CSS Long Term Control Plan Update

LTCPU Executive Summary

City of Alexandria, VA
Department of Transportation and Environmental Services

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ES-1 Introduction

1.1 Background

There are two types of sewer systems in the City of Alexandria – a combined sewer system and a separate sewer system. Separate sewer systems consist of two sets of pipes. One pipe conveys stormwater runoff from storm drains to local waterways. The other pipe conveys sanitary sewage to a local wastewater treatment plant as shown in Figure 1-1.

Figure 1-1
Separate Sewer Systems

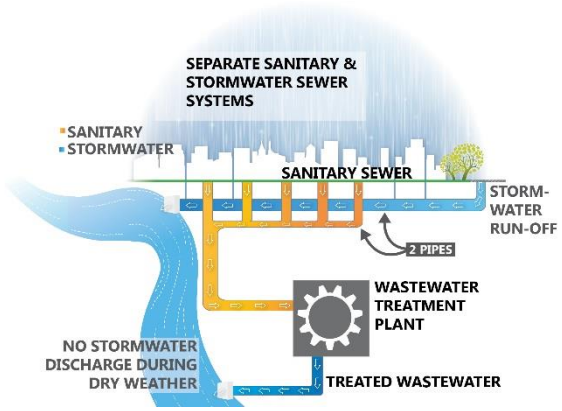
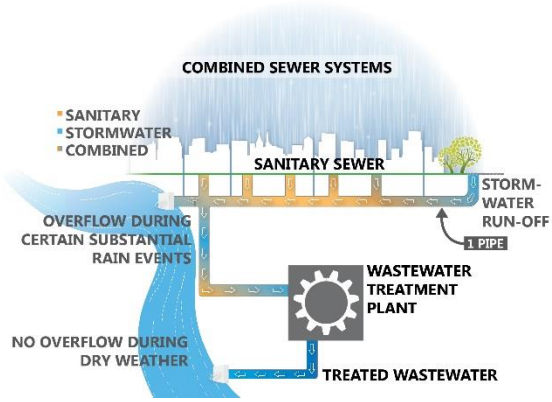


Figure 1-2
Combined Sewer Systems



Combined sewer systems (CSS) have only one pipe which conveys both sewage and stormwater to a wastewater treatment plant as shown in Figure 1-2. Many older cities in the United States are served by combined sewers. During wet weather events, the sewage collection system and/or wastewater treatment plant may be unable to handle the combined flows. During these conditions, Alexandria's combined sewers discharge excess flows into the waterways through one of its four combined sewer outfalls.

