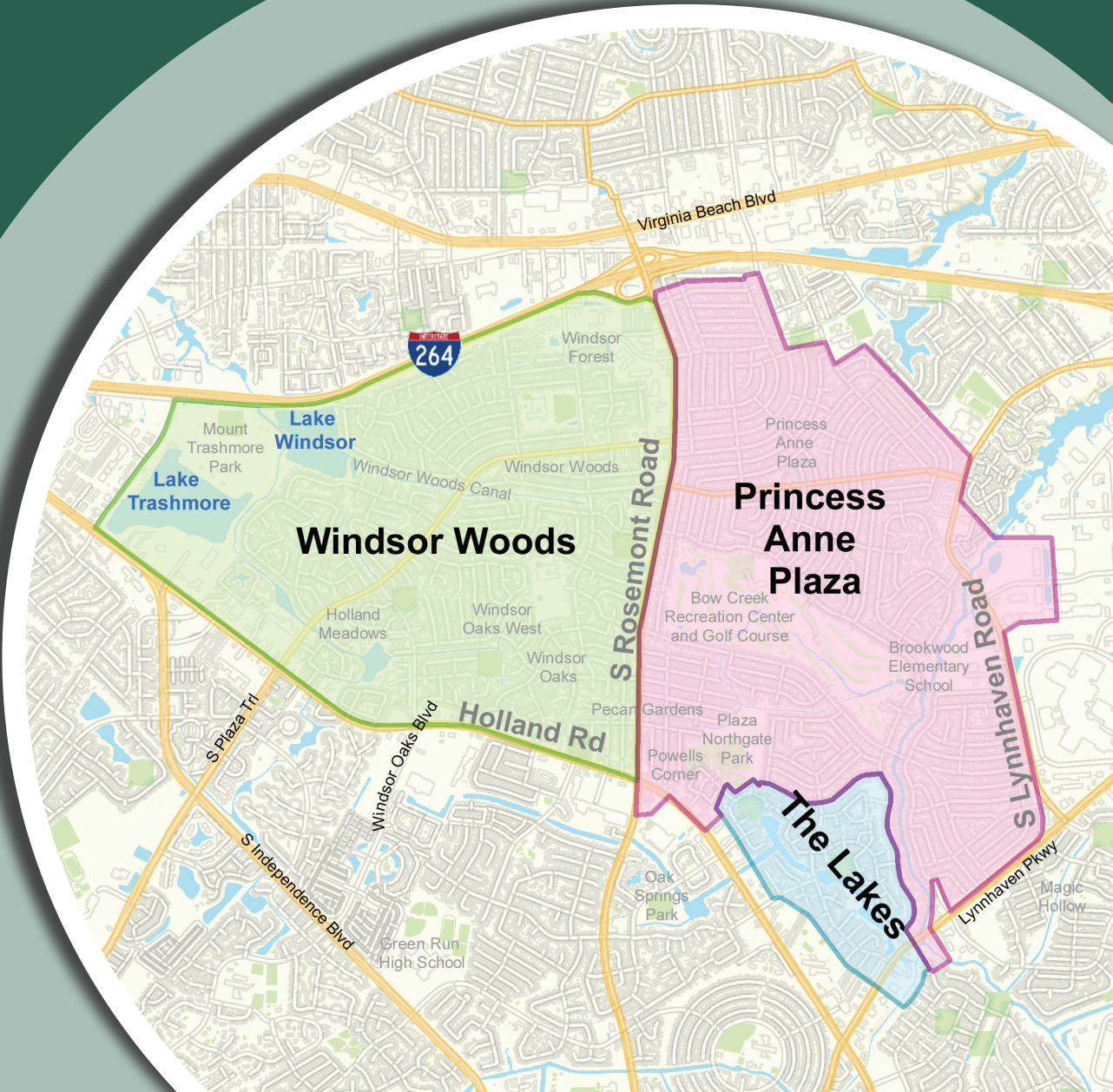


# The Lakes, Princess Anne Plaza, & Windsor Woods COMBINED DRAINAGE IMPROVEMENTS



# A History of Development and Flooding in Windsor Woods, Princess Anne Plaza, and The Lakes

**Windsor Woods, Princess Anne Plaza, and The Lakes** are neighborhoods located in what was once the undeveloped headwaters of the Lynnhaven River. According to aerial photos from 1949, the area was originally forest surrounded by farmland. Much of the area has relatively low elevations. These low elevations, coupled with increasing sea levels

(approximately one foot over the last 50 years) and the increasing frequency of storms with significant tides and rainfall amounts, has resulted in severe flooding during major storm events. Below is a table listing such events and peak water levels.

