Executive Summary
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EXECUTIVE SUMMARY

ES1. Introduction

The Lakes and Princess Anne Plaza Project Area (“TL-PAP”) is located in the center of Virginia Beach. The project area is generally bounded by I-264 to the north, South Rosemont Road and Holland Road to the west, Lynnhaven Parkway to the south, and South Lynnhaven Road to the east (See Figure ES1-1). In addition, the total drainage area includes Chimney Hill and parts of Pecan Gardens and Windsor Oaks.

The TL-PAP project area has experienced repeated flooding issues throughout the years mainly due to its low elevations, tidal influence, lack of stormwater storage and undersized drainage system. A large portion is within FEMA’s 100-year floodplain (i.e. Elevation 7.0 feet, NAVD88 and below). The area is essentially a “bowl” where water becomes trapped in the low-lying areas and in extreme events becomes one large pool of water. Hurricane Matthew (October 2016) resulted in the most severe flooding and subsequent damage this area has ever experienced. More than 730 homes in the TL-PAP-WW project area reported flooding with property damage in excess of $10 million. This prompted the City to expedite a flood mitigation plan and strategy for the area.

The Princess Anne Plaza and The Lakes Neighborhoods Stormwater Management System Flood Mitigation Plan (CDM Smith, April 5, 2018) (TL-PAP Mitigation Plan) evaluated the project area and provided recommended drainage improvements to reduce the flooding issues. The major components of the recommended improvements included:

- Construct a 1,000 cfs pump station, tide gate and flood barrier at the northern limits of London Bridge Creek (near its crossing with South Lynnhaven Road);
- Construct a 600 cfs pump station, tide gate and flood barrier at the southern limits of London Bridge Creek (near its crossing with Lynnhaven Parkway);
- Construct 433 acre-feet (ac-ft) of new stormwater retention for the 100-year storm;
- Increase the capacity of the storm drain pipe network (i.e. increase pipe sizes, add additional storm drain pipes, etc.); and
- Restore the design capacity of Northgate Ditch, Bethune Drive Ditch and Bow Creek.

The TL-PAP Mitigation Plan also defined an achievable Level of Service (LOS) for the project area as:
Figure ES1-1: The Lakes and Princess Anne Plaza Project Area
Limiting peak flood stages to 3-inches or less above the road crown for the 10-year design storm; and
- Preventing structure flooding for the 100-year design storm.

It should be noted the proposed LOS is reduced from the City’s current standard, which requires a 10-year storm to be retained within the storm drain pipe network and the streets to remain passable during the 100-year storm event. However, it is not feasible to meet the standard LOS in this portion of the City due to its low elevations, topography, and the fact that the area is fully developed/built out. The TL-PAP Mitigation Plan LOS was used as the “Benchmark” or “Goal” when evaluating drainage improvements throughout this Preliminary Engineering Report (PER).

Most importantly, proposed improvements cannot cause adverse impacts downstream, upstream, or within the project limits. This directive was incorporated into the TL-PAP Mitigation Plan and carried forward to this PER. All recommended improvements have been evaluated to ensure resulting conditions are no worse than existing conditions. These evaluations will continue to be refined throughout the detailed design process.

ES2. Purpose

The purpose of this PER was to further evaluate, refine, prioritize, and recommend proposed drainage improvements to most efficiently mitigate the flooding within the TL-PAP area. Evaluation matrices were prepared to analyze Cost/Benefit ratios as well as other factors such as constructability, easement acquisitions, and permitting concerns for the proposed alternatives. Preliminary design concepts, cost estimates, and phasing plans were also prepared. The overall goal of the PER was to develop a feasible recommendation to mitigate the most flooding as cost effectively as possible.

ES3. Recommended Drainage Improvements

Evaluation of the TL-PAP project area confirmed there is NOT a single drainage solution or improvement to mitigate the flooding. A combination of complementary infrastructure improvements (i.e. tide gates, pump station, flood barriers, additional storage, and storm drain pipes) must be implemented to achieve the ultimate mitigation benefit and meet the LOS goal for the area.

The proposed solution to mitigate flooding in the project area lies in the “BERM-POND-PUMP” concept, which is a sequenced approach to flood mitigation. The first step is to create the “BERM”. The “BERM” is accomplished in two ways: first, by building tide gates across the northern and southern limits of London Bridge Creek to mitigate the influence of tides, and
secondly, by creating flood barriers to isolate the project area from outside influences such as overland flow in an extreme tidal or storm event. By mitigating tidal impacts, the tide gates effectively increase available storage capacity prior to and during a storm event. Isolation channels at the Southern Tide Gates are also proposed to separate the Green Run and The Lakes flows. A conceptual rendering of the Southern Tide Gates and Channelization is shown in Figure ES3-1.