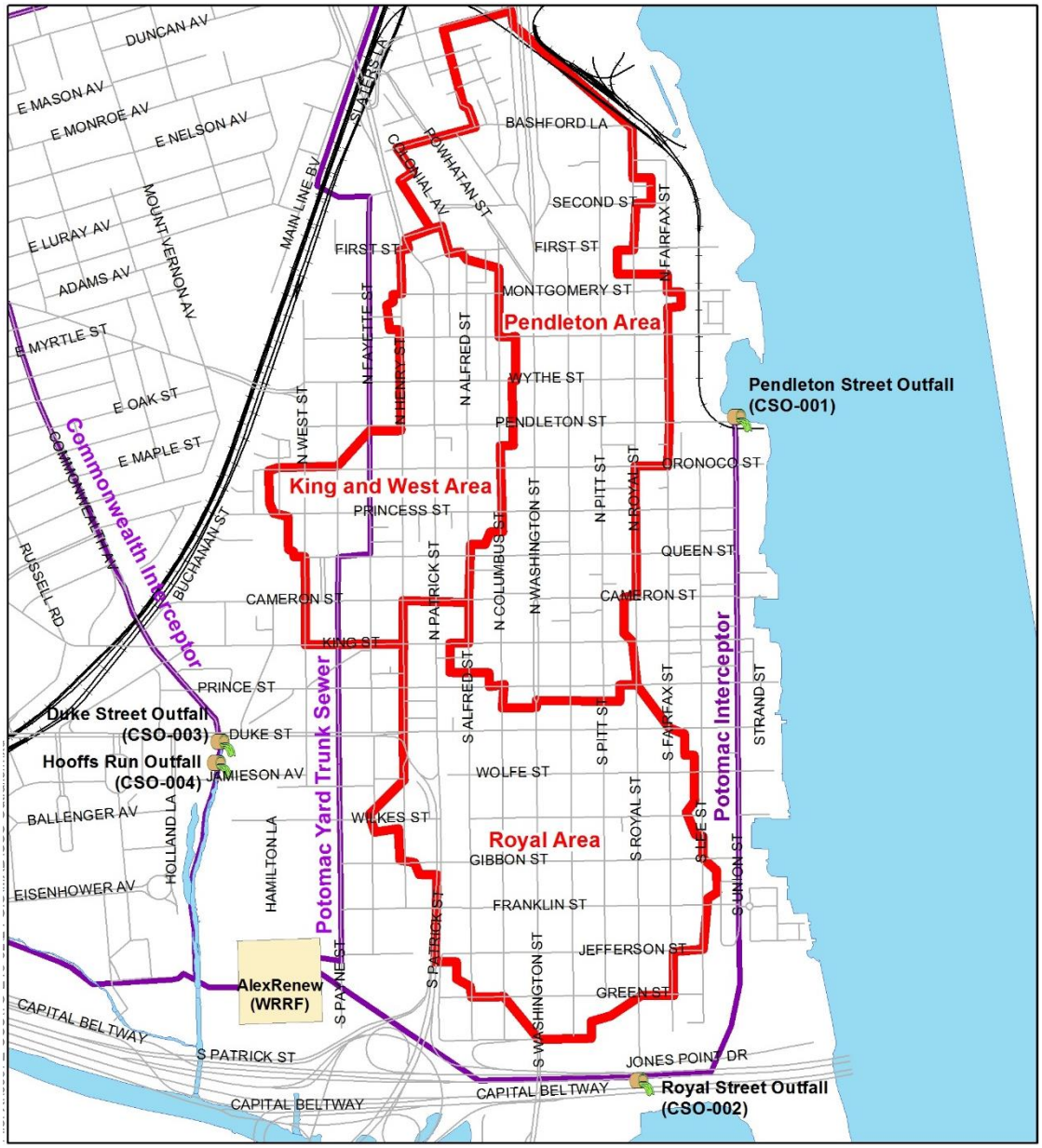
1.2 City's Sewer System

An overview of the City of Alexandria's sewer system is shown in Figure 1-3. The City's sewer system covers approximate 15.4 square miles and consists of both a separate sewer system and a 540 acre combined sewer system (CSS). During wet weather, flows in the CSS discharge to the surrounding waterbodies through four outfalls that serve three subareas within the CSS (CSO-003 and CSO-004 serve the same subarea).

- Pendleton Street CSO (CSO-001);
- Royal Street CSO (CSO-002);
- Duke Street CSO (CSO-003); and

- Hooffs Run CSO (CSO-004).

Figure 1-3
CSS Overview



1.3 City's Approved LTCP (1999)

In 1999 the City developed a Long Term Control Plan (LTCP) consistent with the guidance provided in the United States Environmental Protection Agency's (USEPA) Combined Sewer Overflow (CSO) Control Policy. Through extensive study and modeling it was shown that although the City's waters are impaired, the City's CSO's do not cause the impairment of waters. The 1999 LTCP consists of the EPA's Nine Minimum Controls which are considered best management practices for combined sewer systems throughout the country. This plan was submitted to the Virginia Department of Environmental Quality (VDEQ) and was approved in 1999. The City has been operating its CSS in accordance with the approved 1999 LTCP.

1.4 Hunting Creek Bacterial Total Maximum Daily Load (TMDL)

On November 2, 2010, VDEQ issued Bacteria TMDLs for the Hunting Creek, Cameron Run, and Holmes Run Watersheds. A TMDL can be thought of as a "pollution budget", in this case that pollutant is *E. coli* bacteria. The TMDL assigns bacteria loads to all the sources contributing to Hunting Creek, these bacteria loads are known as Waste Load Allocations (WLA). The WLAs in the TMDL require reductions in bacteria from combined sewer overflows as well as very high reductions in stormwater, septic, and wildlife to meet water quality standards. Actual WLAs in colony forming units, or cfus/year, are shown on Table 1-1. The LTCPU has been developed to address the WLAs in Table 1-1. The Hunting Creek TMDL only applies to CSO-002, CSO-003, and CSO-004. CSO-001 does not discharge to Hunting Creek and therefore is not part of the Hunting Creek TMDL.

