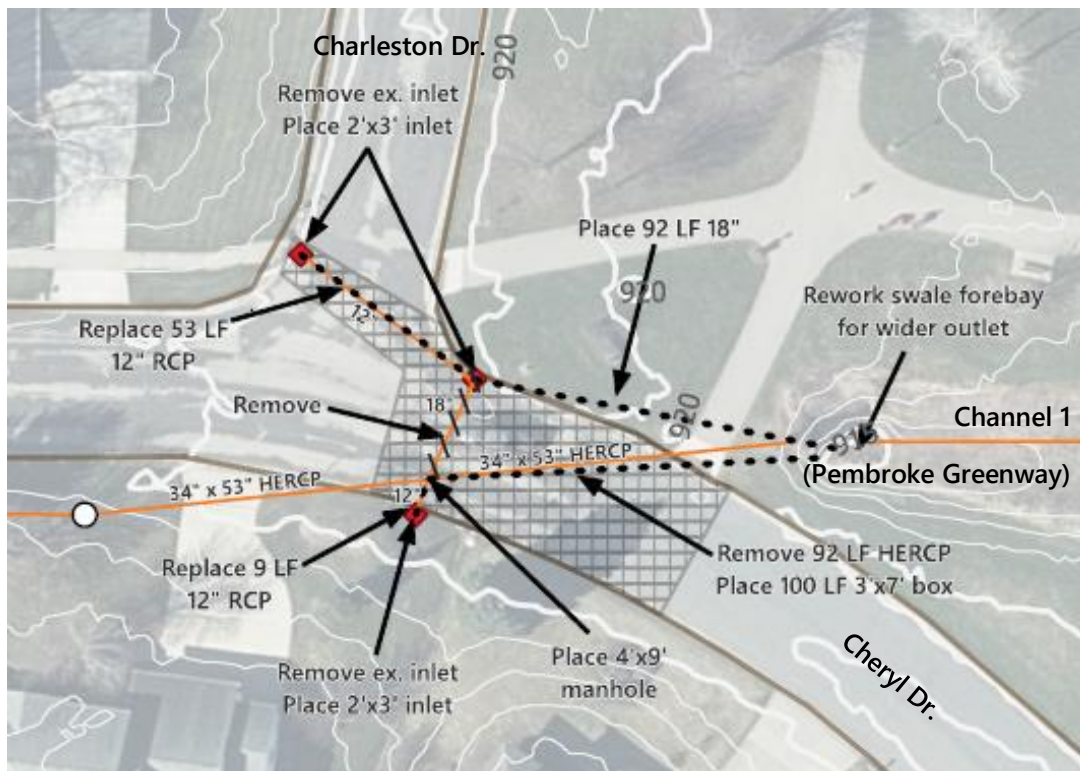
**4.2.1. Alternatives and Results**

After review of preliminary diagnostics and discussion with the City, six potential solutions were identified. Those six solutions, along with four "combination" alternatives with multiple solutions, became the ten alternatives included in this report:

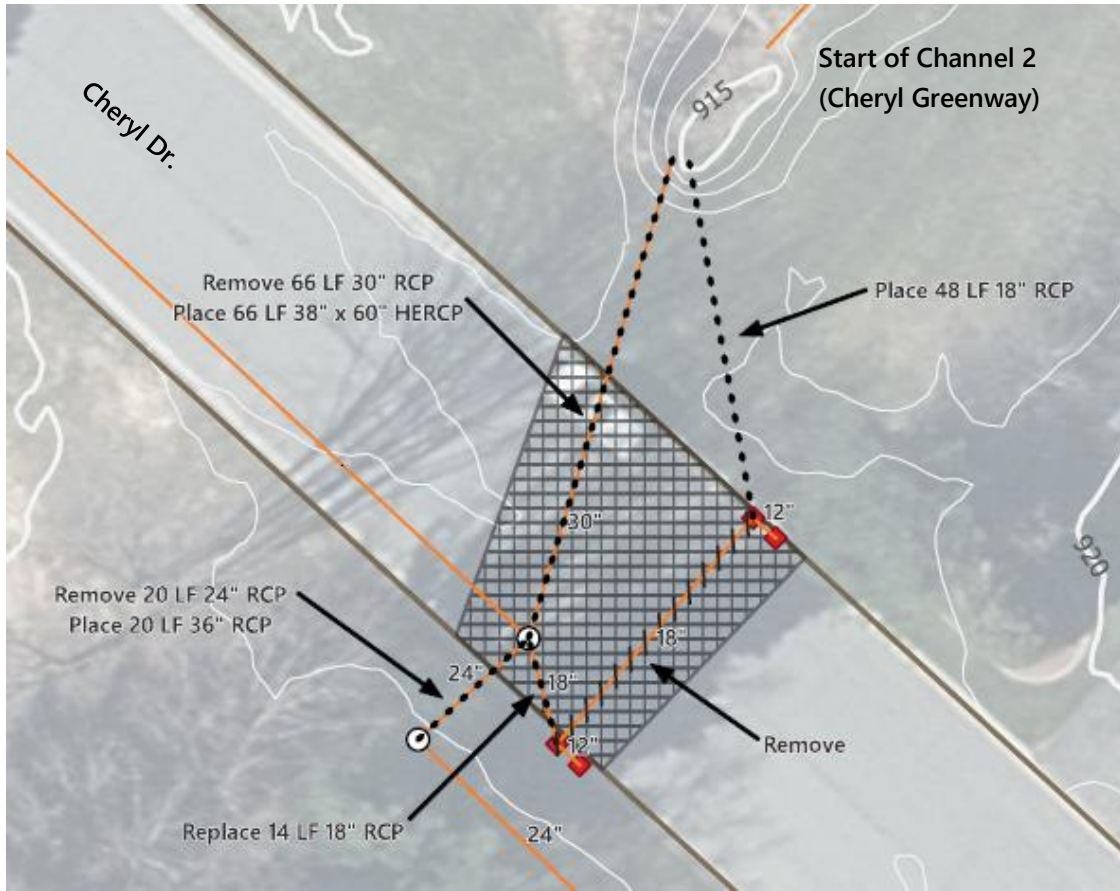
1. Clean out sediment in Channel 1 (sediment mound, general deposition along length of channel)
2. Clean out sediment in Channel 1 and sediment in Channel 2

3. Increased pipe capacity at Cheryl-Charleston (convert the downstream HERCP to a 3' X 7' box and other improvements – see **Figure 9**)
4. Combination of 2 and 3
5. Upsize local pipes upstream of Channel 2 (near Cheryl-Jacquelyn – see **Figure 10**)
6. Combination of 2, 3, and 5
7. Offline storage area in McKee Farm Park between Channels 1 and 2 (in the “triangle”)
8. Combination of 2, 3, 5, and 7
9. Widen Channel 2 by 10 ft to match Channel 1
10. Combination of 2, 3, 5, and 9

Water level and street flooding duration change (compared to existing conditions) for these alternatives for the 10-yr event are shown in **Table 3**.



