CITY OF ALEXANDRIA

Long Term Control Plan Update Summary for the Combined Sewer System

The City's Combined Sewer System

Under most of the City's streets there are two sewers; one for carrying stormwater to streams and rivers and one for carrying sanitary sewage from homes and businesses to the wastewater treatment plant (Figure 1). In a small area of the City, in and around Old Town, the City maintains and operates a Combined Sewer System (CSS)**. A CSS is a sewer system in which there is one pipe that conveys both sanitary sewage and stormwater to a local wastewater treatment plant (Figure 2).** Under dry conditions all flow is conveyed to the treatment plant where it is treated, but during rain events the amount of stormwater entering the sewers can overwhelm the system and the combined sewage overflows into the local receiving waters (e.g., Hunting Creek) out of permitted Combined Sewer Overflows (CSOs). Along with stormwater discharges, these overflows impact local water quality. CSS systems are common in older cities throughout the US.

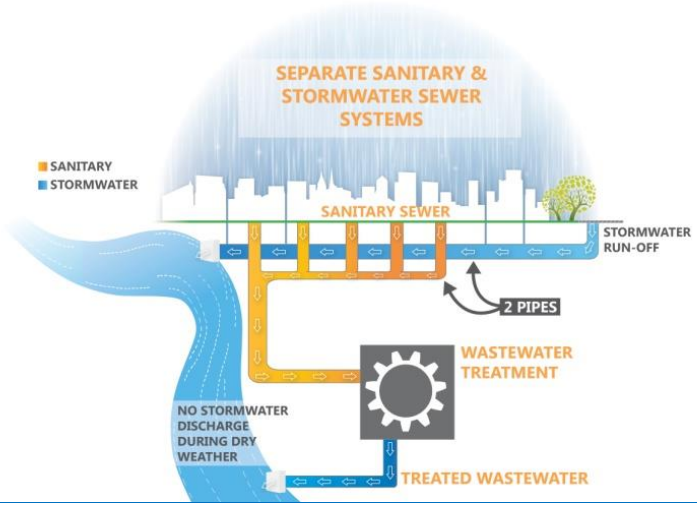

Figure 1: Separate Sewer System

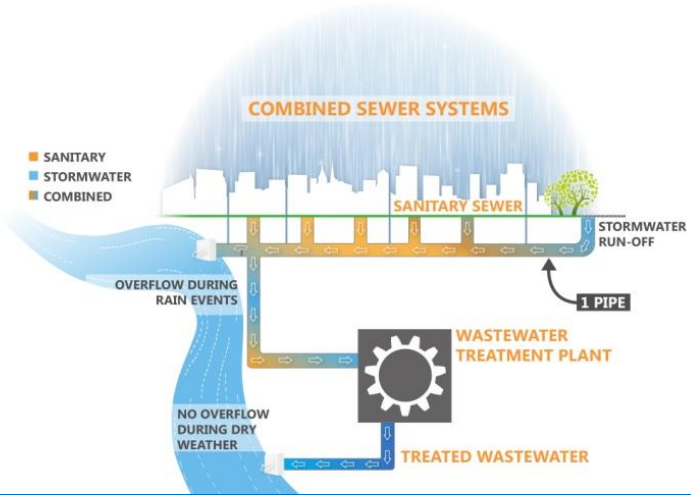

Figure 2: Combined Sewer System

What is a Long Term Control Plan?

The City of Alexandria's Long Term Control Plan (LTCP) is a plan to control and reduce pollution from combined sewer overflows within the City through proper operation and maintenance. The City's initial Long Term Control Plan was approved by the Virginia Department of Environmental Quality in 1999 and incorporated into the City's discharge permit. Consistent with other combined sewer communities, the City's 1999 LTCP was built around best management practices set forth by the Environmental Protection Agency and consists of the Nine Minimum Controls, monitoring of the CSOs, and separation of the CSS as redevelopment occurs. The City has been operating its CSS in accordance with the approved 1999 LTCP.