**HISTORICAL STORM EVENTS AND TIDAL ELEVATIONS AT SEWELLS POINT**

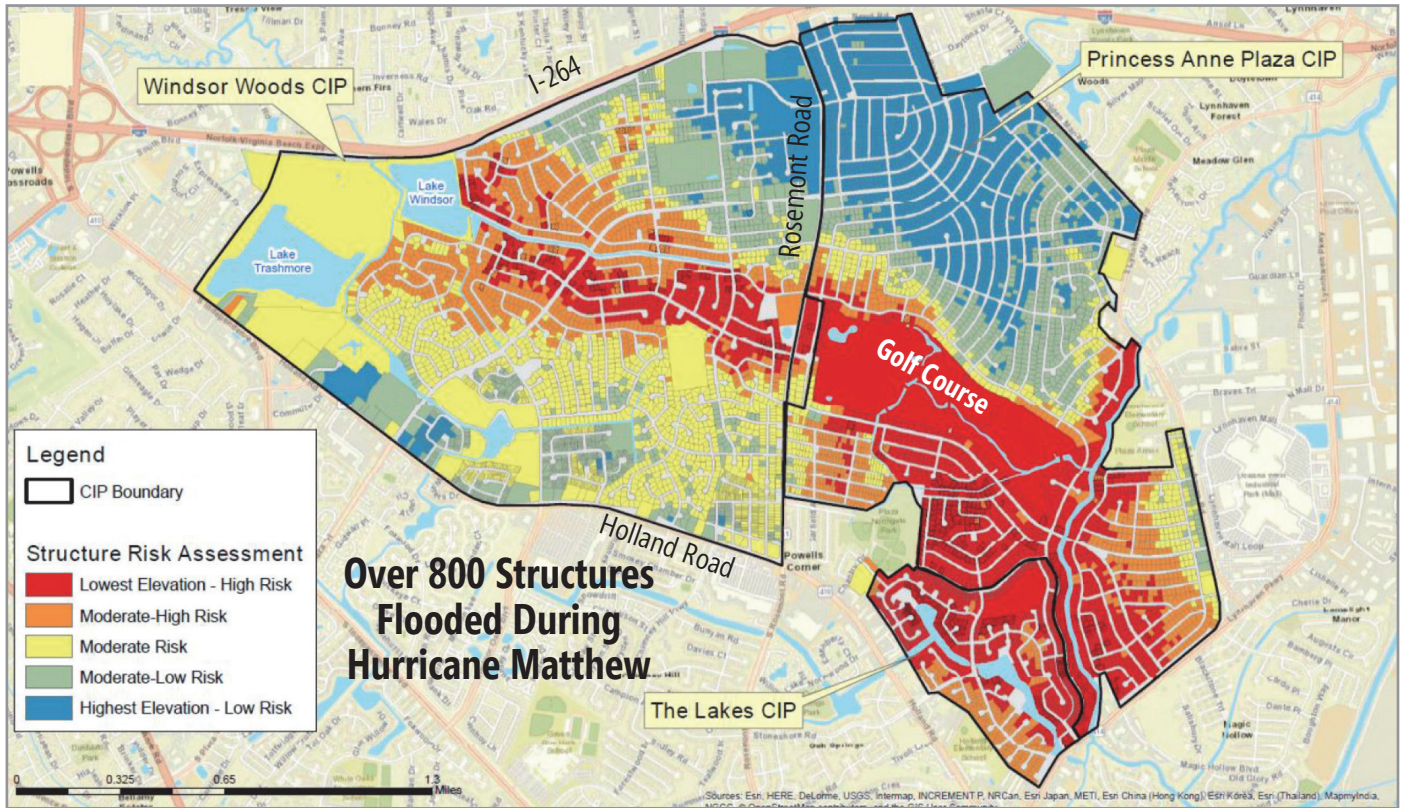
Storm Event	Time (Year)	Maximum Water Level (feet, NAVD88)
Hurricane Floyd	1999	4.36
Nor'ida (Nor'easter)	2009	6.12
Hurricane Irene	2011	5.94
Hurricane Sandy	2012	5.18
Hurricane Hermine	2016	4.53
Tropical Storm Julia	2016	2.56
Hurricane Matthew	2016	4.11

Rainfall from Hurricane Matthew in October 2016 (approximately 10 inches) caused flooding throughout the City. Neighborhoods that experienced flooding include Windsor Woods, Princess Anne Plaza, the Lakes, Ashville Park, Central Resort District, Sherwood Lakes, Chubb Lake/Lake Bradford, and Eastern Shore Drive. Hurricane Matthew came on the heels of Hurricane Hermine (Labor Day weekend), which dropped an average of 10 inches of rain, and the remnants of Tropical Depression Julia (September 15-18), which dropped an average of 11 inches of rain in the City.

This significant amount of rain led to extremely high-water levels in the canals, ponds, and lakes before the arrival of Hurricane Matthew. Records indicate approximately 800 residences in the **Windsor Woods-Princess Anne Plaza-The Lakes** area had various levels of flood damage. Many streets were impassable. In addition to significant rainfall, high tides and low elevations also contributed to flooding in the neighborhoods.

The map below illustrates the elevations within the project area, with the **RED** shaded areas being the lowest elevations and the highest risk of flooding.

### Elevations within the Project Area



As a result of the extreme flooding from Hurricane Matthew, Virginia Beach Public Works has conducted an extensive engineering analysis to identify significant issues that contributed to street and structure (home flooding) to identify infrastructure improvements needed to mitigate flooding in the **Windsor Woods-Princess Anne Plaza-The Lakes** neighborhoods. It has been determined that a combination of complementary infrastructure improvements are required to achieve the maximum flood mitigation benefit as identified below:

#### The engineering analysis identified significant issues:

- Low Elevations (homes and streets)
- Undersized existing storm drain pipes and lack of stormwater storage
- Tidal influence resulting in a substantial reduction of stormwater storage in existing lakes and canals
- Intense storm events resulting in more frequent flooding and increased property damage

#### Proposed improvements to mitigate flooding include:

- Tide gates to minimize tidal impacts and flooding
- Stormwater pump stations to manage water levels and increase storage capacity
- Creation of additional stormwater storage capacity to manage the water
- New storm drain pipes to move water within the system and reduce street flooding

The proposed infrastructure improvements discussed on the next pages are presented in more detail on the Overall Project website: [www.vbgov.com/windsor-woods](http://www.vbgov.com/windsor-woods).

The map below shows the locations of the major improvements in relation to the project area.

## Infrastructure Improvements to Mitigate Street and Structure Flooding



Major infrastructure improvements (items 1-5 above) include tide gates, pump stations, barriers, channel improvements, and storm drains. Brief descriptions of each improvement are provided on the following pages.



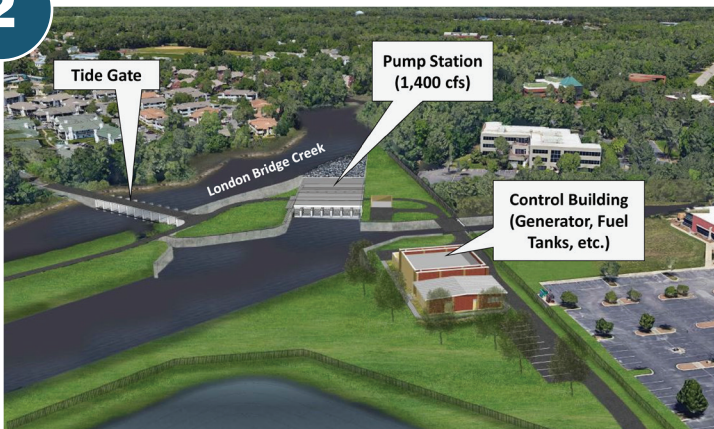
Rendering of WW Tide Gate and Pump Station

### Windsor Woods Tide Gate & Pump Station

Significant issues for the service area are low elevations, minimal capacity of existing storm drain systems, high tides resulting in significant reduction of stormwater storage in Lake Trashmore and Lake Windsor, and intense storm events that result in more frequent flooding and increased property damage. Potential solutions include construction of barriers and gates to minimize tidal flooding, stormwater pump stations, creation of additional lake storage capacity, and increasing the capacity of the storm drain pipes.