**Figure 9. Proposed improvements at Cheryl-Charleston intersection.**



**Figure 10. Proposed improvements west of Cheryl-Jacquelyn intersection.**

**Table 3. Alternative results compared to existing conditions, 10-yr event.**

	<i>Benefits for 10-yr event, compared to existing conditions (change to water level or duration as noted)</i>								
<b>Alternative</b>	Cheryl-Richardson HGL	Cheryl-Charleston HGL	Cheryl-Charleston street flood duration	Ch. 1 stilling basin HGL	Ch. 2 stilling basin HGL	Cheryl-Jacquelyn HGL	Cheryl-Jaquelyn street flood duration	Cheryl-Tami HGL	Cheryl-Florann HGL
1) Channel 1 sediment cleanout	-0.20'	-0.53'	-0.23 hrs	-0.75'	-	-	-	-	-
2) Both channels sediment cleanout	-0.07'	-0.53'	-0.23 hrs	-0.75'	-0.18	-0.06	-0.05 hrs	-	-
3) Upsize pipe at Cheryl-Charleston	-0.72'	-0.96'	-0.21 hrs	+0.01'	-	-	-	-	-
4) Combo: 2 and 3	-1.69'	-2.10'	-0.66 hrs	-0.75'	-0.17'	-0.06'	-0.05 hrs	-	-
5) Upsize local pipes upstream of Ch. 2	-	-	-	-	+0.04'	-0.59'	-0.39 hrs	-	-
6) Combo: 2, 3, 5	-1.17'	-1.48'	-0.47 hrs	-0.76'	-0.13'	-0.74'	-0.39 hrs	-	-
7) Storage area	-0.58'	-0.81'	-0.25 hrs	-1.28'	-0.25'	-0.22'	+0.08 hrs	-	-
8) Combo: 2, 3, 5, 7	-2.19'	-2.48'	-0.66 hrs	-1.75'	-0.92'	-1.56'	-0.39 hrs	-	-
9) Widen Channel 2	-0.20'	-0.53'	-0.23 hrs	-0.75'	-1.15'	-0.40'	-0.26 hrs	-	-
10) Combo: 2, 3, 5, 9	-1.33'	-1.66'	-0.51	-0.76	-1.1	-1.61	-0.39	-	-

**4.2.2. Alternatives Discussion**

The tested alternatives were all effective in some reduction of flood depths and durations, although the magnitude and location of impact varied by alternatives. Since there are two distinct areas of known street flooding, each area is discussed separately below.

## Cheryl-Charleston

**Appendix A – Figure A4** shows the 10-yr HGL in the Cheryl-Charleston area for different alternatives. There were several individual alternatives that showed promise for improving street flooding here, and these alternatives perform even better when done in combination. For example:

- The simplest and likely cheapest solution, cleaning out the sediment in Channel 1 (Alt. 1), was estimated to lower the 10-yr water level at Cheryl-Charleston by over half a foot (0.53 ft) and reduce the duration of local street flooding for that event from 0.66 hours to 0.43 hours (35% reduction).
- Increasing the capacity of the pipe that runs from the center of the intersection to the outfall (Alt. 3) and connecting two of the inlets directly to the swale was even more effective at lowering the 10-yr water level, with an estimated reduction of 0.96 ft. However, the reduction in local street flooding duration was smaller (32% reduction) because the channel is still restricted. Unlike the channel cleanout, this solution also impacted the water level one block up at the Cheryl-Richardson intersection, with an estimated water level reduction of 0.72 ft. This could both any reduce local issues there and prevent inlet overflow from flowing downhill to the Cheryl-Charleston intersection, exacerbating issues in that location.
- The Channel 1 cleanout and increased pipe capacity worked even better as a combined solution (see Alt. 4), resulting in a lowering of the Cheryl-Charleston 10-yr water level of 2.1 ft and eliminating any duration of street flooding. The water level up the hill at Cheryl-Richardson was also estimated to drop significantly (1.69 ft).

## Cheryl-Jacquelyn

**Appendix A – Figure A5** shows the 10-yr HGL in the Cheryl-Jacquelyn area for different alternatives. The individual alternatives for improving street flooding at and near the Cheryl Dr – Jacquelyn Dr intersection were moderately effective, although unlike the Cheryl-Charleston solutions it seemed that improvements were generally local and did not impact the storm sewer further upstream (to the east along Cheryl Dr). Single actions like cleaning the swale or upsizing one or two pipes did not have a great deal of impact, although widening Channel 2 to match the width of Channel 1 was fairly effective at lowering water in the swale, which increased storm sewer drainage. Like Cheryl-Charleston, with combinations of alternatives there could be substantial improvements to flooding in this area. For example:

- Removing the 0.5 – 0.75 ft of sediment from the upper portion of Channel 2 (Alt. 2) had limited effect; it was estimated to lower the 10-yr water level in the street near Cheryl-Jacquelyn by 0.06 ft and decreased the duration of local street flooding from 0.39 hours to 0.34 hours (13% reduction).
- Increasing local storm sewer capacity upstream of Channel 2 (Alt. 5) included upsizing two main pipes that cross Cheryl Ave., increasing the size of two inlet leads on the south side, and connecting the two inlets on the north side of the street directly to Channel 2. These changes lowered the 10-yr water level in the street by 0.59 ft (eliminated street flooding for that event).

- Increasing the bottom width of Channel 2 by 10 ft ([Alt. 9](#)) to match the bottom width of Channel 1 had the most impact. Note it was assumed that the sediment clean-out of upper Channel 2 would be included in this action. By itself, Alt. 9 lowered the 10-yr water level by 0.40 ft and decreased local street flooding duration from 0.39 hours to 0.13 hours (67% reduction).
- Taking several of these actions in combination showed potential to sizably reduce or eliminate street flooding at the intersection. For the case of sediment removal and widening of Channel 2 combined with upsizing pipes upstream of Channel 2 ([Alt. 10](#)), the 10-yr water level in the storm sewer was reduced by 1.61 ft and street flooding was eliminated.

### Offline Storage

The approximately 10 acre triangular area between Channels 1 and 2 is currently a raised mound that sits above the channels' floodplain. Lowering this area to create flood storage was tested by identifying the square footage of area potentially available, and then creating a 2 ft deep depression adjacent to the channels that could siphon overflow from both Channels 1 and 2 during storm events. A shallow depression was assessed because we were strictly looking at flood reduction potential using elevations that would still allow water to drain back to the downstream channels after a storm. If the City did pursue storage here, it might likely be as part of a wet detention basin, with a lined bottom excavated several feet deeper and a permanent pool of water for water quality treatment.

While this idea could be considered for the future, initial testing showed that as originally modeled:

- There was more benefit to Cheryl-Charleston than Cheryl-Jacquelyn. This may be due to channel elevations, but also indicates that detailed design and optimization would be needed to identify the best overflow elevations to best maximize storage, and it may not be feasible to connect both channels to the storage area.
- Removing the existing stockpile and digging down two feet throughout the triangular area required a substantial amount of earthwork – over 14,300 cubic yards of excavation, much of which would likely need to be hauled off-site unless it could be placed elsewhere within the park.
- After testing the widening of Channel 2, it seemed that creating a larger conveyance channel and moving water down to the stormwater ponds more quickly functioned better than trying to store water near the upstream end of the swales. While optimizing and limiting inflows could maybe prove otherwise, it seems that simply widening the swales rather than creating offline floodplain storage is a simpler, more cost-effective path forward.

### **4.2.3. Dredging or Expansion of McKee Farms Ponds**

The City requested that the impacts of water levels in the connected McKee Farms Park North and South Ponds be assessed during this project and wanted to know if dredging or reconfiguring the ponds would be part of a potential solution. If the Cheryl Drive storm sewer and surface drainage system was sensitive to

water levels in the ponds, additional modeling was to be performed including adding large additional watershed areas to the model to simulate potential pond levels during storm events.

To test this, the existing conditions model was rerun with a series of different starting water levels in the pond system, ranging from 909 ft to 915 ft. For reference, the normal pond elevation is between 910 and 911 ft and the diagnostic models were all run with 912 ft as a starting pond elevation. For the 10-yr design storm, impacts from the highest tested water levels (914 and 915 ft) did appear in the swale system, but only extended up to the Channel 1 and Channel 2 junction and did not have impacts on the Cheryl Drive storm sewer system. This is due to the elevation difference between the two areas and because there is considerable overbank storage adjacent to the swale in its lower portions that can handle overflow during storm events. Additionally, the natural ground overflow of the North Pond is approximately 914.5 ft, so it is unlikely that the pond would get much higher than 915 ft. In that case, water would overflow to the swale that drains the Park travelling northeast towards Fish Hatchery Rd.

Dredging the bottom of the ponds would also not be effective at solving Cheryl Drive storm sewer problems. The depth of a stormwater "wet pond" that is below its normal pool level (controlled by the outlet) is used for sediment trapping but is not active storage that can be utilized during a storm event. However, during field visits sediment buildup and vegetation growth were observed at the six-culvert southern inlet of the South Pond, both on the pond side of the recreational trail and on the swale side. It is recommended that this material be removed to prevent blocking of the culverts. Similarly, the outlet from the "Tower Hill Greenway" which enters South Pond in its southeast corner should be dredged and cleared of excessive vegetation grown. Costs for these "Add-on" dredging projects are included in the report cost estimates.

