Technical Memorandum

Date: Friday, January 18, 2019
Project: Sanitary Sewer Master Plan FY18 Update
To: City of Cedar Rapids
From: Anthony Vecchi/HDR, David Dechant/HDR
Subject: TM 3.1.1 C Avenue NE Hydraulic Model Study

This Technical Memorandum (TM) documents the evaluation of proposed sanitary sewer extensions from the City of Cedar Rapids sanitary sewer network into the C Avenue NE growth corridor. The City’s hydraulic model was used to provide an overview of the new sewer’s performance and any downstream capacity impacts. This TM is organized as follows.

- Background and Objective
- Summary
- Modeling Methodology
- Model Results
- Study Recommendations
- Attachments
  - A – Model Results – Existing 2- and 5-year events

Background and Objective
The City of Cedar Rapids (City) is planning for extending sanitary sewer service to a growth area along C Avenue NE north of Robins Road. This area was previously studied as part of the North Growth Area Sanitary Sewer Service Plan in 2017. In that study, this area was identified as requiring minor sanitary sewer extensions to connect to existing City infrastructure.

The objective of this Hydraulic Model Study is to affirm the proposed sanitary sewer extension sizing, to evaluate the downstream capacity implications of the extensions along C Avenue NE north of Robins Road, and to determine if any improvements are required. The City’s existing sanitary sewer hydraulic model was modified to include the proposed development and sanitary sewer extensions and to evaluate how their inclusion affects the system.

Summary
The planned development and sanitary sewer extensions along C Avenue NE, shown in Figure 1 could present challenges to the downstream sanitary sewer and Dry Run / Indian Creek Trunk sewer. The City’s existing sanitary sewer hydraulic model was used to evaluate the impact of adding these new developments to the City’s sanitary sewer service area. The proposed 10” PVC sewer west of C Avenue NE would add an average of 0.13 MGD to the system and the proposed 15” PVC sewer east of C Avenue NE would add an average of 0.31 MGD to the system at a location within the City of Marion.
Model results for two population conditions and two storm events illustrate the fact that the proposed extensions and existing sanitary sewer have sufficient capacity to convey wet weather flows to the downstream trunk sewer. An existing bottleneck on the downstream Dry Run / Indian Creek Trunk sewer near Boyson Park between Boyson Road and W 14th Ave could result in potential basement backups or overflows, depending on how quickly the proposed growth areas develop, prior to a planned capacity improvement on that sewer. Development in these areas could be monitored until that improvement is constructed to ensure that it does lead to overflows or backups near Boyson Road.

![Figure 1: Proposed Landuse and Sanitary Sewer Extensions](image)

**Modeling Methodology**

The hydraulic model study for the C Avenue NE growth areas follows the same approach and methods outlined in *TM 3.0 Hydraulic Modeling*, and uses several of the same population and sanitary flow estimates outlined in *TM 7.1 North Growth Area*. The approach for adding this growth area to the existing hydraulic model is outlined below.

**Landuse and Population**

The proposed landuse for the new development east and west of C Avenue NE and north of Robins Road was from the City’s EnvisionCR planning document. The 130 acres of developable land west of C Avenue NE will be 93% urban low intensity and 7% urban medium intensity. Using the same assumptions used in TM 7.1, this equates to an estimated population of 1,340
at ultimate development conditions. The 268 acres of developable land east of C Avenue NE will be 72% urban low intensity and 28% urban medium intensity. This equates to an estimated population of 3,070 at ultimate development conditions. A summary of these areas is shown in Table 1.

**Table 1: C Avenue NE Growth Area Landuse**

<table>
<thead>
<tr>
<th>Location</th>
<th>Zoning</th>
<th>Acres</th>
<th>Density (persons/Acre)</th>
<th>Population</th>
<th>Total Population</th>
<th>Total Flow (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West of C Ave NE</td>
<td>Urban Low Intensity</td>
<td>121.1</td>
<td>10</td>
<td>1,210</td>
<td>1,340</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Urban Medium Intensity</td>
<td>8.9</td>
<td>15</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East of C Ave NE</td>
<td>Urban Low Intensity</td>
<td>192.1</td>
<td>10</td>
<td>1,920</td>
<td>3,070</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>Urban Medium Intensity</td>
<td>76.3</td>
<td>15</td>
<td>1,150</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Flow Allocation**

These two development areas were defined in the model as two unique sewersheds. Each sewershed loads the pipe network based on its base flow and wet weather response characteristics. Modeled base flow is composed of base sanitary flow and groundwater infiltration. Base flow estimates for each development area were based on the IDNR design standard of 100 gallons per capita per day (gpcd). The diurnal residential sanitary flow patterns for these areas were assumed to match the pattern used for the rest of the City.