The first step is the tide gates. The gates are necessary to stop the incoming tides from reducing available storage. When the tide gates are closed (to stop the tides), pump stations are necessary to pump water (from rainfall) around the tide gates and barriers to Thalia Creek. For more information, see the Windsor Woods Tide Gate project brochure located on the Overall Project website: [www.vbgov.com/windsor-woods](http://www.vbgov.com/windsor-woods).

2



**Rendering of Potential North London Bridge Creek Tide Gate & Pump Station**

### **North London Bridge Creek Tide Gate & Pump Station**

As with Thalia Creek, tide gates are necessary to stop the incoming tide from London Bridge Creek from reducing available storage within the existing Princess Anne Plaza drainage system. When the tide gates are closed (to stop the tides), a pump station is necessary to pump water (from rainfall) around the tide gates and barriers to London Bridge Creek. Additional information is to be provided at a later date as plans are further developed.

3



**Rendering of Potential South London Bridge Creek Tide Gate & Channelization**

### **South London Bridge Creek Tide Gate & Channel Rendering**

For West Neck Creek, tide gates are necessary to block incoming tides from the south and north (from Canal No. 2). Channel improvements are also needed to separate and redirect stormwater flows from The Lakes and Green Run Canals to West Neck Creek. Depending on tide and wind patterns, water can flow multiple directions in this area. Flow can head north along Canal No. 2 or continue along West Neck Creek to the north or south. Additional information is to be provided at a later date as plans are further developed.

# 4

## Bow Creek Stormwater Park

In The Lakes and Princess Anne Plaza areas, existing stormwater storage is limited. To achieve the maximum flood mitigation benefit for the area, additional stormwater storage is necessary to capture and manage large amounts of rainfall from significant storm events. Without creating the required amount of stormwater storage, flood mitigation cannot be achieved. Therefore, creating storage to manage rainfall from intense storms is critical to mitigating flooding of homes and streets within The Lakes, Princess Anne Plaza, and Windsor Woods neighborhoods.

The City of Virginia Beach has developed a plan that explores optimization of the approximately 121-acre, City-owned Bow Creek Golf Course (BCGC) for flood mitigation. The vision for the project is to convert the land use from a golf course to a multi-faceted facility that will provide significant stormwater storage to mitigate flooding and restore natural systems while providing active and passive recreational opportunities.

### Significant issues include:

- Existing stormwater storage within the Princess Anne Plaza area is inadequate
- Limited options available for stormwater storage
- To acquire private property is not a practical option; especially since City-owned property in the center of the most flood prone area is available (i.e., Bow Creek Golf Course)
- Off-site storage would result in a significant increase in project cost

### Potential solutions include:

- Utilize City-owned property to create stormwater storage to help mitigate flooding
- Combine stormwater storage with multi-use park facility
- Provide park facilities to encompass both passive and active recreational opportunities

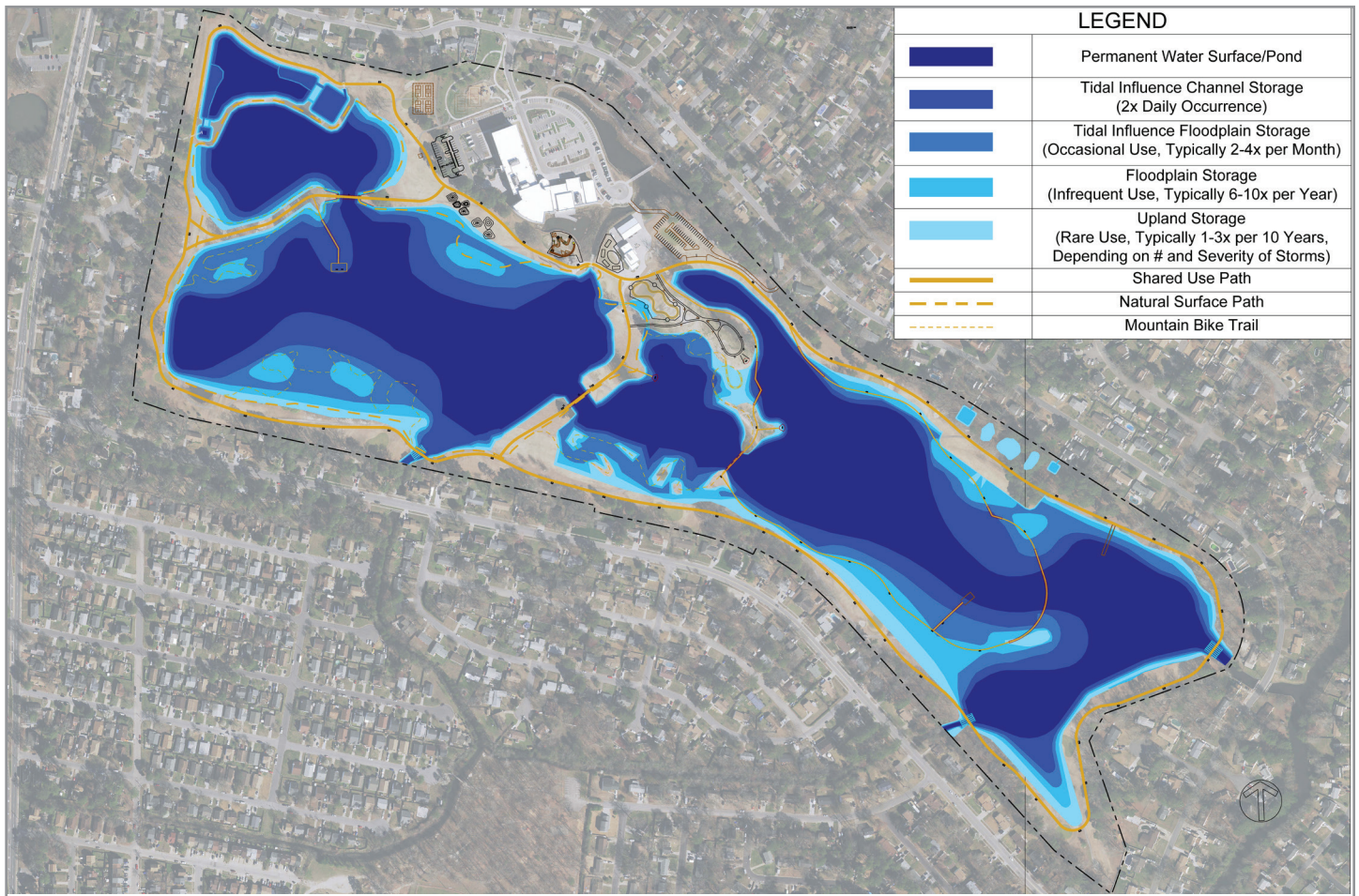
For more information on the Bow Creek Stormwater Park, please see [www.vbgov.com/BowcreekSWPark](http://www.vbgov.com/BowcreekSWPark).