## 5. PROPOSED SOLUTION COSTS

Estimated costs were generated for the solutions used in the alternatives analysis. Project totals including construction, permitting, and design are shown in **Table 4** and an itemized construction cost estimate for each is included in **Appendix B**. Note that it was assumed that sediment removal would be done for both channels if that option was selected, so the “Channel 1 only” alternative (Alt. 1) is not costed separately. It was assumed that excavated soils would need to be hauled off-site, so for smaller projects the excavation cost could be slightly lower if excess soils could be spread on site instead. It does not seem likely that the volume of spoils created by Alt. 7 (offline storage) could be kept on site. Contamination of soils may be an issue, particularly material dredged from the swales. Some of the material may need to be landfilled or covered with clean fill, depending on soil condition.

Construction unit costs used were generally higher than typical averages to account for the relatively small size of these projects. Based on current City plans, the storm sewer improvements (Alt. 3 and Alt. 5) were estimated with the assumption that they would be combined as part of a larger resurfacing project. For Alt. 3, asphalt replacement costs are not included since the asphalt is due to be resurfaced, but asphalt replacement costs are included for Alt. 5 because that area does not need resurfacing. Alt. 9 costs assume that the channel widening would be done as an add-on to the other channel work (Alt. 2). Design and permitting costs for Alt. 7 were based on a common 10% estimate of construction costs; for the other alternatives, EOR is currently developing detailed proposals for those items and therefore the design and permitting costs were taken from more detailed analyses.

**Table 4. Proposed solution costs.**

Solution	Estimated total permitting, design, and construction cost (w/ 20% contingency)
Alt 2 – Clean out sediment from both channels	\$95,500
Alt. 3 – Upsize pipe and direct-connect two inlets at Cheryl-Charleston <sup>1</sup>	\$137,900
Alt. 5 – Upsize two main pipes, two inlet leads, and direct-connect two inlets near Cheryl-Jacquelyn <sup>2</sup>	\$147,600
Alt. 7 – Create offline storage area in “triangle” <sup>3</sup>	\$357,100
Alt. 9 – Widen Channel 2 by 10 ft <sup>4</sup>	\$40,400

1 – Assumes project is part of a larger resurfacing project. The cost of the road resurfacing is not included in the estimated total costs.

2 – Assumes project is part of a larger resurfacing project. The cost of the road repairs in impacted areas is included in the estimated total costs.

3 – Assumes a stand-alone project and design/permitting costs to be 10% of construction costs.

4 – Assumes project is an add-on to Alt. 2.

## 6. CONCLUSIONS AND RECOMMENDATIONS

The modeling and analysis of the stormwater system along Cheryl Drive generated several conclusions related to stormwater system performance and flooding issues:

- The swales, particularly Channel 1, are clogged with extra sediment and thick vegetation in places and are no longer functioning as designed. This limits the ability for the storm sewer upstream of these swales to drain properly, causing excessive street flooding depths and durations during the 10-yr design storm.
- The two elliptical pipes near the intersection of Cheryl Drive and Charleston Drive are very flat and appear undersized, especially the downstream section of pipe that outlets to Channel 1. The upstream end of that pipe has a failing connection to two inlet leads at a pre-formed cross, with no manhole for access or inspection. Upsizing that pipe has considerable benefits in that area and uphill to the next intersection.
- The entire run of storm sewer from Lyman Lane to McKee Farms Park along Cheryl Drive appears under-sized for the current 10-yr design storm. Upsizing pipes near the Cheryl-Jacquelyn intersection does have some benefits to intersection flooding in the immediate vicinity, but downstream restrictions will likely be easier and cheaper to fix first.
- An offline storage area in the triangle (or the creation of much wider swales downstream) might make sense in the future, such as if the pipe network along Cheryl Drive was to be upsized everywhere and more storage volume was needed. Limited testing showed that increasing pipe size further up Cheryl Drive (such as near the Tower Hill intersection) made flooding worse at Jacquelyn, as would be expected. It is likely that some new storage would be needed if the entire system were to be upsized. Opportunistically creating upstream storage (or green infrastructure opportunities) may be worth considering even if pipes are not upsized along Cheryl Drive.
- Water levels in the connected pond system downstream in the Park did not have a great impact on drainage from Cheryl Drive. The elevation differential, the pond overflow elevation, and the large amount of overbank flood storage adjacent to the ponds is not conducive to water stacking up high enough to have a hydraulic impact at Cheryl Drive. This means expanding the downstream ponds would not have a significant upstream impact on the street flooding.

Based on the above, we recommend the following sequence of actions as shown on **Appendix A - Figures A6 and A7**:

1. As soon as feasible (1-2 years):
  - Excavate the excess sediment in Channels 1 and 2 to return them to their intended design profile (Alt. 2). Estimated cost: \$95,500
  - Widen Channel 2 to 10 ft at the swale bottom (Alt. 9): \$40,400

- It is recommended that this work be accompanied by a long-term inspection, maintenance dredging, and more aggressive vegetation management plan to prevent these conditions from developing in the future. Model testing indicates that the storm sewer HGL at the Cheryl-Charleston intersection rises by 0.2 ft when there is 0.5 ft of sediment built up in the upper section of Channel 1, and by 0.5 ft when sediment has built up to 1 ft of depth, Therefore, it is recommended that maintenance dredging be scheduled when there is 0.5 ft (6 inches) of sediment built up in the upper section of Channel 1, and be completed before there is 0.75 ft (9 inches) of build-up.
  - This work by itself is estimated to reduce the 10-yr water surface at both the Cheryl-Charleston and Cheryl-Jacquelyn intersections by nearly half a foot.
  - **Total swale improvement cost: \$135,900**
  - Though not discussed elsewhere in this report, we also recommend performing a storm sewer video inspection along the entirety of the Cheryl Drive storm sewer (~2,500 ft). This would help identify other failing structures or connections, potentially identify other blockages causing flooding issues, and inform any pipe replacement design.
  - **Storm sewer video inspection estimated cost: \$7,500**
2. **Near-term (2-3 years):**
- Replace the failing pre-formed cross at the Cheryl-Charleston junction (Alt. 3) and replace the HERCP with a 3' x 7' box culvert, along with other minor changes. Estimated cost: \$137,900
  - *Potentially* complete the storm sewer upsizing near Jacquelyn (Alt. 5), particularly if flooding problems continue and/or the video inspection reveals major issues. Estimated cost: \$147,600
  - **Total cost: \$285,500**
3. **Long-term (8-10 years):**
- Re-evaluate entire storm sewer system along Cheryl Drive as part of street resurfacing. If possible, any upsizing of pipes should be accompanied by increased storage to minimize downstream impacts.
  - Potentially construct the triangular offline storage area, particularly if the upstream storm sewer network is upsized. Consider if lowering this area that can be coordinated with other park development to have mutual benefits (e.g. a playfield that can be inundated occasionally).