The CSS is comprised of approximately 540 acres that is generally located in the Old Town area east of U.S. Route 1. During dry weather, sanitary wastewater collected in the CSS is conveyed to the wastewater treatment facility, owned and operated by Alexandria Renew Enterprise (AlexRenew). During periods of rainfall, the capacity of the CSS may be exceeded and excess flow, which is a mixture of stormwater and sanitary wastewater, is discharged directly to Hunting Creek, Hooffs Run, or Oronoco Bay through the City's four permitted combined sewer overflow (CSO) outfall structures. The CSO outfalls are regulated under the City's Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0087068.

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The CSS is divided into three separate combined sewer subareas based on the conveyance of combined sewer flow to the outfalls. The three subareas are known as Pendleton, Royal, and King &West, and are shown in red in Figure 3.

Figure 3: CSS Overview

The outfall and corresponding overflows are summarized in Table 1.

Table 1: CSO Outfalls

Permitted Outfall Number	Description	No. of Overflows Per Year	Subarea	Size (acres)
001	Pendleton Street CSO	50-60	Pendleton	230
002	Royal Street CSO	45-60	Royal	194
003	Duke Street CSO	60-70	King & West	120
004	Hooffs Run CSO	60-70		

Water Quality and New Regulations; Total Maximum Daily Load

The Virginia Department of Environmental Quality (VDEQ) determined that Hunting Creek, Cameron Run, and Holmes Run watersheds exceeded water quality standards for *E. coli* bacteria and on November 2, 2010 issued a Total Maximum Daily Load (TMDL) for *E. coli* bacteria for these watersheds. **The TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The TMDL can be thought of as "a pollutant load budget".** The bacteria TMDL issued by VDEQ assigns bacteria Waste Load Allocations (WLAs) to all sources contributing to each watershed and requires reductions in the *E. coli* bacteria discharged from the identified sources to meet the water quality standards set. Sources of bacteria under the TMDL include stormwater from the City of Alexandria and Fairfax County, the City of Alexandria's CSOs, the AlexRenew Water Resource Recovery Facility permitted discharge, separate sanitary sources (such as failing septic systems), and wildlife. The CSO-002 (Royal Street), CSO-003 (Duke Street), and CSO-004 (Hooffs Run) within the City's CSS area are included as sources of *E. coli* bacteria for Hunting Creek and reduction in these CSO discharges are required to meet the bacteria TMDL requirements established. Both CSOs 003 and 004 require 99% reduction and CSO 002 requires an 80% reduction, for an overall reduction of 86%. There are also reductions in bacteria from stormwater and wildlife sources in the TMDL as well.

Purpose of the Long Term Control Plan Update

The City was issued a new CSS discharge permit in 2013 that requires the City to update its Long Term Control Plan by August 2016. The Long Term Control Plan Update (LTCPU) is a strategic plan that will provide a path for the City to meet the Hunting Creek TMDL for *E. coli* bacteria over time. It addresses the Hunting Creek TMDL by focusing on decreasing the amount of bacteria discharged into the receiving waters and reducing impacts from the combined sewer system. The LTCPU identifies CSO controls at CSO-002, CSO-003, and CSO-004 as required by the Hunting Creek TMDL.

A summary of CSO control strategies evaluated, evaluation criteria, facilities sizing and siting analysis, recommendations, project implementation schedule, costs and rate impacts is provided in this LTCPU summary document.

Public Outreach and Participation

The City has developed a comprehensive and robust public participation program to disseminate information and receive feedback in general compliance with the City's *What's Next Alexandria* initiative. These efforts included presenting at local neighborhood meetings, formal public meetings, and the development of a CSS Community Stakeholder group.

Figure 4: *What's Next Alexandria* Principles of Engagement

A summary of the public outreach and participation can be found on the City's website: (www.alexandriava.gov/Sewers)

CSO Technologies Screening

As part of the LTCPU, the City performed a technology screening to identify suitable CSO control technologies for further evaluation. The technologies considered were evaluated for their ability to meet the following primary goals:

- Bacteria reduction
- CSO volume reduction

In addition, the following secondary goals were also considered:

- Biochemical oxygen demand (BOD) reduction / dissolved oxygen (DO) enhancement
- TSS reduction
- Floatables reduction
- Ancillary environmental / public benefit

Based upon the screening of technologies, the following technologies were identified as primary technologies for detailed consideration as part of the alternatives evaluation:

- Disinfection
- Green Infrastructure
- Sewer Separation
- Storage Tanks
- Storage Tunnels

These technologies formed the basis of CSO control alternatives strategies developed.