### Bow Creek Stormwater Park Concept



## Levels of Stormwater Storage at Bow Creek Stormwater Park

The drawing below illustrates the varying levels of storage proposed as part of the Park. The **dark blue** represents Bow Creek as influenced by daily tide changes of West Neck Creek during normal weather conditions. The **medium blue** represents the additional water levels within the Park during moderate to heavy storms. Finally, the **light blue** represents the additional water levels within the Park during significant storms.



View from Maintenance Sheds looking southeast

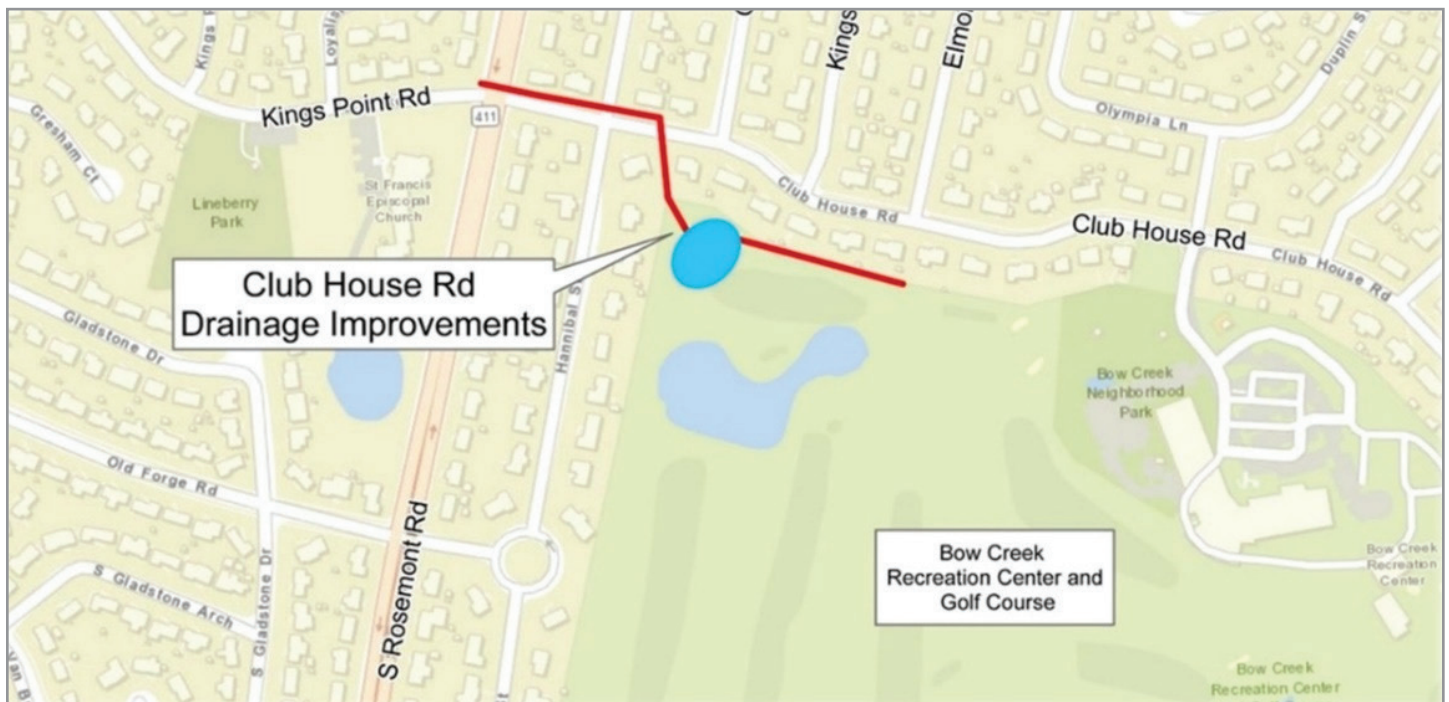
## 5 Storm Drain Projects

The engineering analysis has determined that approximately 50,000 feet of new storm drain pipe systems are anticipated to be constructed over the next 10 to 20 years. The construction of tide gates, barriers, and pump stations provides the most significant mitigation to structural flooding and will be constructed in advance of most of the new storm drains. New storm drains principally provide mitigation to street flooding.



There are several new storm drain pipe systems currently being designed. The projects are:

The Club House Road Drainage Project is to reduce the amount of stormwater that floods the low point on Rosemont Road between Club House Road and Country Club Circle by diverting stormwater to the golf course, east of Rosemont Road, which outlets to Bow and London Bridge Creeks.





The City funded three projects using FEMA reimbursement funds.

**Project 1** is along South Plaza Trail from Rosemont Road to Presidential Boulevard and Presidential Boulevard to the Windsor Woods Canal.

Project 1 is to reduce the amount of stormwater that floods the low point on Rosemont Road between Club House Road and Country Club Circle by diverting stormwater to the Windsor Woods Canal and Thalia Creek.

**Project 2** has been combined with **Project 3** and runs along Old Forge Court to Old Forge Road to Red Line Road to the Windsor Woods Canal.