## APPENDIX A. FULL-SIZE FIGURES

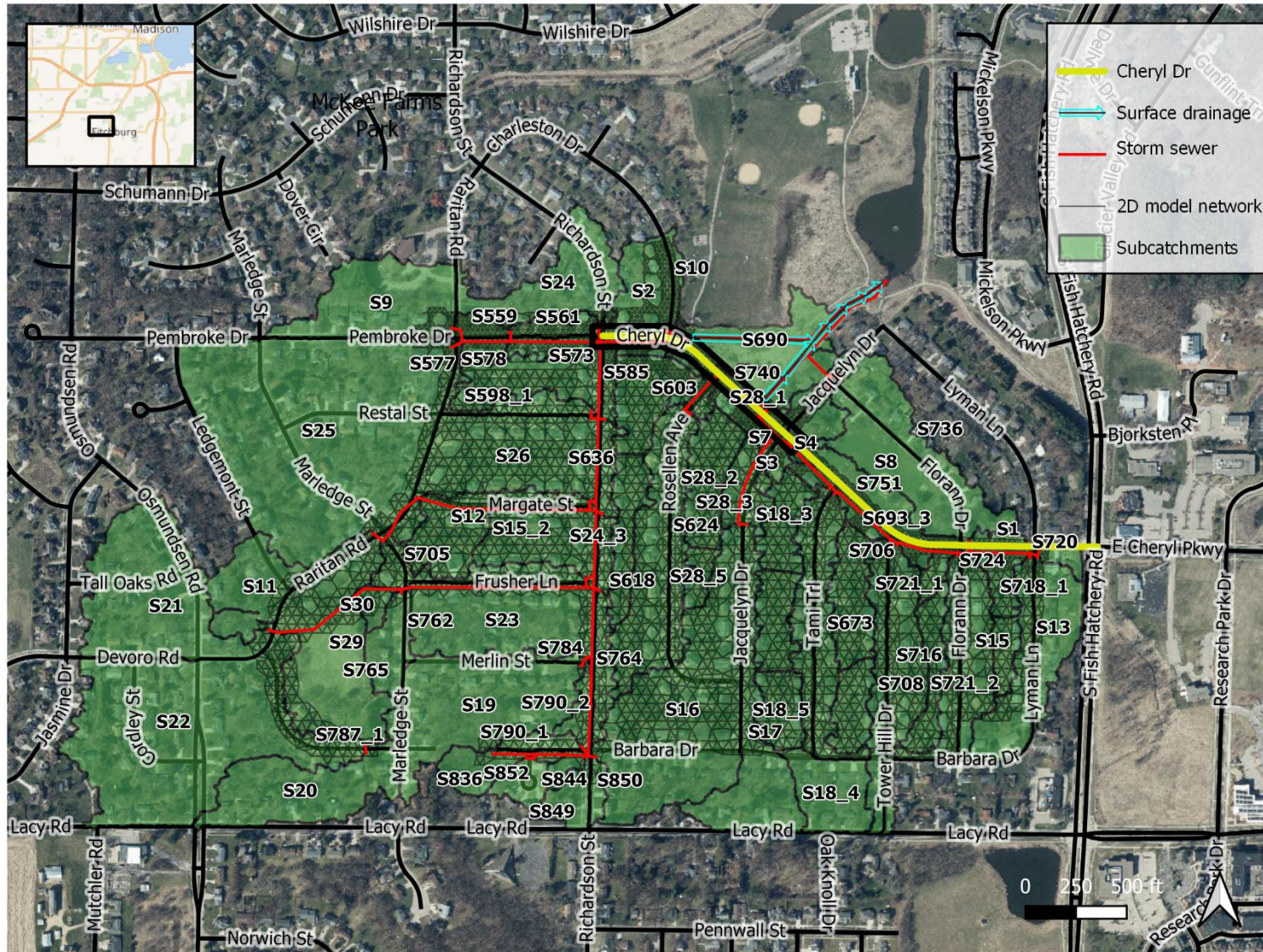


Figure A1 – Model schematic showing model domain (subcatchments), storm sewer, surface drainage, and 2D network.

# 10-YR PROFILE FROM RARITAN TO MCKEE FARMS PARK ALONG CHERYL - PEMBROKE

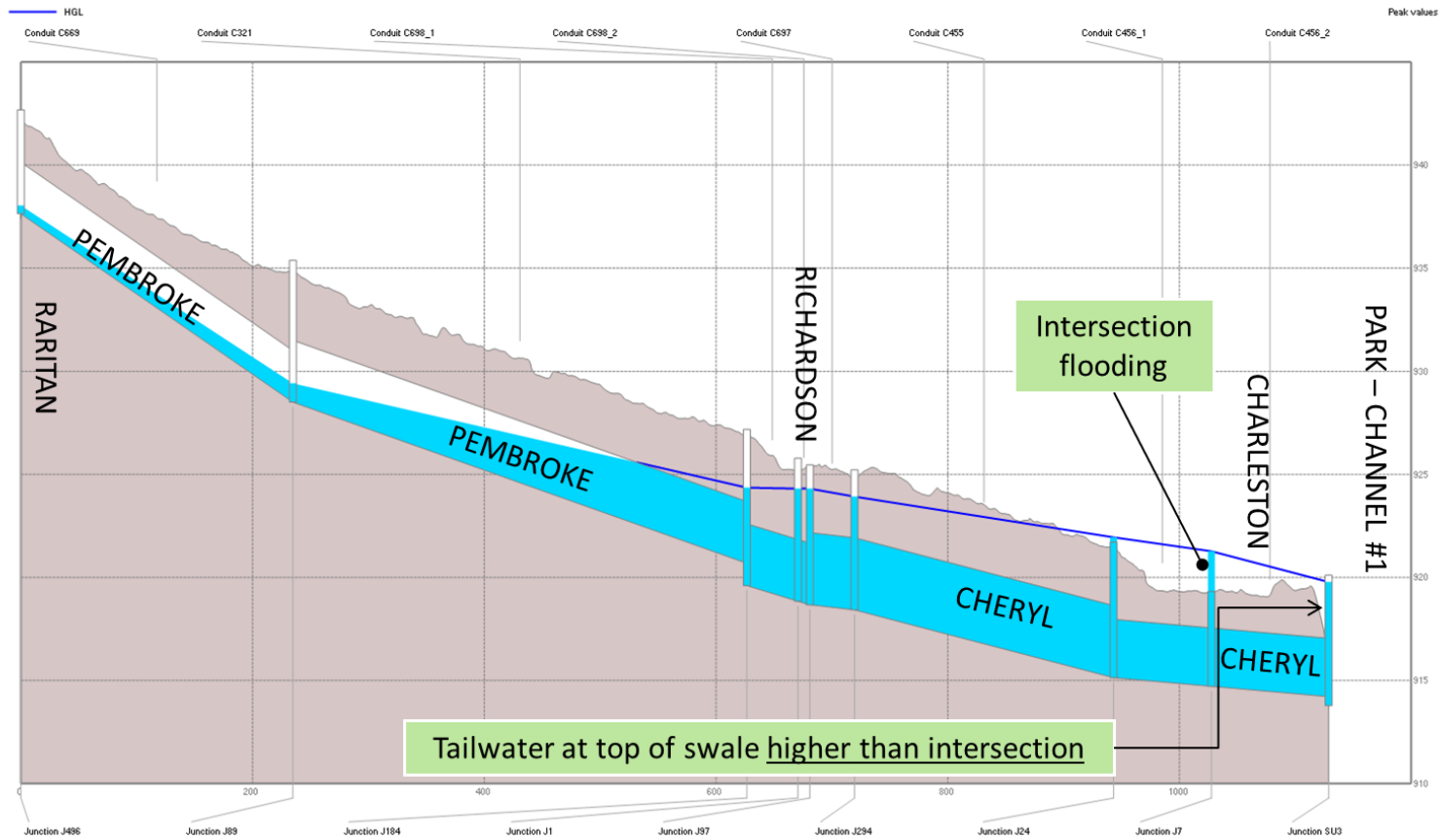


Figure A2 – 10-yr peak hydraulic grade line from Raritan Street to McKee Farms Park along Cheryl Drive.