CSO Control Strategies Evaluation Criteria

Evaluation criteria were developed and used to rate each of the preliminary CSO control alternatives during the alternatives analysis portion of LTCPU. The criteria used and weighting factors are summarized in the Evaluation Criteria Weightings chart (Figure 5).

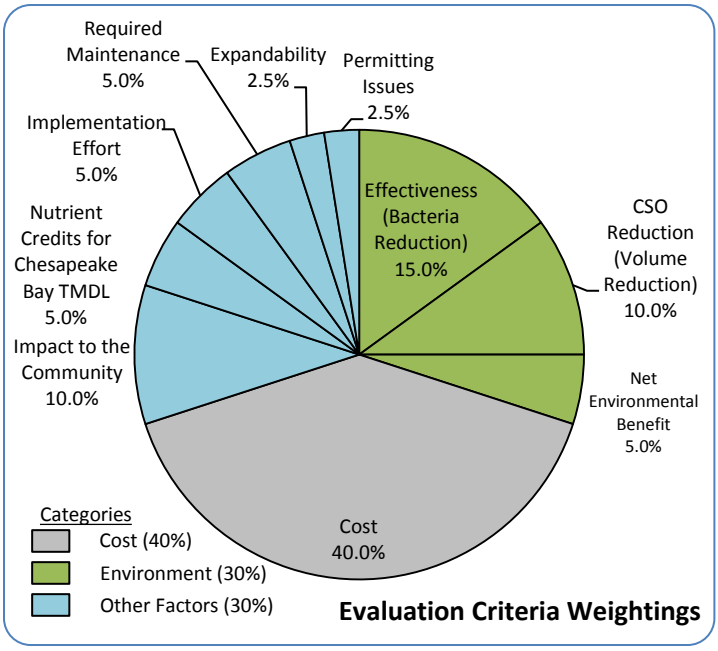

Figure 5: CSO Control Strategy Evaluation

CSO Control Strategies Evaluated

A total of nine combined sewer control strategies were considered and ranked based on applying a series of evaluation criteria (Table 2). Combined sewer control strategies ranked 1, 2, and 3 were carried forward for further evaluation. Green infrastructure and sewer separation were also retained to be evaluated as integral complementary strategies. The remaining control strategies were eliminated from further consideration.

Table 2: CSO Control Strategy Ranking

Rank	CSO Control Strategy	Score
9	Complete Sewer Separation	2.10
8	Green Infrastructure	3.13
7	Separate Disinfection Facilities	3.34
6	One Storage Tunnel (relocate outfalls to the Potomac)	3.68
5	Storage Tunnel for Hooffs Run and Disinfection at Royal Street	3.69
4	Separate Storage Tanks	3.76
3	One Storage Tunnel	3.86
2	Storage Tunnel for Hooffs Run and Storage Tank at Royal Street	3.97
1	Separate Storage Tunnels	3.98

Shortlisted CSO Control Strategies

3. One Storage Tunnel

Combined sewer overflows from CSO-002, CSO-003, and CSO-004 would be diverted into a large CSO storage tunnel. The tunnel would capture and store most wet weather events throughout the year. After the rain event, the stored volume would be sent to the wastewater treatment plant for a high level of treatment. Very large wet weather events would fill up the tunnel and the remaining CSO volume would overflow to a relocated CSO-004 outfall on Hooffs Run near AlexRenew and to the existing CSO-002 outfall on Hunting Creek.