Estimating the wet weather response for newly developed areas is not as direct as it is for areas with recorded flow data. For the purposes of this evaluation, the wet weather response of these two areas was assumed to be identical to the nearby, calibrated sewersheds. The level of inflow and infiltration in this area is generally in line with newer developments and is relatively lower than citywide levels. This conservative estimate is more realistic than assuming no rainfall dependent infiltration and inflow, especially when considering the sanitary sewer performance 20 years from now.

**Sanitary Sewer Network**

The proposed extensions to the sanitary sewer network were added to the hydraulic model using elevations, slopes, and pipe sizes outlined in engineering designs by others provided by City staff. East of C Avenue NE, the proposed 15” PVC pipe connects to a 21” RC pipe owned by the City of Marion. West of C Avenue NE, the proposed 10” PVC pipe connects to an existing 12” sewer south of Robins Road. Both new sewer extensions eventually drain to the Dry Run / Indian Creek Trunk Sewer south of Boyson Road.

**Model Scenarios**

The hydraulic performance of these sewer extensions, and their impact on the downstream trunk sewer, was evaluated based on model results for four different scenarios. The scenarios are based on a combination of two different design rainfall events and two different population
conditions. The population scenarios include 2018 population and 2040 projected population. In both cases, full development conditions are assumed for the C Avenue NE growth area. The four model scenarios are outlined below.

- 2018, 2-Year Design Storm
- 2018, 5-Year Design Storm
- 2040, 2-Year Design Storm
- 2040, 5-Year Design Storm

Model results are evaluated using the same key metrics outlined in TM 3.0 and TM 3.1. These metrics are the surcharge state of each modeled pipe and the freeboard at each manhole. The surcharge state is used to identify any pipes that are bottlenecks in the system and to understand why other pipes are full. The freeboard at each manhole is used to estimate locations where basement backups, or sanitary sewer overflows, could occur based on how close sanitary flow is to the manhole rim.

**Model Results**

Hydraulic model results can identify bottlenecks and potential overflows in the system. Additionally, the model can demonstrate the impact of improvement projects to ensure that they are truly solving the problems experienced in the system. Model results for each scenario are outlined below and shown in Appendix A of this memorandum.

**2018, 2-Year Design Storm**

If the C Avenue NE development were to be fully developed today, the proposed extensions and existing sanitary sewer have sufficient capacity to convey 2-year wet weather flows to the downstream trunk sewer. Under this scenario, the Dry Run / Indian Creek Trunk sewer is a bottleneck that results in potential basement backups south of Boyson Road. There are previously planned capacity improvements to the trunk sewer in this area to address the known bottleneck in the coming years. However, the current modeling effort did not include simulation and verification of the planned improvements.

**2018, 5-Year Design Storm**

The proposed extensions and existing sanitary sewer has sufficient capacity to convey 5-year wet weather flows to the downstream trunk sewer. Under this scenario, the Dry Run / Indian Creek Trunk sewer is a bottleneck that results in potential basement backups and overflows near Boyson Road. The potential backups and overflows north of Boyson Road near Timber Creek Dr are primarily caused by flow backing up behind the Dry Run / Indian Creek Trunk sewer bottleneck downstream. As noted above, there are previously planned improvements to address the known bottleneck.

**2040, 2-Year Design Storm**

Under 2040 projected population conditions, model results show a similar results to 2018 conditions for a 2-year event. The proposed and existing sanitary sewer have capacity to deliver flows to the downstream trunk sewer without leading to overflows or backups. As before, a
bottleneck on the Dry Run / Indian Creek Trunk sewer could cause backups and overflows near Boyson Road. However, this bottleneck is expected to be upsized before 2040.

**2040, 5-Year Design Storm**
Under 2040 projected population conditions, model results show a similar results to 2018 conditions for a 5-year event. As before, a bottleneck on the Dry Run / Indian Creek Trunk sewer could cause backups and overflows near Boyson Road and to the north west of Timber Creek Dr. However, this bottleneck is expected to be upsized before 2040.

**Study Recommendations**
Using the City’s existing sanitary sewer hydraulic model to evaluate the impact of sewer extensions can help illustrate the impact of development and ensure that new sewers are sized correctly. In this evaluation, two developments along C Avenue NE were added to the model to ensure that flow generated by these areas during a wet weather event would not result in overflows or backups upstream of the Dry Run / Indian Creek Trunk sewer. These additions to the model were informed by previous modeling and growth studies performed by HDR and relied on similar assumptions and data sources. The calibrated wet weather response of the surrounding area within current City limits was assumed to match the wet weather response of these new developments, a conservative assumption for 2018 conditions but a more realistic one for 2040 conditions.

The hydraulic performance of the proposed extensions and existing system show that the development can be serviced as planned. Downstream bottlenecks along the Dry Run / Indian Creek Trunk sewer could result in potential overflows or backups if the growth areas fully develop before the planned improvements on that trunk sewer are constructed. Development in these areas should be monitored until the Dry Run / Indian Creek Trunk sewer improvements are completed.
Attachment A – Model Results, 2- and 5-year Storm Events