# 10-YR PROFILE FROM LYMAN TO MCKEE FARMS PARK ALONG CHERYL DR

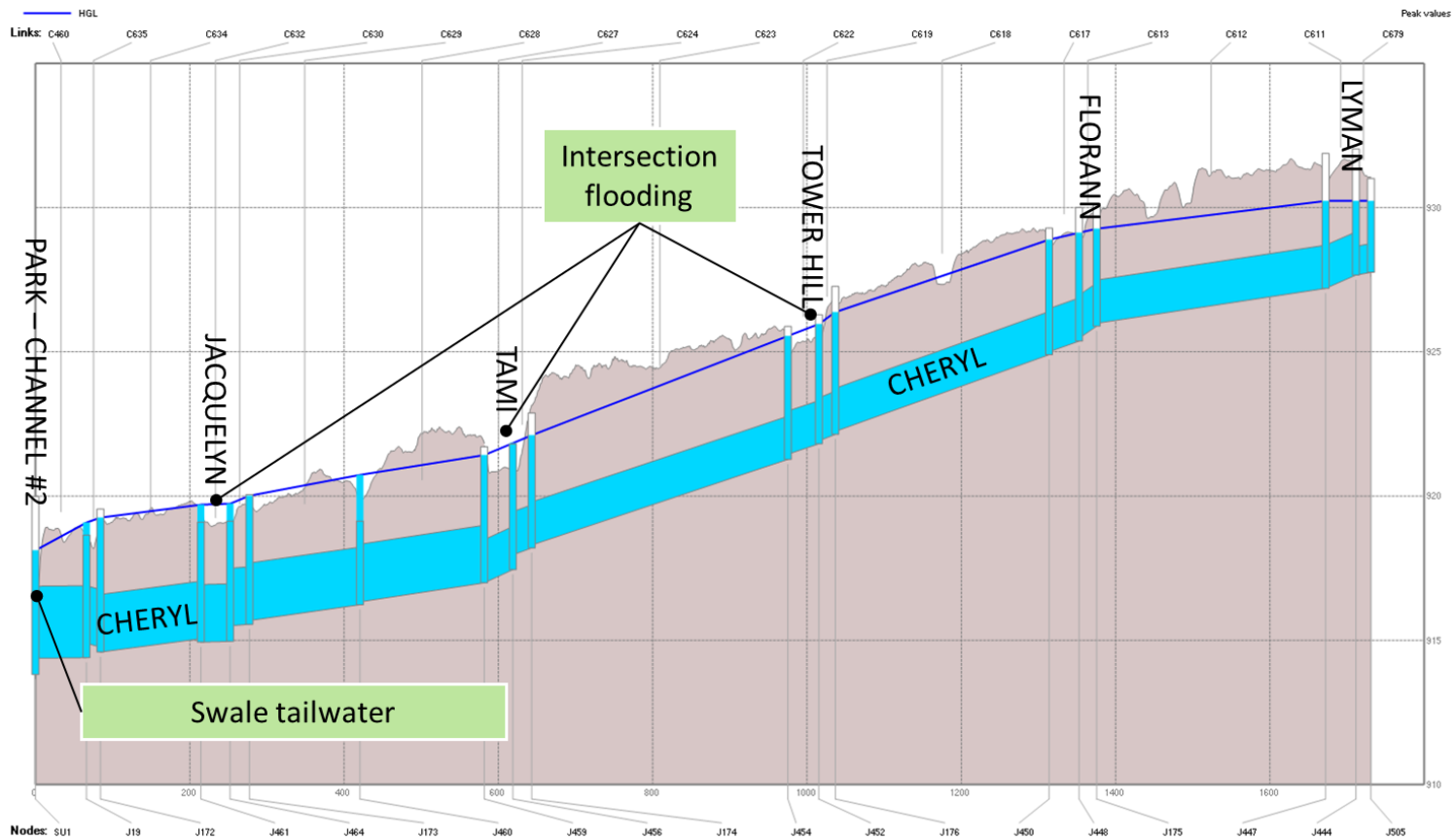


Figure A3 – 10-yr peak hydraulic grade line from Lyman Lane to McKee Farms Park along Cheryl Drive.

# ALTERNATIVES COMPARISON – WESTERN AREA

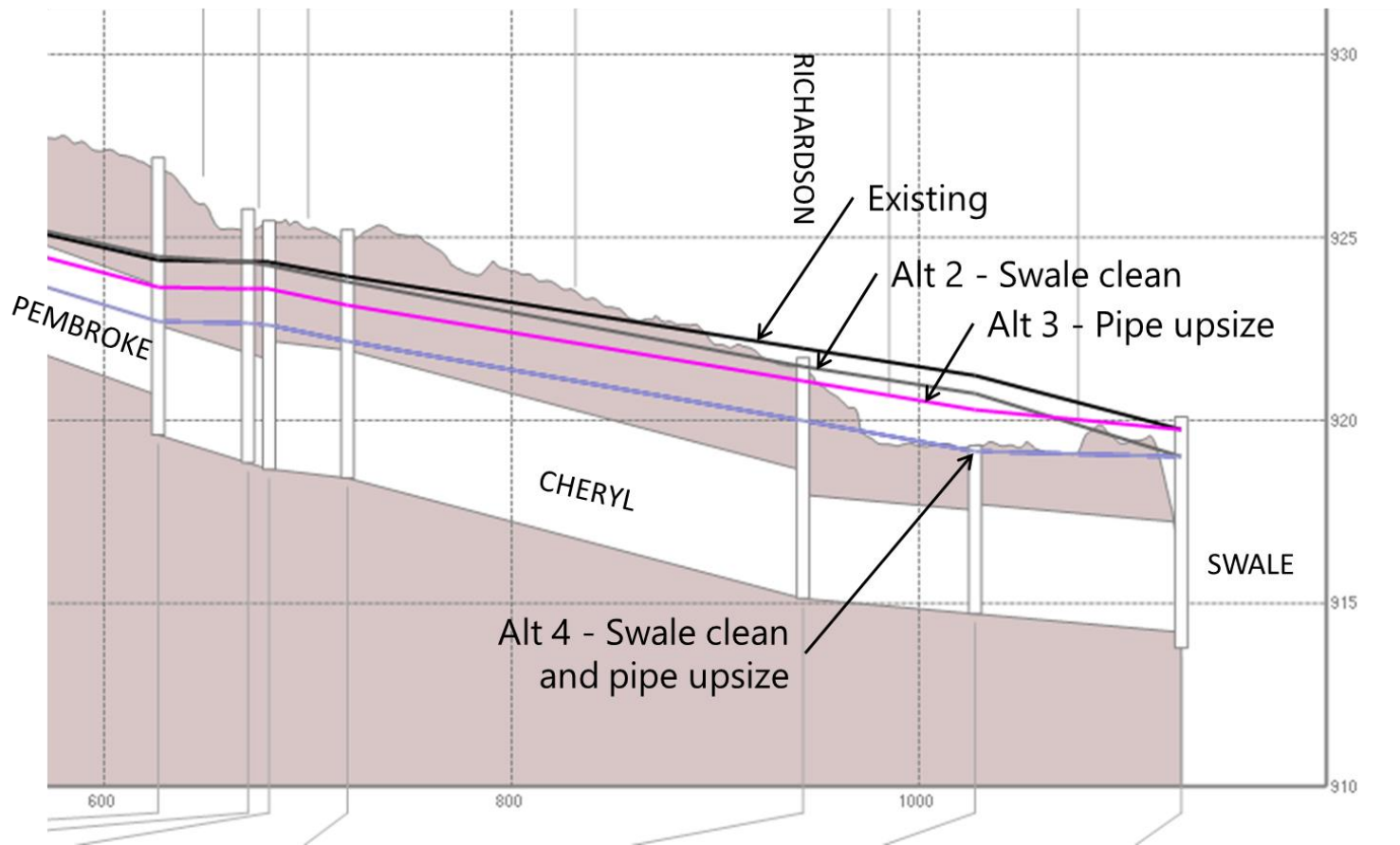


Figure A4 – 10-yr peak hydraulic grade line for different alternatives from Pembroke to McKee Farms Park along Cheryl Drive.