Once the tide gates are installed, storage capacity (the “POND”) in the TL-PAP project area can be increased since deployment of the gates blocks the incoming tide from filling the available space. Additional storage is critical to the TL-PAP project area. Under existing conditions, the lack of storage results in stormwater backing up in the storm drain pipe network. The network eventually fills and then overflows resulting in roadway flooding. As most structures in the TL-PAP project area are slab-on-grade construction with finished floor less than 1-foot above the top of curb, once flooding exceeds top of curb, structure flooding quickly follows.

The TL-PAP project area does not have any large water bodies to serve as stormwater retention; therefore, storage will have to be created. The TL-PAP project area is essentially “built-out” (i.e., no large vacant developable areas exist) so few possible locations for additional storage exist. Multiple candidate locations were evaluated for stormwater retention. Recommended storage sites are the Bow Creek Golf Course and Plaza Northgate Park because they are relatively undeveloped and do not require significant property acquisition. Additional stormwater retention is recommended in the Chimney Hill area by installing a flood gate on the culvert under Holland Road. Combined, the Bow Creek Golf Course, Plaza Northgate Park and the Holland Road Flood Gate provide the estimated additional storage recommended for the 100-year storm event. For additional information see Chapter 11 of the PER.

Figures ES3-2 through ES3-5 demonstrate existing and proposed conditions in the TL-PAP project area, existing tidal impacts, and how the gate will assist in increasing available storage capacity.

Figure ES3-2 shows the current, low tide conditions in the various lakes, creeks and ditches (water bodies) in the TL-PAP project area. During low tide, storage capacity is available due to the lack of tidal influence. When the tide is out, there is available storage capacity in the water bodies since the tide is not occupying this space. However, as depicted in Figure ES3-3, in a high tide condition, there is very little storage available within the water bodies, as the tide is now occupying the storage space previously available at low tide. As shown by the red “High Tide” area, the storage capacity is dramatically reduced due to the influence of the tide.
Figure ES3-1: Southern Tide Gates and Isolation Channels
Figure ES3-4 demonstrates what currently occurs during a rainfall event at high tide. During the event, stormwater flows into the water bodies via storm drain pipes and overland sheet flow. Since there is limited or no storage available as a result of the high tide, the level of the storage areas rises quickly and with nowhere for the water to go, flooding occurs due to the high-water levels and low existing topography.

Figure ES3-5 depicts the resulting conditions after placement of the proposed tide gates. Once the tide gates are installed, they will be closed pre-storm to eliminate tidal influence. Blocking the tide creates additional storage capacity within the water bodies (as represented in blue below). This additional storage capacity allows the stormwater to be more effectively managed throughout the system to reduce flooding during storm events.
The third program element is “PUMP”. The pump station will be used to drawdown the water level of the lakes, creeks and ditches in advance of a storm and increase storage. The pump station will also pump during a storm event to maintain water levels below flood stage as long as possible. Pumps will be operated so there are no adverse downstream or upstream impacts (i.e., flooding will not be any worse than what existed before the project).

During evaluation of pump station locations, it was determined a single, 1,400 cfs capacity pump station, located at the northern project limits of London Bridge Creek could adequately serve the TL-PAP project area. This was designated the “1 PS Option”. Regardless of the pump station option, southern tide gates and barriers are required to prevent tidal intrusion into the storm retention areas via Canal #2. The “1 PS Option” is the recommended solution for the TL-PAP project area due to reduced project and maintenance costs and simpler system operation. A rendering of the proposed permanent pump station and tide gate on London Bridge Creek is shown in Figure ES3-6.

In addition to these three major program elements (BERM-POND-PUMP), storm drain pipe improvements are also required. The storm drain pipes are needed to route stormwater from the upper reaches of the watershed, along the streets, and from properties to the mainline channels and storage areas in a timely and efficient manner. The existing storm drain system throughout the TL-PAP project area is undersized, in poor condition or non-existent.

The storm drain pipe improvements assist in mitigating street flooding for the 10-year and smaller storm events but have little to no impact in mitigating structural flooding during more extreme events. It is the combination of the tide gates, pump station, and increased storage which provides the greatest structural flood mitigation benefit to the project area.