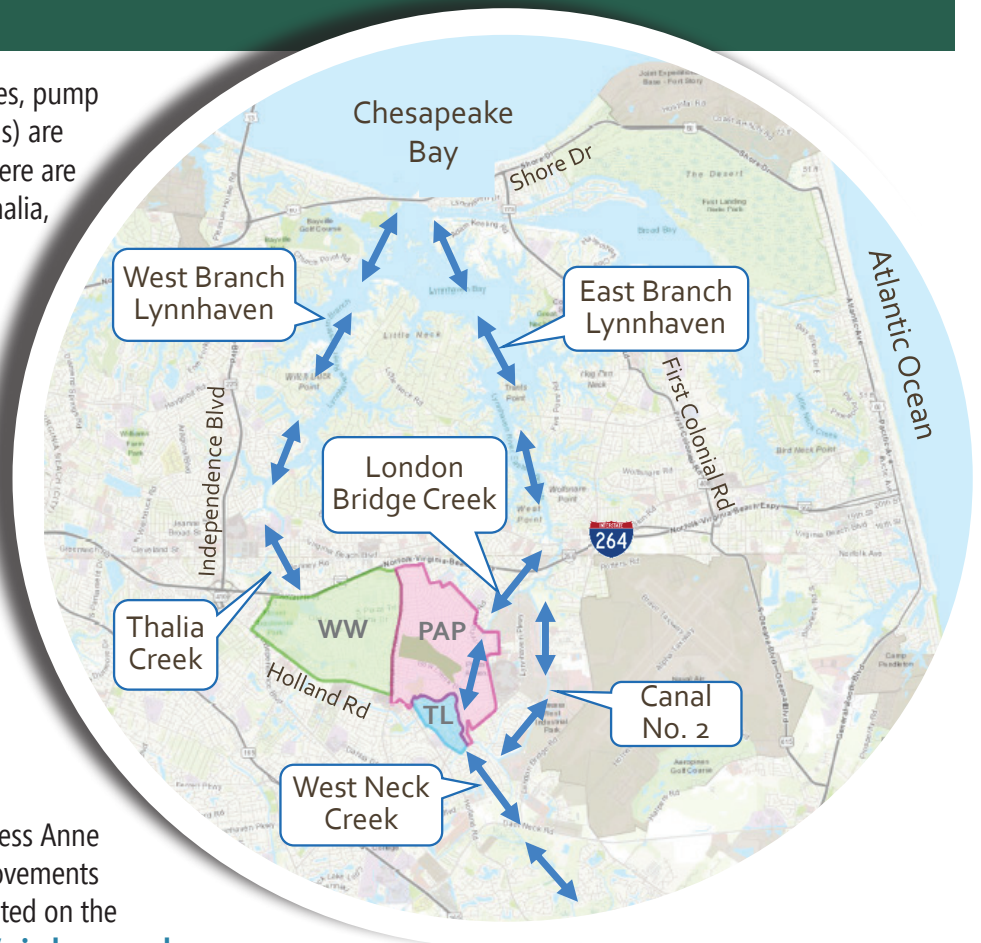
Projects 2 and 3 provide improved street flooding mitigation.



## Downstream Considerations

The proposed improvements (i.e., tide gates, pump stations, barriers, storage, and storm drains) are being designed and reviewed to ensure there are no negative downstream impacts along Thalia, London Bridge, and West Neck Creeks. The tide gates and pump stations will be used prior to and during an extreme storm event. While in use, water levels will continually be monitored both downstream and upstream to ensure there are no adverse impacts. Project implementation WILL NOT increase or cause flooding downstream. Water levels after the installation of the proposed improvements will be less than or equal to current (i.e., today's) water levels.

For a detailed discussion of tidal impacts, water surface elevations, and downstream considerations please see The Lakes, Princess Anne Plaza and Windsor Woods Drainage Improvements Downstream Considerations brochure located on the Overall Project website: [www.vbgov.com/windsor-woods](http://www.vbgov.com/windsor-woods).