Notes

- 8-foot diameter tunnel
- 7,400 linear feet
- 3 million gallons of storage
- Reduction from 60 – 70 overflows to 4 overflows per year
- Overflows to Hunting Creek and/or Hooffs Run

2. Storage Tunnel for Hooffs Run and Storage Tank at Royal Street

This strategy consists of a CSO storage tunnel that would capture flows from CSO-003 and CSO-004. The tunnel would capture and store most wet weather events throughout the year. After the rain event, the stored volume would be sent to the wastewater treatment plant for a high level of treatment. Very large wet weather events would fill up the tunnel and the remaining CSO volume would overflow to a newly constructed outfall on Hooffs Run near AlexRenew. The existing CSO-004 would be eliminated.

Additionally a storage tank would be constructed in the vicinity of CSO-002. During a rain event the combined sewer overflow would be diverted a new storage tank that would store the flow and send it back to the wastewater plant for a high level of treatment following the event.

Notes

CSO-003/004 (Hooffs Run) Tunnel

- 8-foot diameter tunnel
- 2,600 linear feet
- 1 million gallons storage tunnel
- Reduction from 60 – 70 overflows to 4 overflows per year
- Overflows to Hooffs Run

CSO-002 (Royal St.) Tank

- 2 million gallon storage tank
- Reduction from 40 – 50 overflows to 4 overflows per year
- Overflows to Hunting Creek

1. Separate Storage Tunnels

This strategy consists of a CSO storage tunnel that would capture flows from CSO-003 and CSO-004. The tunnel would capture and store most wet weather events throughout the year. After the rain event, the stored volume would be sent to the wastewater treatment plant for a high level of treatment. Very large wet weather events would fill up the tunnel and the remaining CSO volume would overflow to a newly constructed outfall on Hooffs Run near AlexRenew. The existing CSO-004 would be eliminated.

Additionally a second tunnel would be constructed in the vicinity of CSO-002. During a rain event the combined sewer overflow would be diverted to this new tunnel. Following the event, the flows stored in the tunnel would be pumped back into the sewer system where it would flow to the treatment plant for a high level of treatment.

Notes

CSO-003/004 (Hooffs Run) Tunnel

- 8-foot diameter tunnel
- 2,600 linear feet
- 1 million gallons of storage
- Reduction from 60 – 70 overflows to 4 overflows per year
- Overflows to Hooffs Run

CSO-002 (Royal St.) Tunnel

- 15-foot diameter tunnel
- 1,700 linear feet
- 2 million gallons of storage
- Reduction from 40 – 50 overflows to 4 overflows per year
- Overflows to Hunting Creek

Recommended Strategy

After further evaluation CSO Strategy 2 (Storage Tunnel for Hoofs Run and Storage Tank at Royal Street) was selected as the preferred strategy for the following reasons:

- Lowest capital and operating costs
- Least disruptive to the community
- Operation and maintenance advantages

CSO Strategy 1 (Separate Storage Tunnels) and CSO Strategy 3 (One Storage Tunnel) were eliminated primarily due to higher cost and increased impacts and disruption to the public.

LTCPU Recommendation

Overall Strategy

The overall strategy for the Long Term Control Plan Update is best represented with the pyramid shown in Figure 6. A store and treat approach will be implemented as the primary strategy with green infrastructure and targeted sewer separation as complementary strategies. The City will continue to evaluate other potential opportunities overtime as they arise.

Figure 6: Overall Strategy for the City's Long Term Control Plan Update

Store and Treat

Based on the alternatives strategies, facilities sizing and siting information evaluated, as well as feedback received from the Public, technical review panels, and the CSS Stakeholder Group, a 10-foot diameter tunnel (1.6 million gallons) is recommended for implementation to address CSO-003/004 and a 3.0 million gallon storage tank is recommended to address CSO-002. Once this infrastructure is in place, the number of overflows will decrease to no more than 4-6 in an average rainfall year.