The major flood mitigation improvements recommended for the TL-PAP project area are noted below. Improvements should be constructed in sequence to achieve the greatest flood mitigation benefit. See Figure ES3-7 for a map showing project locations.
Figure ES3-6: Northern Pump Station, Tide Gate & Control Building Conceptual Rendering
Figure ES3-7
PER Recommended Flood Mitigation Improvements
ES4. PER Recommended Improvements

The PER recommended flood mitigation improvements are:

- Construct Tide Gates at the northern and southern project limits of London Bridge Creek;
- Create additional storage by constructing new stormwater retention;
- Construct a 1,400-cfs pump station at northern project limits of London Bridge Creek;
- Install Flood Barriers at the northern and southern project limits of London Bridge Creek; and
- Construct Storm Drain Pipe Improvements throughout the project area.

The first major project proposed is the installation of the Tide Gates. As previously discussed, eliminating tidal effects increases available stormwater storage capacity. The Tide Gates are recommended first as their construction period is relatively short and they provide immediate flood mitigation benefits.

The second major proposed project is creation of stormwater retention on the Bow Creek Golf Course since it has the greatest potential storage capacity. Due to its size and overall cost, the conversion has been divided into three Sections (See Figure ES4-1). Creation of storage is recommended second, ahead of the pump station, because additional storage is required for the pump station to be effective.

The next major improvement is the proposed pump station. The ultimate 1,400-cfs pump station will allow City Operations to fully utilize the storage behind the tide gate in the project area and provide further control over water levels during a storm event. The ultimate pump station design will also allow the water levels to be lowered to elevation 0.0 feet NAVD88 prior to a storm event to maximize the available stormwater capacity. Flows from the pump station and water levels will be closely monitored during operation by sensors and tide gauges both upstream and downstream. Levels will be monitored to ensure flood conditions are not any worse than what existed before the pump station and gates were installed.

Finally, it is recommended the flood barriers be constructed. Completion of the flood barriers to the design elevation, along with the other recommended improvements, will meet the Federal Emergency Management Agency requirements for protecting the TL-PAP project area allowing for reduced insurance rates under the National Flood Insurance Program. Construction of all recommended improvements provides the greatest flood insurance reduction benefit. However, incremental benefits may be achieved as each stage of construction is completed.
Figure ES4-1
Bow Creek Golf Course Construction Phasing

Legend
- - - - 50’ Wide Access Corridor

Cell 1
Cell 2
Cell 3
Cell 4
Cell 5
Cell 6
Cell 7
Buffer Zone
The TL-PAP area was developed from the 1960s to the late 1970s, before today's stormwater design standards. Therefore, much of the existing storm drain pipe network is undersized or non-existent. The *TL-PAP Mitigation Plan* recommended approximately 33,000 linear feet of new pipe and culvert improvements. This PER further refined the proposed storm drain pipe improvements. A constructability and cost-effectiveness review was performed to achieve the following:

- Optimize the pipe alignments;
- Minimize potential structure impacts and utility conflicts;
- Combine existing and proposed pipes where most efficient; and
- Avoid or define needed easements.

After this constructability review, the storm drain pipe network was further refined and optimized to reduce cost by reducing pipe sizes and eliminating pipe segments. A total of 32,600 linear feet of new storm drain pipe is included in this alternative. The locations of the proposed storm pipe improvements and their phasing are shown on Figure ES3-7.

The process of arriving at the recommended storm drain pipe improvements can be found in Chapter 10 of the PER. The proposed storm drain network improvements consists of large diameter pipes, requiring wide trenches and heavy-duty construction equipment. In some cases, removal of the existing storm drain pipe will be required. Project construction will be difficult, time-consuming and disruptive to the public. The work will primarily occur within the roadway requiring detours and will, at times, impact normal traffic patterns.

Table ES4-1 lists the recommended TL-PAP infrastructure improvements along with their cumulative cost. Also, included is the incremental benefit in terms of street and structural flood mitigation projected to be achieved with the construction of each major infrastructure improvement along with the current conditions as a baseline. Currently, it is estimated approximately 41,690 linear feet of streets flood during a 10-year design storm and 601 structures flood during a 100-year event within the Project Area. After construction of the PER Recommended Improvements, the street flooding is reduced to approximately 5,200 linear feet and structure flooding to 18.

Table ES4-1 shows the major infrastructure improvements (i.e., - tide gate, pump station, and additional storage) provide the greatest structure flooding mitigation benefit. As a result, these items are recommended to be constructed first (Phase IA) followed by additional storage on Bow Creek and at Holland Road (Phase IB) and the storm drain pipe projects (Phase II). A
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A separate Execution and Implementation Plan is under development which further outlines this phasing approach. Please see this document for further details.