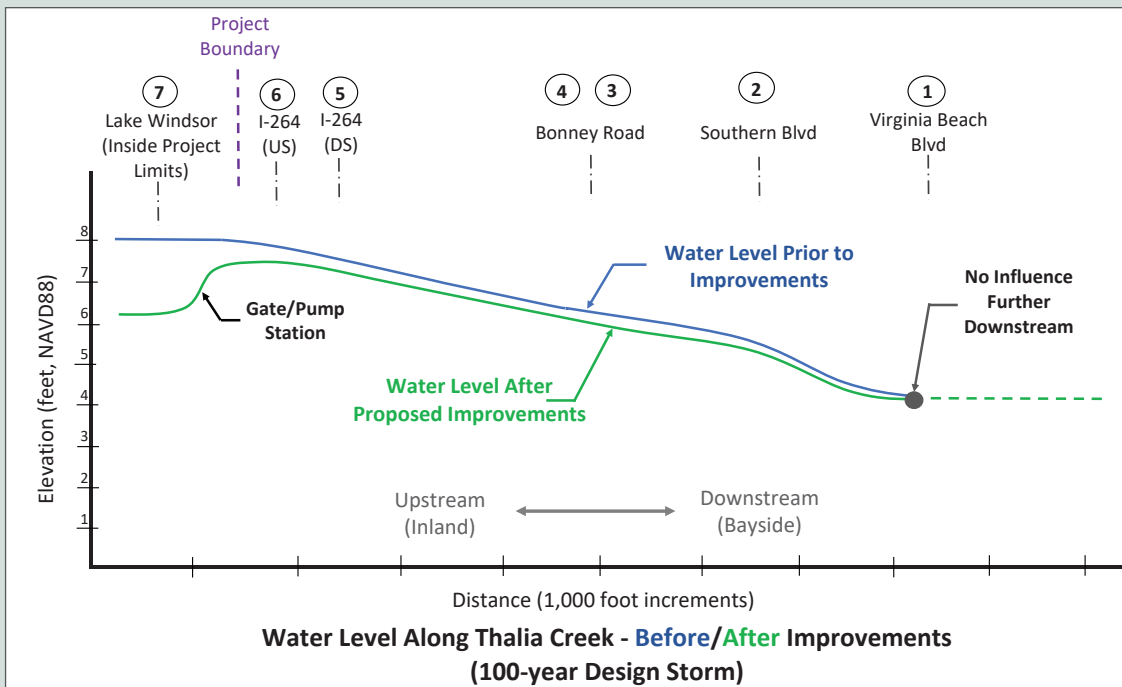
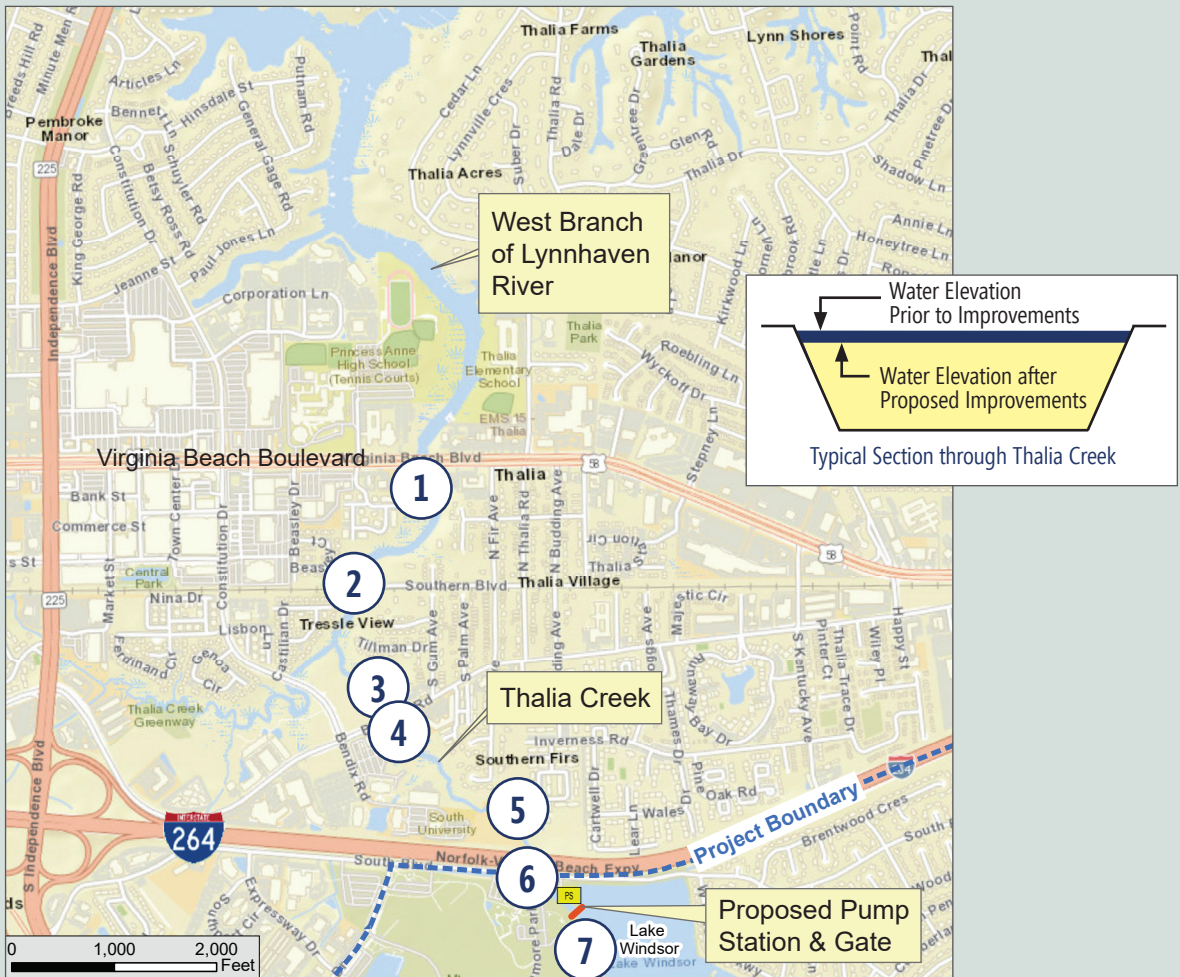


**Downstream Stormwater Modeling:** Extensive hydraulic modeling has been performed to evaluate conditions prior to and after project implementation downstream of the tide gates and pump stations. Model results demonstrate that downstream water surface elevations are equal to (or below) existing elevations as a result of the proposed drainage improvements. By creating additional stormwater storage capacity upstream of the tide gates and using the pump station to control the release of the stormwater into the downstream system, we can ensure that downstream water levels are not adversely impacted.

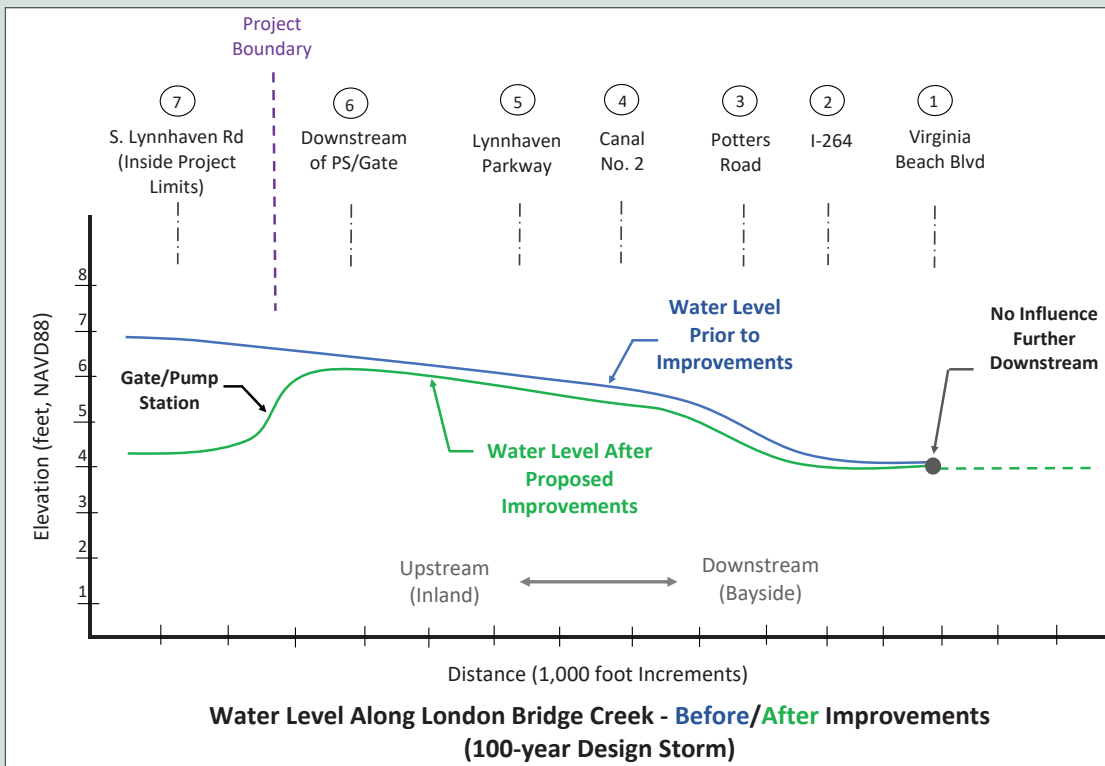
**The maps, charts, and graphs on the following pages show the downstream locations along Thalia Creek, London Bridge Creek, and West Neck Creek evaluated with the conditions prior to project implementation and resulting water surface elevations after the installation of the recommended improvements (i.e., before and after).** The blue line shown in the graphs represents the water levels prior to construction of the proposed improvements (i.e., the before). The green line represents the resulting water levels once the improvements are in place (i.e., the after). Each of the graphs show that the water levels after the proposed improvements are less than or equal to water levels before the improvements. This further demonstrates that the proposed improvements are NOT increasing downstream water levels and/or flooding. In fact, at many locations, project implementation actually improves (i.e. lowers) downstream water levels as shown in the graphs on the next pages.