Green Infrastructure

While green infrastructure cannot be used to meet the goals of the Hunting Creek TMDL on its own it can be used to reduce the stormwater entering the combined sewer system and provide other ancillary benefits for the community. Green infrastructure is incorporated in the LTCPU as a complementary strategy that will be implemented Citywide. In the next CSS permit cycle, anticipated to occur from 2018-2023, the City will propose and implement green infrastructure projects throughout the City and add $1-2 million in funding in the Capital Improvement Program between 2018-2023. An adaptive management approach will then be implemented to evaluate the performance of the implemented green infrastructure and a determination will be made as to how much additional funding will be allocated for green infrastructure in future permit cycles.

Targeted Sewer Separation

The City currently has a policy that requires sewer separation as a condition of redevelopment in the CSS and also has in its Capital Improvement Program funding for targeted sewer separation. Targeted sewer separation and sewer separation as a condition of redevelopment is recommended to continue as part of the LTCPU as a complementary strategy. Sewer separation over time will continue to further reduce the bacteria load in the remaining CSOs following the construction of the store and treat infrastructure.

Other Potential Opportunities

Other potential opportunities include evaluating incentives for private property owners, including rebates for installation of water-saving fixtures. These opportunities will be continued to be evaluated as LTCPU progresses.

Proposed Infrastructure

The LTCPU evaluates the project locations available to implement store and treat infrastructure for CSO-003/004 and CSO-002. Three tunnel alignments were evaluated to address CSO-003/004 and four storage tank sites were evaluated to address CSO-002. These alignments and sites were evaluated based on weighted evaluation criteria developed for this analysis.

CSO-003/004 Tunnel Alignments

The three potential tunnel alignments for CSO-003/004 are presented in Figure 7. The tunnel will be 80 – 100 feet underground, with shafts between 20 and 30 feet in diameter along the route.

Alignment 1 starts just north of Duke Street and generally runs underneath Hooffs Run through the Alexandria African American Heritage Park to a turning shaft located inside the park just northeast of the intersection of Holland Lane and the entrance to AlexRenew.

Alignment 2 also starts just north of Duke Street continues straight southwest to a second shaft located in the intersection of Holland Lane and Jamieson Avenue. This portion of the alignment passes underneath several buildings. The alignment then continues due south to a third shaft located in the southern portion of the Eisenhower traffic circle. The shaft is shown in the traffic circle because there are plans under development to remove the traffic circle and put in a T-type intersection. The tunnel then continues southeast underneath the Dominion Virginia Power substation to AlexRenew.

Alignment 3 is a curved alignment which begins heading south out of the upstream shaft and continues under Hooffs Run. The tunnel then ends at the AlexRenew. This alignment does not pass under any buildings or structures and does not traverse under the African American Heritage Park or the cemeteries.