Table ES4-1: Phase I & Phase II Incremental Improvements

<table>
<thead>
<tr>
<th>Major Stormwater Improvement Projects</th>
<th>Cumulative Cost ($ x Million)</th>
<th>Street Flooding (10-yr Storm)</th>
<th>Structure Flooding (100-yr Storm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current Conditions (No Improvements)</strong></td>
<td>$0</td>
<td>41,690 ft</td>
<td>601</td>
</tr>
<tr>
<td>Tide Gates</td>
<td>$21.0</td>
<td>28,490 ft</td>
<td>531</td>
</tr>
<tr>
<td>Bow Creek Golf Course Section I w/ Amenities</td>
<td>$50.2</td>
<td>22,740 ft</td>
<td>382</td>
</tr>
<tr>
<td>1,400-cfs Pump Station and Barriers</td>
<td>$111.9</td>
<td>21,160 ft</td>
<td>236</td>
</tr>
<tr>
<td>Bow Creek Golf Course Section II w/ Amenities</td>
<td>$133.7</td>
<td>19,890 ft</td>
<td>90</td>
</tr>
<tr>
<td>Bow Creek Golf Course Section III Amenities</td>
<td>$138.2</td>
<td>19,890 ft</td>
<td>90</td>
</tr>
<tr>
<td>Holland Road Flood Gate</td>
<td>$146.3</td>
<td>19,780 ft</td>
<td>82</td>
</tr>
<tr>
<td>Storm Drain Pipe Improve. &amp; Additional Storage</td>
<td>$216.0</td>
<td>5,230 ft</td>
<td>18</td>
</tr>
</tbody>
</table>

ES5. Summary

Due to the impacts of the tide, rainfall, and low elevations, a combination of complementary infrastructure improvements (i.e., tide gate, pump station, flood barriers, additional storage, and storm drain pipes) must be implemented to achieve maximum flood mitigation benefits throughout the TL-PAP project area. The major program elements, such as the tide gate, additional storage and pump station, provide the greatest individual flood mitigation benefit in terms of structural flooding for the 100-year design storm. The storm drain pipes have the biggest impact in mitigating street flooding during the 10-year design storm.

Many of the proposed improvements, such as the tide gates, pump station and most notably the additional storage, are costly, large in scale, and will require multi-year design and construction. The proposed storm drain pipe projects consist of large diameter pipes and are located in fully developed neighborhoods. Projects will need to be phased to allow daily access for residents, postal service, school buses, police, and other emergency services. Overall, this is a multi-year, multi-phase program to mitigate the flooding issues throughout the area. However, as each
improvement is constructed, incremental benefit will be realized building to the ultimate mitigation benefit at the end of the Overall Program.

The “PER Recommended Improvements” relieve the most flooding for the lowest estimated cost. While full flood mitigation (100% reduction) is not feasible for this area, the “PER Recommended Improvements” address a substantial portion of the flooding issues for the Windsor Woods project area. Roadway flooding is reduced by 87% (from 41,690 LF to 5,230 LF) during the 10-year design storm and structural flooding by 97% (from 601 to 18 structures) during the 100-year design storm. See Table ES5-1 for existing and proposed flooding data.

<table>
<thead>
<tr>
<th>Condition/Scenario</th>
<th>Length of Road Flooding (10-yr Design Storm)</th>
<th>Structure Flooding (100-yr Design Storm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing (Current)</td>
<td>41,690 LF</td>
<td>601</td>
</tr>
<tr>
<td>PER Recommended Improvements</td>
<td>5,230 LF</td>
<td>18</td>
</tr>
<tr>
<td>Flood Mitigation Benefit (% Reduction)</td>
<td>87%</td>
<td>97%</td>
</tr>
</tbody>
</table>

The planning-level opinion of probable project cost for the “PER Recommended Improvements” is approximately $216 million (in 2018 dollars, without escalation).

A tentative schedule has been prepared for each major component and a detailed discussion regarding the phasing can be found in Chapter 5. However, due to the total cost of the Overall Program, a separate Execution and Implementation Plan for the Recommended Improvements will be developed that further prioritizes projects in relation to available budget and flood mitigation benefits. This document will outline the next steps and strategy to effectively implement the Program, including the incremental benefits achieved as the work progresses.

END OF EXECUTIVE SUMMARY