Table 1-1
Wasteload Allocation for COA Combined Sewer System

Permit Number	CSO Outfall	Wasteload Allocation (cfu/year)	Percent Reduction (%)
VA0087068	CSO-002	6.26E+13	80%
	CSO-003	7.68E+11	99%
	CSO-004	8.52E+11	99%
	Total	6.42E+13	86%

1.5 Purpose of the LTCPU

While the City has reduced the impact of combined sewers through its approved 1999 LTCP, these measures are not adequate to meet the requirements of the Hunting Creek TMDL. In 2013 VDEQ issued the City a new combined sewer system discharge permit. As part of the Permit the City is required to update the LTCP to address the Hunting Creek TMDL and the plan must be implemented by 2035. This Long Term Control Plan Update (LTCPU) presents a plan which the City will implement to address new bacteria waste load allocations for Combined Sewer Overflow (CSO) discharges to Hunting Creek. The

LTCPU evaluates CSO controls at CSO-002, CSO-003, and CSO-004 as required by the Hunting Creek TMDL. Although there is no regulatory driver for CSO-001, the City is also including a phased approach for the reducing overflows at CSO-001 as part of the LTCPU.

ES-2 Public Participation

The City has developed a public participation program to disseminate information and receive feedback. The City has implemented four different types of public participation:

- Local Outreach
- Public Meetings
- Technical Review Panel
- CSS Stakeholder Group

2.1 Local Outreach

City staff has gone to several local civic groups throughout the development of the LTCPU, beginning in October of 2013 and continuing through April 2016. At these meetings staff walked the groups through the Long Term Control Plan Update (LTCPU) process, including the background information, reasons the LTCPU is required, combined sewer overflow (CSO) technologies, shortlist of CSO strategies, and the selected final plan. Although not a regulatory requirement, the City believes that engaging the public as much as possible helps to produce a plan with public support.

2.2 Public Meetings

In addition to the local outreach, the City's combined sewer system (CSS) permit requires public meetings at specified times during the LTCPU development. Three public meetings were held during the development of the LTCPU, in February and May 2015 and in April 2016. Similar to the local outreach, these meetings inform the public of the LTCPU process and development. This is an opportunity for the public to provide feedback and have influence in the development of the LTCPU and the final plan.

2.3 Technical Review Panel

While obtaining public feedback is an important part of the LTCPU process, it is also important to receive feedback from technical personnel who are familiar with combined sewer systems and the available technologies to effective reduce the impacts of CSOs on the environment. The City convened a panel of directors from CSO communities who participated in technical review panels held in May 2015 and March 2016. Through a series of meetings, this group has provided technical feedback related to the development of the LTCPU which has been valuable in helping the City choose the best path forward.

2.4 CSS Stakeholder Group

City Council passed a resolution in June 2015 that established an ad hoc stakeholder group with the charge of providing input to City staff throughout the development of the LTCPU. City staff conducted a series of monthly meetings beginning in October 2015 and ending in April 2016 that walked the group through every step of the development of the LTCPU. The feedback received has been incorporated in to the final LTCPU.

2.5 CSS Website

All the information developed and distributed to the public can be found on the City's website (https://www.alexandriava.gov/Sewers).

The City also has created an online survey on the AlexEngage website to solicit feedback on the LTCPU (https://engage.alexandriava.gov/portals/191/Forum_537/Issue_3543). The results of this survey are used to inform decisions made in the final LTCPU.

ES-3 Basis of Planning

The EPA CSO Control Policy lays out a framework for developing the LTCPU. One approach for addressing water quality under the CSO Control Policy is the *Presumption Approach*. This approach states that if the CSO's can be limited to 4 – 6 overflows per year during a typical year, then it is presumed that water quality standards are met. All of the strategies evaluated in the LTCPU meet this level of control.

3.1 Typical Year Selection

As suggested under the EPA CSO Control Policy, the City used a typical rainfall year to evaluate the alternatives and select a proposed approach for the Long Term Control Plan Update (LTCPU). Choosing the appropriate assessment year is important since any analysis conducted for the LTCPU will be based on the typical assessment year.