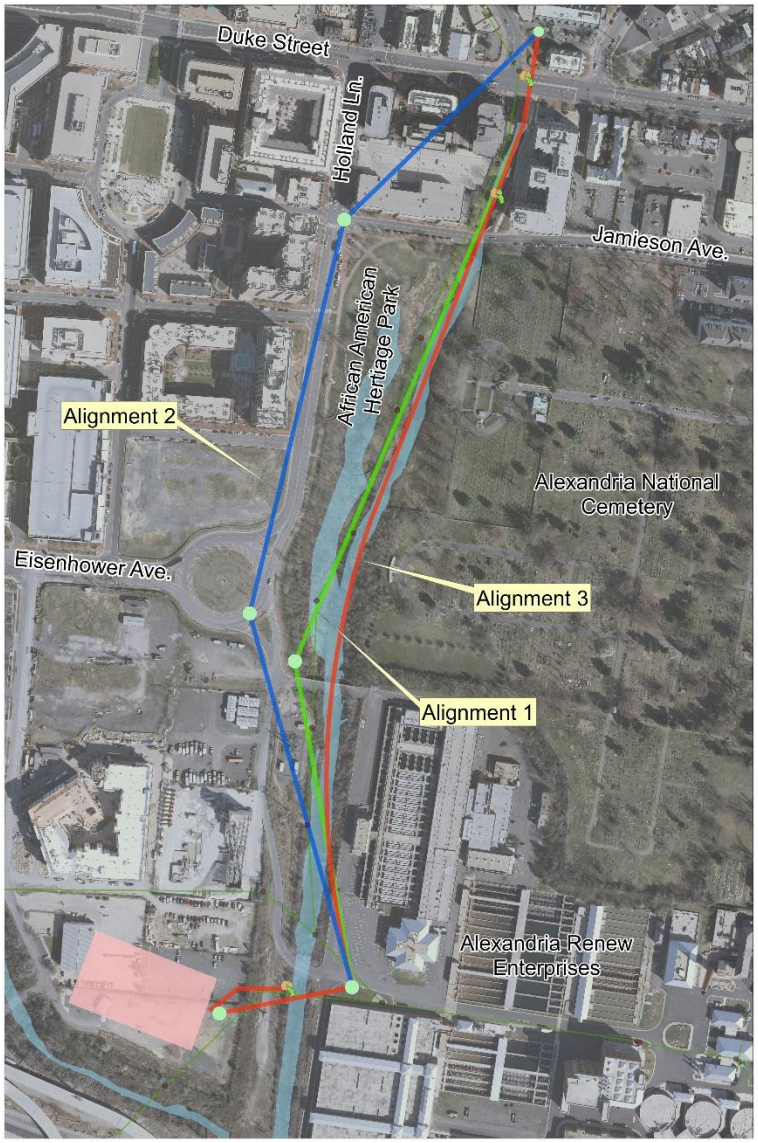

Figure 7: CSO-003/004 Tunnel Alignments

Based on the evaluation and associated ratings, Alignment 2 was eliminated because it is the most expensive alignment, passes underneath several buildings, and passes underneath a Dominion Virginia Power substation all of which are not desirable when constructing a tunnel. Alignment 3 was selected as the preferred alignment for CSO-003/004 primarily

because it eliminates one of the shafts and does not impact park property. Alignment 1 will be retained in the final LTCPU should issues arise with Alignment 3 during design.

CSO-002 Storage Tank Sites

Four alternative storage tank locations were evaluated as presented in Figure 8. All tanks are at or below the ground.

Tank Alternative 1 is located on private property (Bridgeyard Apartments, previously known as Hunting Point) and within a resource protection area (RPA) and VDOT easement. The tank is 166 feet long, 126 feet wide and 20 feet deep, with the top of the tank located just below the ground surface.

Tank Alternative 2 is located in the cul-de-sac and the southernmost end of Royal Street. This tank can be located within the City right-of-way. The tank is approximately 146 feet long, 110 feet wide and 25 feet deep. The top of the tank will be located below the ground surface and will be designed to allow car and truck traffic to drive on top of it.

Tank Alternative 3 is located directly on the end of the existing CSO-002 outfall and in the embayment itself. The tank is not located on any known private property, City street, or national park. The tank will be approximately 300 feet long, 50 feet wide, and store flow 30 feet deep.

Tank Alternative 4 is not designed as a traditional tank, but rather a as a series of side-by-side box culverts. This alternative utilizes the alignment of the service adjacent to the Woodrow Wilson Bridge as the basis for the tank shape. The tank is approximately 50 feet wide and 1,100 feet long with a storage depth of 8 feet. In order to construct such a tank, the City will need to negotiate with the National Park Service.

Due to the anticipated phasing of construction for the CSO-003/004 infrastructure and the CSO-002 infrastructure, all storage tank sites are retained in the LTCPU. Following approval of the LTCPU by VDEQ, the tank sites will be further evaluated and a final storage tank site will be selected.

Figure 8: CSO-002 Storage Tank Sites

Infrastructure Sizing Evaluation

The LTCPU also evaluated the most appropriate size for the proposed infrastructure. Following a preliminary sizing evaluation the following tunnel and storage tank sizes where shortlisted for further evaluation:

CSO-003/004 Tunnel Sizes

- 8-foot diameter (1.0 million gallons)
- 10-foot diameter (1.6 million gallons)
- 12-foot diameter (2.3 million gallons)