# ALTERNATIVES COMPARISON – EASTERN AREA <sup>50</sup>

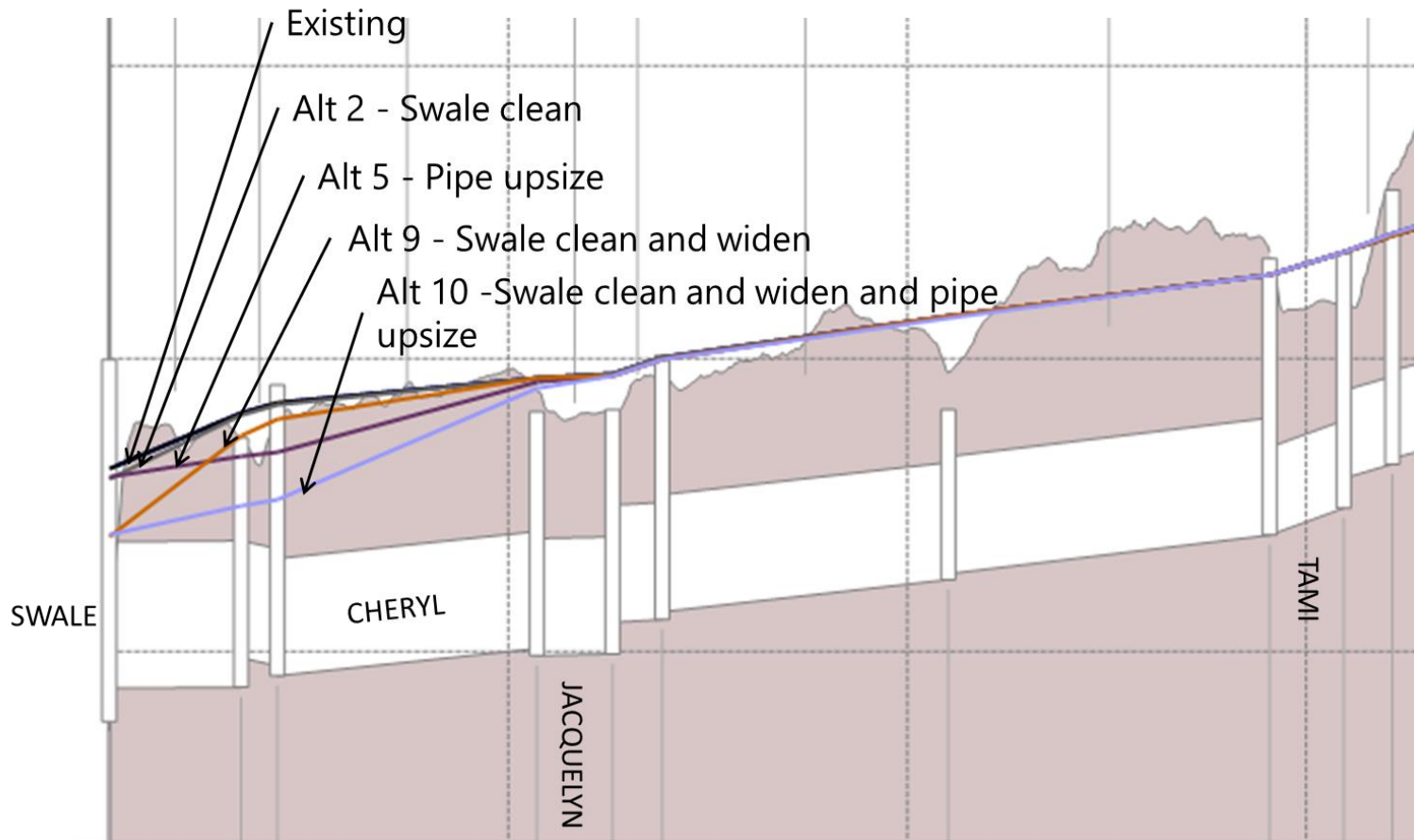


Figure A5 – 10-yr peak hydraulic grade line for different alternatives from Tami Trail to McKee Farms Park along Cheryl Drive.

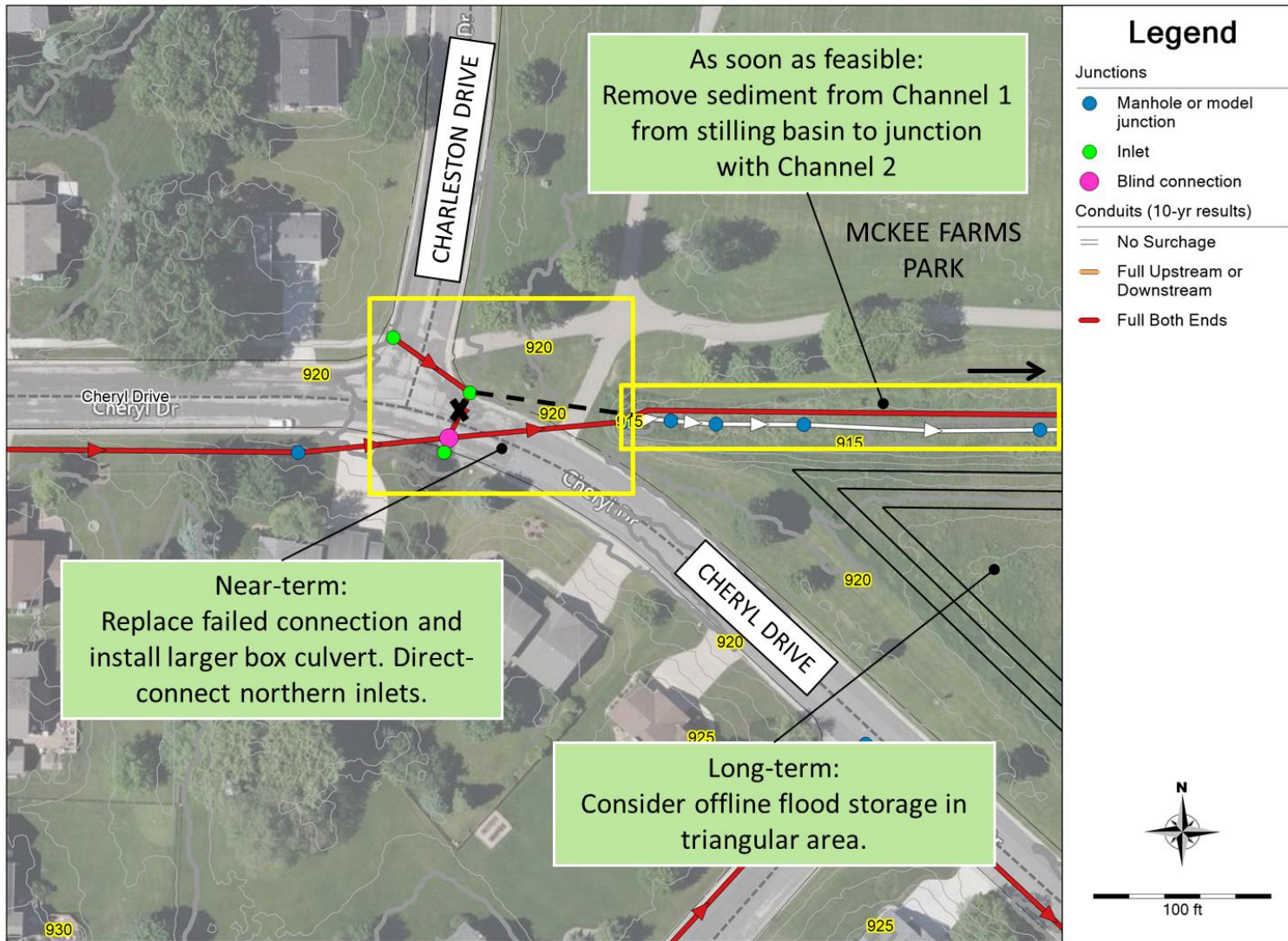


Figure A6 – Proposed solutions near Cheryl Drive – Charleston Drive intersection.