The graphs on the following pages also illustrate how the proposed improvements work together to lower water levels within the project area upstream/inland of the project boundary (i.e. behind the gates and pump stations). This is demonstrated by the drop in water levels just inside the project boundary after the proposed improvements are in place (represented by the green lines in the graphs).

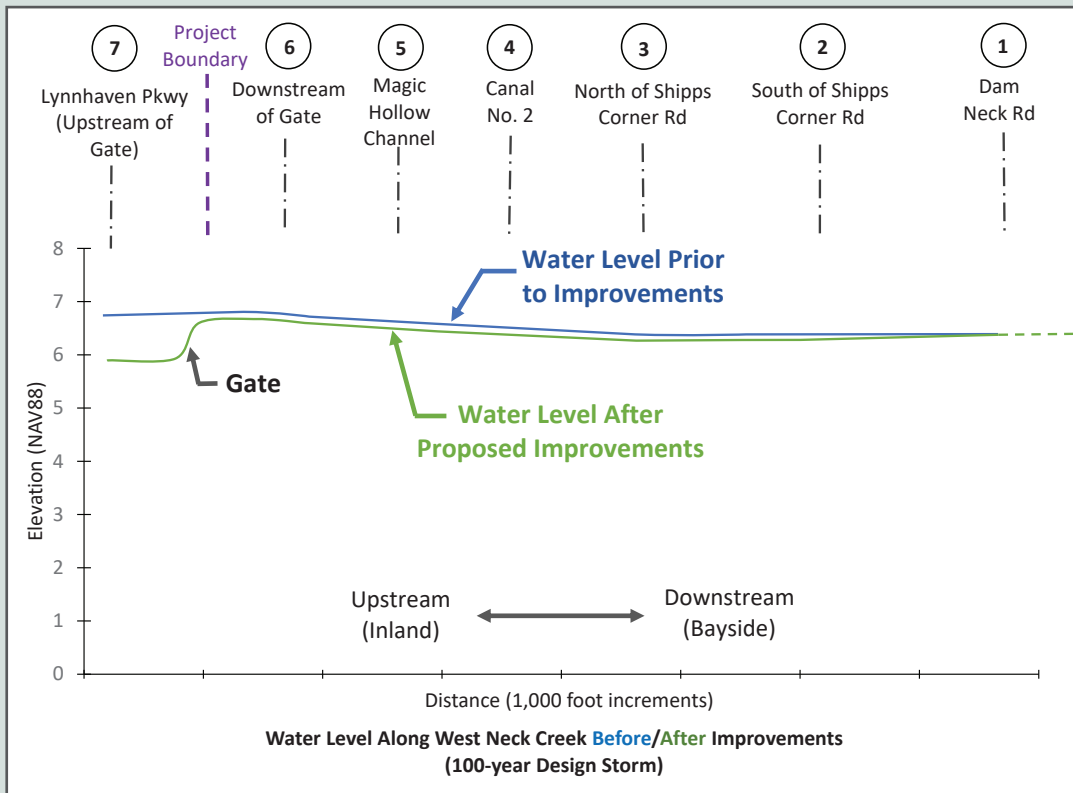
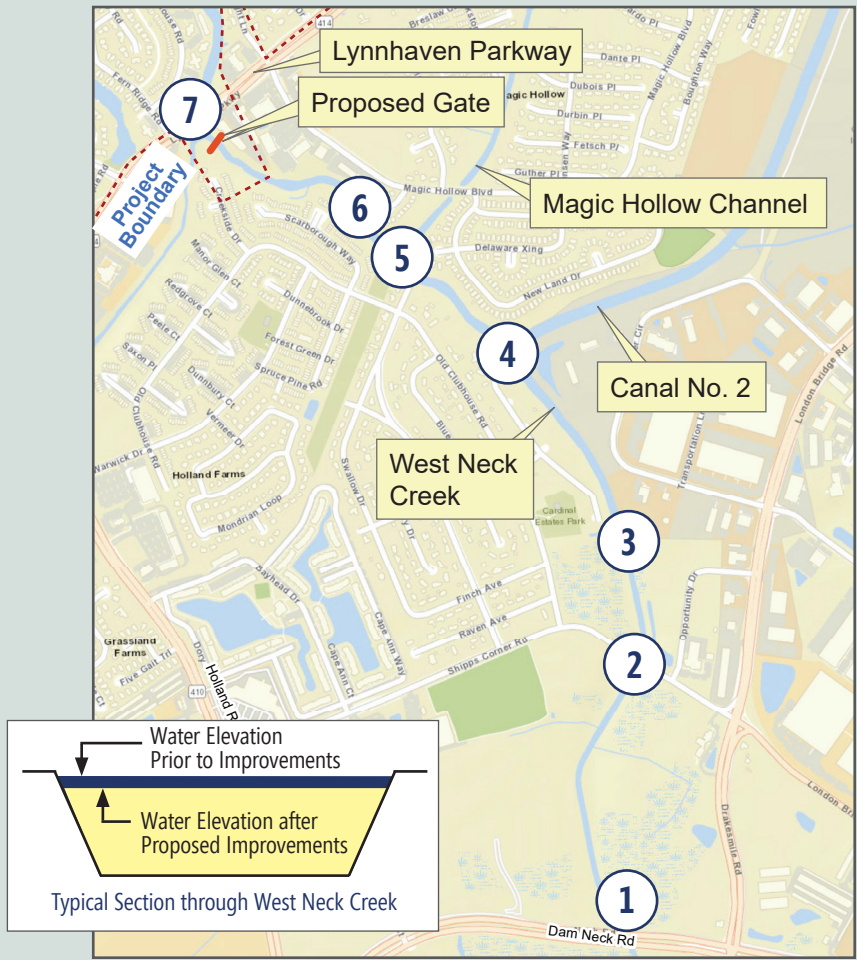
## Thalia Creek Results:



# London Bridge Creek Results:



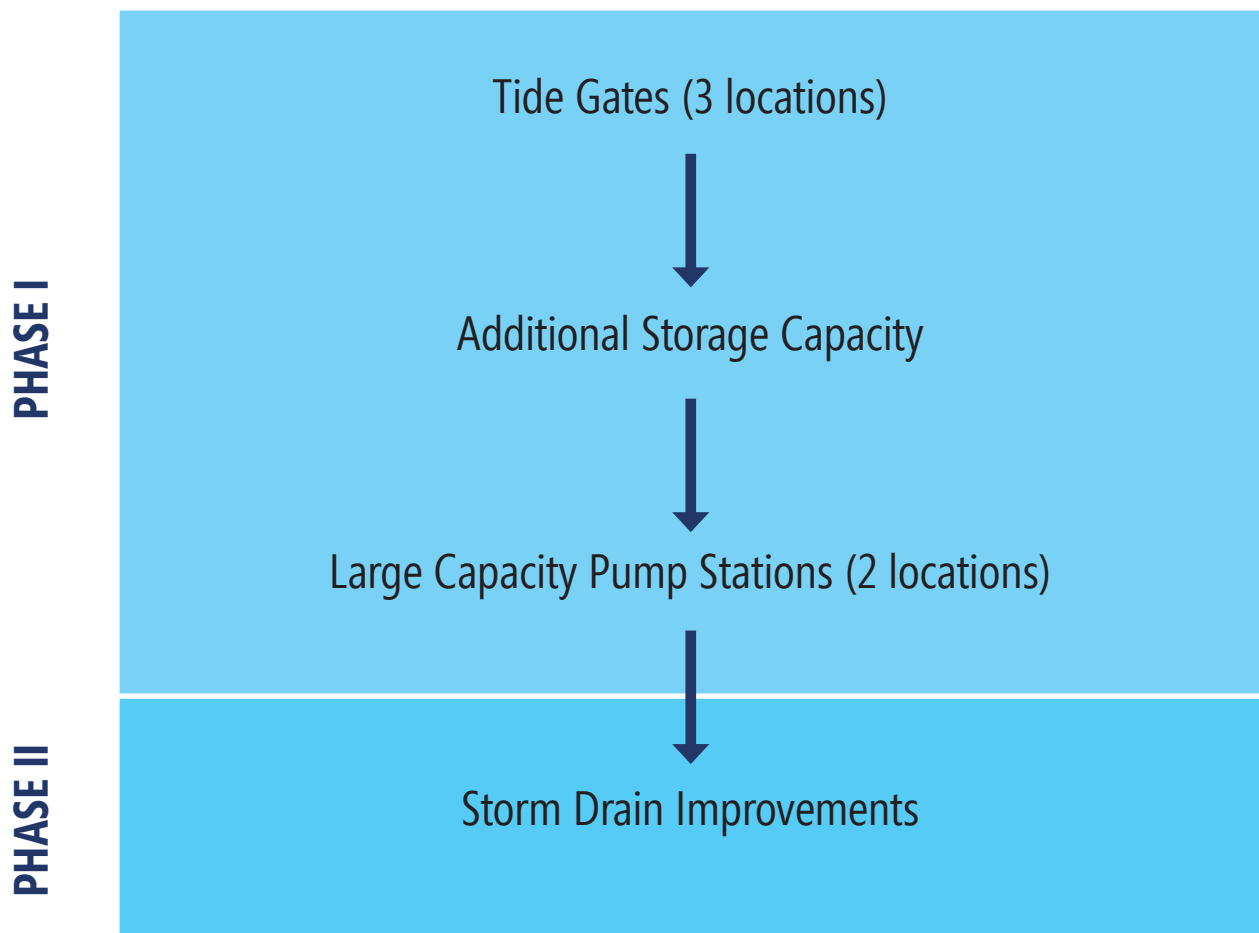
## West Neck Creek Results:



## Schedule & Phasing

The City has developed a multi-year and multi-phase comprehensive strategy to address the flooding in the Windsor Woods, Princess Anne Plaza, and The Lakes areas. Projects are proposed to be funded over the course of 10 to 20 years.

The major infrastructure improvements (tide gates, pump stations, and additional storage) provide the greatest flood mitigation benefit by addressing structural flooding. The proposed storm drain pipes assist in mitigating street flooding. As a result, the major infrastructure improvements are proposed to be constructed first (as part of Phase I) followed by the storm drain improvements second (Phase II). There will be multiple sub-phases within overall Phases I and II due to the magnitude and cost of the improvements. Below is an exhibit outlining the general sequence of construction for the major elements.



In addition, the proposed improvements are being coordinated with the City's Sea Level Rise Adaptation Strategy, which aims to address such items as rising sea levels and recurrent flooding. Proposed improvements as part of The Lakes, Princess Anne Plaza, and Windsor Woods will compliment the Sea Level Rise Strategy and enhance flood mitigation efforts. Please see [www.vbgov.com/pwSLR](http://www.vbgov.com/pwSLR) for more information.



**CONTACT INFORMATION:**

Michael S. Bumbaco III, PE  
Stormwater Project Manager

City of Virginia Beach  
Department of Public Works

757-385-4131

[papww@vbgov.com](mailto:papww@vbgov.com)  
[www.vbgov.com/windsor-woods](http://www.vbgov.com/windsor-woods)

For more information,  
hover over the QR code with  
your smartphone camera.