CSO-002 Storage Tank Sizes

- 2.0 million gallons
- 3.0 million gallons
- 4.0 million gallons

All of the infrastructure sizes above meet regulatory requirements related to the United States Environmental Protection Agency (USEPA) Combined Sewer Overflow (CSO) Control Policy, which calls for no more than 4-6 overflows for a typical rainfall year. To assess the additional potential benefit by providing larger tunnels and tanks the following are assessed:

- Number of Overflows per year
- Percent CSO Capture to the AlexRenew wastewater treatment facility
- Potential Recreational Benefit

Based on the evaluations completed and input received from various stakeholders and the community, the City has selected the 10-foot diameter (1.6 million gallons) for the CSO-003/004 Tunnel and 3.0 million gallons for the CSO-002 Storage Tank. With the sizing, the City satisfies the regulatory requirements, but also constructs some additional storage capacity to account for future weather patterns and other uncertainties.

Preliminary Program Implementation Schedule

Based on the needs of the City and synergies with other sewer projects in the City, and for AlexRenew, the CSO-003/004 tunnel will likely be constructed first and the CSO-002 storage tank will be constructed following completion and a performance evaluation of the CSO-003/004 tunnel. A program implementation schedule for the recommended projects included in the LTCPU is provided in Table 3.

Table 3: Program Implementation Schedule

Long Term Control Plan Update Program Component	Anticipated Timeframe
CSO-003/004 Storage Tunnel and Facilities	2019 – 2025
CSO-002 Storage Tank and Facilities	2026 – 2032
Green Infrastructure	2016 – 2035
Targeted Sewer Separation	2016 – 2035

Summary of the LTCPU Costs

A summary of the capital costs for the Long Term Control Plan Update is included in Table 4. All costs presented are in 2015 dollars.

Table 4: LTCPU Costs Summary

Long Term Control Plan Update Program Component	Capital Cost (in millions)
CSO-003/004 Storage Tunnel and Facilities	$80 - $120
CSO-002 Storage Tank and Facilities	$35 - $53
Green Infrastructure	$5 - $7.5
Targeted Sewer Separation	$5 - $7.5
Total	$125 - $188

The LTCPU projects will be funded through the issuance of bonds which are paid back through the sanitary sewer rates. Currently, the average household in Alexandria pays $45-50 per month on their sewer bill. Studies are underway to determine the impact of these projects on the sewer rates, but preliminary estimates indicate that the expected impact will be an increase of $10-15 per month on the monthly sewer bill for these projects. These increases to the billing will be implemented over time.

CSO-001

There is a combined sewer overflow at the end of Pendleton Street (CSO-001) as shown on Figure 3. This outfall discharges into Oronoco Bay, which is a Virginia water that is tidally influenced by the Potomac River. The Potomac River and Oronoco Bay are not part of the Hunting Creek TMDL.

For outfalls 002, 003, and 004, the store and treat improvements have been prioritized, in part, due to regulatory requirements. For CSO-001, the City will be taking a two-phased approach as follows:

- CSO-001 Phase I – Continue sewer separation and implement green infrastructure in the Pendleton sewershed to reduce overflows at CSO-001 over time. Additionally, the City will conduct a feasibility study of additional controls for CSO-001 during the 2018-2023 permit cycle. The feasibility study will take into account existing infrastructure and utilities, permitting issues and environmental issues in order to determine which locations would be most suitable to construct future combined sewer infrastructure.
- CSO-001 Phase II – Beginning in 2026, assess the level of control following substantial completion of the CSO project for CSO-003 and CSO-004, performance of CSO-001 Phase I, and future regulatory requirements. This assessment will include engineering analyses that will recommend future infrastructure (potentially a store and treat strategy) to address remaining overflows at this outfall. Also, planning level costs, rate impacts and timeline option(s) for implementation will be provided.

The phased approach allows for synergies with the significant redevelopment planned in the Pendleton sewershed, including the Old Town North Small Area Plan. The Old Town North area has been designated an Eco-District, with goals to assess CSO and stormwater infrastructure requirements and apply green infrastructure where feasible and cost effective. The continued sewer separation, stormwater controls, and green infrastructure in this area will progressively reduce overflows from CSO-001 over time and their associated impacts.