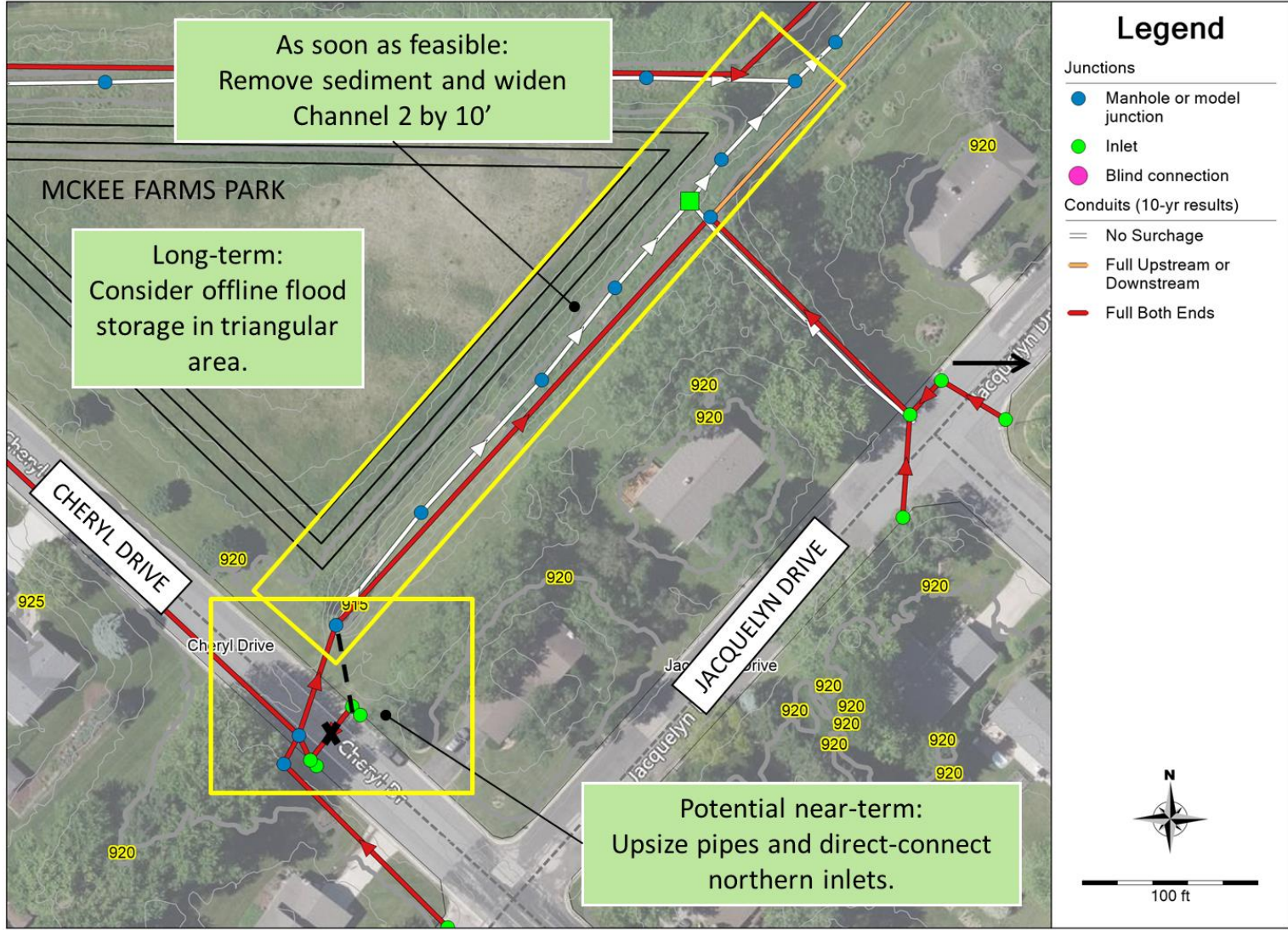


Figure A7 – Proposed solutions near Cheryl Drive – Jacquelyn Drive intersection.

**APPENDIX B. CONSTRUCTION COST ESTIMATES**

## Alt. 2 Cheryl Swale Excavation and Dredging

Contractor :

PROJECT: Cheryl Drive  
 LOCATION: Fitchburg, WI  
 DATE: 8/6/2021

PROJECT NO.: 01052-0009

No.	Bid Item	Qty	Unit	Bid Unit Price	Bid Price
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**Earthwork**

1	Strip & Stockpile Topsoil	1,175	CY	\$3.00	\$ 3,525.00
2	Clearing and Grubbing	1	LS	\$1,500.00	\$ 1,500.00
3	Common Excavation and Haul Off	1,075	CY	\$15.00	\$ 16,125.00
4	Spread Topsoil	1,375	CY	\$5.00	\$ 6,875.00
					<b>\$ 28,025.00</b>

**Erosion Control**

5	Silt Fence, Install, Maintain, & Remove	500	LF	\$4.00	\$ 2,000.00
6	Ditch Checks, Install, Maintain, & Remove	10	EA	\$550.00	\$ 5,500.00
7	Erosion Matting Class I, Type A Urban	2,775	SY	\$5.00	\$ 13,875.00
8	Erosion Matting Class II, Type C	750	SY	\$15.00	\$ 11,250.00
9	Construction Entrance, Place and Maintain	1	EA	\$1,400.00	\$ 1,400.00
					<b>\$ 34,025.00</b>

Subtotal | \$ 62,050.00  
 Contingency 20%  
**Total | \$ 74,500.00**

**Add-On 1: Pond Throat**

10	Dredging Spoils and Haul Off	500	CY	\$30.00	\$ 15,000.00
11	Erosion Matting Class I, Type A Urban	550	SY	\$5.00	\$ 2,750.00
12	Riprap	30	CY	\$75.00	\$ 2,250.00
13	Silt Curtain, Install, Maintain, & Remove	30	LF	\$15.00	\$ 450.00
					<b>\$ 20,450.00</b>

**Add-On 2: Pond SE**

14	Dredging Spols and Haul Off	105	CY	\$30.00	\$ 3,150.00
15	Erosion Matting Class I, Type A Urban	750	SY	\$5.00	\$ 3,750.00
16	Riprap	40	CY	\$75.00	\$ 3,000.00
17	Silt Curtain, Install, Maintain, & Remove	75	LF	\$15.00	\$ 1,125.00
					<b>\$ 11,025.00</b>

Subtotal (Both Add-ons) | \$ 93,525.00  
 Contingency 20%  
**Total | \$ 112,200.00**

## Alt. 3 Cheryl-Charleston Pipe Upsize

Contractor :

PROJECT: Cheryl Drive  
 LOCATION: Fitchburg, WI  
 DATE: 9/7/2021

PROJECT NO.: 01052-0009

No.	Bid Item	Qty	Unit	Bid Unit Price	Bid Price
<b>Storm Sewer</b>					
1	48" Storm Manhole with Inlet	3	EA	\$2,500.00	\$ 7,500.00
2	4' x 9' Storm Manhole	1	EA	\$7,500.00	\$ 7,500.00
3	12-inch RCP Class III Storm Sewer	63	LF	\$45.00	\$ 2,835.00
4	18-inch RCP Class III Storm Sewer	92	LF	\$60.00	\$ 5,520.00
5	7' x 3' Precast Box Culvert	100	LF	\$395.00	\$ 39,500.00
6	Storm Sewer Trench Backfill	255	TF	\$12.00	\$ 3,060.00
7	Box Wing Walls	1	EA	\$1,800.00	\$ 1,800.00
8	Riprap	30	CY	\$75.00	\$ 2,250.00
9	Concrete Weir	5	CY	\$750.00	\$ 3,750.00
10	Remove Inlets	3	EA	\$400.00	\$ 1,200.00
11	Remove Manhole	1	EA	\$650.00	\$ 650.00
12	Remove 12" RCP Storm Sewer	64	LF	\$30.00	\$ 1,920.00
13	Remove 18" RCP Storm Sewer	30	LF	\$35.00	\$ 1,050.00
14	Remove 34" x 53" HERCP Storm Sewer	100	LF	\$35.00	\$ 3,500.00
15	Remove Apron Endwall	1	EA	\$500.00	\$ 500.00
					<b>\$ 82,535.00</b>
<b>Earthwork</b>					
16	Strip & Stockpile Topsoil	150	SY	\$15.00	\$ 2,250.00
17	Clearing and Grubbing	1	LS	\$1,500.00	\$ 1,500.00
18	Common Excavation	50	CY	\$15.00	\$ 750.00
19	Spread Topsoil	150	SY	\$15.00	\$ 2,250.00
20	Restoration	150	SY	\$10.00	\$ 1,500.00
					<b>\$ 8,250.00</b>
<b>Erosion Control</b>					
21	Silt Fence, Install, Maintain, & Remove	30	LF	\$20.00	\$ 600.00
22	Erosion Matting Class I, Type A Urban	50	SY	\$5.00	\$ 250.00
23	Erosion Matting Class II, Type C	50	SY	\$15.00	\$ 750.00
24	Construction Entrance, Place and Maintain	1	EA	\$1,400.00	\$ 1,400.00
					<b>\$ 3,000.00</b>
<b>Street Improvement (storm sewer work only - resurfacing project not included)</b>					
25	30" Concrete Curb and Gutter	20	LF	\$300.00	\$ 6,000.00
26	Sawing Asphalt	140	LF	\$5.00	\$ 700.00
27	Sawing Concrete	10	LF	\$5.00	\$ 50.00
28	Remove Curb and Gutter	20	LF	\$10.00	\$ 200.00
29	5" Concrete Sidewalk w/ Base	30	SF	\$8.00	\$ 240.00
30	6" Concrete Curb Ramps w/ Base	90	SF	\$10.00	\$ 900.00
31	Adjust Structures in Pavement	4	EA	\$325.00	\$ 1,300.00
					<b>\$ 9,390.00</b>
<b>Subtotal</b>					<b>\$ 103,175.00</b>
Contingency					20%
<b>Total</b>					<b>\$ 123,800.00</b>

## Alt. 5 Cheryl-Jacquelyn Pipe Upsize

Contractor :

PROJECT: Cheryl Drive  
 LOCATION: Fitchburg, WI  
 DATE: 9/7/2021

PROJECT NO.: 01052-0009

No.	Bid Item	Qty	Unit	Bid Unit Price	Bid Price
<b>Storm Sewer</b>					
1	48" Storm Manhole with Inlet	2	EA	\$2,500.00	\$ 5,000.00
2	7' Storm Manhole	1	EA	\$6,000.00	\$ 6,000.00
3	12-inch RCP Class III Storm Sewer	10	LF	\$45.00	\$ 450.00
4	18-inch RCP Class III Storm Sewer	62	LF	\$60.00	\$ 3,720.00
5	36-inch RCP Class III Storm Sewer	20	LF	\$75.00	\$ 1,500.00
6	38" x 60" HERCP Storm Sewer	66	LF	\$395.00	\$ 26,070.00
7	Storm Sewer Trench Backfill	158	TF	\$12.00	\$ 1,896.00
8	38" x 60" HERCP Apron End	1	EA	\$3,200.00	\$ 3,200.00
9	Riprap	25	CY	\$75.00	\$ 1,875.00
10	Concrete Weir	5	CY	\$750.00	\$ 3,750.00
11	Remove Inlets	2	EA	\$400.00	\$ 800.00
12	Remove Manhole	1	EA	\$650.00	\$ 650.00
13	Remove 18" RCP Storm Sewer	63	LF	\$35.00	\$ 2,205.00
14	Remove 24" RCP Storm Sewer	20	LF	\$35.00	\$ 700.00
15	Remove 30" RCP Storm Sewer	66	LF	\$35.00	\$ 2,310.00
16	Remove Concrete Weir	3	CY	\$350.00	\$ 1,050.00
17	Remove Apron Endwall	1	EA	\$500.00	\$ 500.00
					<b>\$ 61,676.00</b>
<b>Earthwork</b>					
18	Strip & Stockpile Topsoil	190	SY	\$15.00	\$ 2,850.00
19	Common Excavation	250	CY	\$15.00	\$ 3,750.00
20	Spread Topsoil	570	SY	\$15.00	\$ 8,550.00
21	Restoration	250	SY	\$10.00	\$ 2,500.00
					<b>\$ 15,150.00</b>
<b>Erosion Control</b>					
22	Silt Fence, Install, Maintain, & Remove	65	LF	\$20.00	\$ 1,300.00
23	Erosion Matting Class I, Type A Urban	190	SY	\$5.00	\$ 950.00
24	Erosion Matting Class II, Type C	75	SY	\$15.00	\$ 1,125.00
25	Construction Entrance, Place and Maintain	1	EA	\$1,400.00	\$ 1,400.00
					<b>\$ 4,775.00</b>
<b>Street Improvement (includes small area of resurfacing)</b>					
26	HMA Pavement 4 LT 58-28 H (Upper)	19	Tons	\$200.00	\$ 3,800.00
27	HMA Pavement 3 LT 58-28 S (Lower)	25	Tons	\$200.00	\$ 5,080.00
28	Clean, Mill, and Tack	150	SY	\$1.00	\$ 150.00
29	Base Aggregate Dense 3-Inch	65	Tons	\$30.00	\$ 1,962.00
30	Base Aggregate Dense 1 1/4-Inch	40	Tons	\$300.00	\$ 11,910.00
31	30" Concrete Curb and Gutter	20	LF	\$300.00	\$ 6,000.00
32	Sawing Asphalt	74	LF	\$5.00	\$ 370.00
33	Remove Asphaltic Road Surface	150	SY	\$23.00	\$ 3,450.00
34	Remove Curb and Gutter	20	LF	\$10.00	\$ 200.00
35	Adjust Structures in Pavement	2	EA	\$325.00	\$ 650.00
					<b>\$ 33,572.00</b>

**Subtotal** | \$ 115,173.00  
 Contingency 20%  
**Total** | \$ 138,200.00

## Alt. 7 Cheryl Offline Storage Area

Contractor :

PROJECT: Cheryl Drive  
 LOCATION: Fitchburg, WI  
 DATE: 8/6/2021

PROJECT NO.: 01052-0009

No.	Bid Item	Qty	Unit	Bid Unit Price	Bid Price
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**Earthwork**

2	Strip & Stockpile Topsoil	2,200	CY	\$3.00	\$ 6,600.00
3	Clearing and Grubbing	1	LS	\$1,500.00	\$ 1,500.00
4	Common Excavation and Haul Off	14,335	CY	\$15.00	\$ 215,025.00
5	Spread Topsoil	2,200	CY	\$5.00	\$ 11,000.00
					<b>\$ 234,125.00</b>

**Erosion Control**

6	Silt Fence, Install, Maintain, & Remove	500	LF	\$4.00	\$ 2,000.00
8	Erosion Matting Class I, Type A Urban	6,600	SY	\$5.00	\$ 33,000.00
10	Construction Entrance, Place and Maintain	1	EA	\$1,400.00	\$ 1,400.00
					<b>\$ 36,400.00</b>

<b>Subtotal</b>	<b> </b>	<b>\$ 270,525.00</b>
Contingency		20%
<b>Total</b>	<b> </b>	<b>\$ 324,600.00</b>

## Alt. 9 Cheryl Swale 2 Widening

Contractor :

PROJECT: Cheryl Drive  
 LOCATION: Fitchburg, WI  
 DATE: 9/8/2021

PROJECT NO.: 01052-0009

No.	Bid Item	Qty	Unit	Bid Unit Price	Bid Price
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**Earthwork**

1	Strip & Stockpile Topsoil	370	CY	\$3.00	\$ 1,110.00
2	Clearing and Grubbing	1	LS	\$1,500.00	\$ 1,500.00
3	Common Excavation and Haul Off	861	CY	\$15.00	\$ 12,915.00
4	Spread Topsoil	370	CY	\$5.00	\$ 1,850.00
5	Concrete Weir	3	CY	\$700.00	\$ 2,100.00
					<b>\$ 19,475.00</b>

**Erosion Control**

6	Silt Fence, Install, Maintain, & Remove	500	LF	\$4.00	\$ 2,000.00
7	Ditch Check, Install, Maintain, & Remove	5	EA	\$550.00	\$ 2,750.00
8	Erosion Matting Class I, Type A Urban	1,100	SY	\$5.00	\$ 5,500.00
9	Construction Entrance, Place and Maintain	1	EA	\$1,400.00	\$ 1,400.00
					<b>\$ 11,650.00</b>

<b>Subtotal</b>	<b> </b>	<b>\$</b>	<b>31,125.00</b>
Contingency			20%
<b>Total</b>	<b> </b>	<b>\$</b>	<b>37,400.00</b>