To determine the typical assessment year, a 40-year time period from 1974 through 2013 was selected and analyzed. Several evaluation criteria were developed and each criterion was assigned a weighting. A weighted ranking was calculated based on the assigned weightings. Based on the results of weighted rankings, the year 1984 was ranked first and selected as the typical year for the LTCPU and best represents the long-term average rainfall conditions.

3.2 Hydrologic and Hydraulic Modeling

Hydrologic and hydraulic modeling is used to estimate the quantity of flow in the City's sewers and the number and total volume of combined sewer overflows. The City of Alexandria's hydrologic and hydraulic combined sewer system (CSS) model has been developed, updated, and maintained for over 15 years. This model was used to evaluate the impact that various CSO controls have on the system during the alternatives analysis portion of the City's Long Term Control Plan Update (LTCPU). The results of these model runs were used to size and implement proposed CSO controls appropriately.

3.3 CSO Technologies Screening

A wide range of technologies were screened to identify suitable CSO control technologies for further evaluation. The technologies considered were evaluated for their ability to meet the following primary goals: 1) bacteria reduction; 2) CSO volume reduction.

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

- Combinations of the above technologies

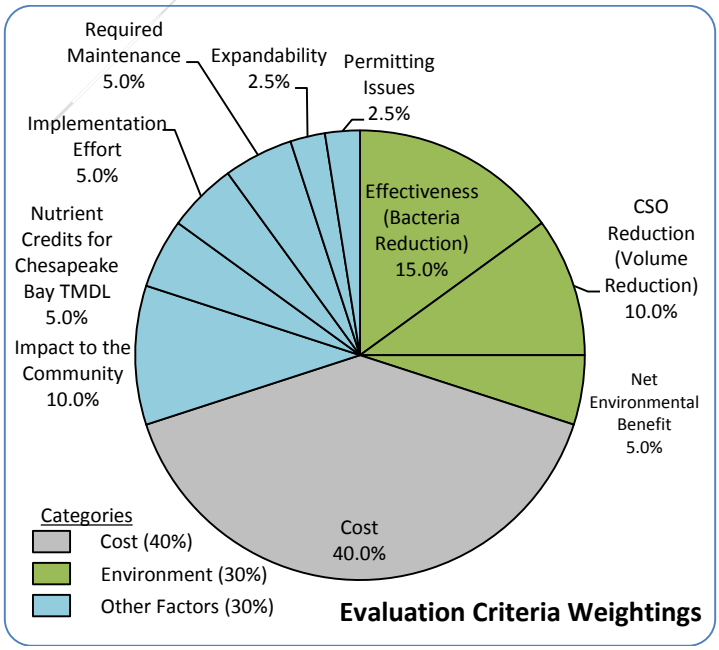
ES-4 Evaluation of Preliminary Alternatives

4.1 Evaluation Criteria

Evaluation criteria were developed and used to rate each of the CSO control alternatives during the alternatives analysis portion of the Long Term Control Plan Update (LTCPU). The evaluation criteria were developed and tailored to meet the requirements of the Hunting Creek Total Maximum Daily Load (TMDL) requirements while providing a solution unique to the needs of the City of Alexandria. City specific criteria were developed to score each alternative based on a rating of very high, high, medium, low, minimal, or none (if applicable).

The criteria presented in Figure 4-1 were assigned a weighting that was applied to each rating to determine an overall weighted rating for each alternative. The alternatives were then ranked based on the highest weighted rating. Upon completion of the alternatives evaluation a select number of alternatives, based on their ranking, were selected for further development.

Figure 4-1
Evaluation Criteria



4.2 Summary of Evaluation

Based on the weighted ratings of each of the alternatives, a combination of storage tank and storage tunnels was selected for further evaluation. The three primary strategies considered further were: 1) a storage tunnel for CSO-003/004 and a separate storage tunnel for CSO-002; 2) a storage tunnel for CSO-

003/004 and a storage tank for CSO-002; and 3) one continuous tunnel connecting CSO-002/003/004. These three options were further evaluated, which resulted in a storage tank being the preferred store and treat alternative for CSO-002 mainly because it was more cost effective than a tunnel, there would be less disruption during construction when compared to a tunnel, and the public generally supported it. The alignments and siting evaluation described below was performed to determine where the CSO-003/004 tunnel and the CSO-002 storage tank would potentially be located.

ES-5 Proposed Infrastructure

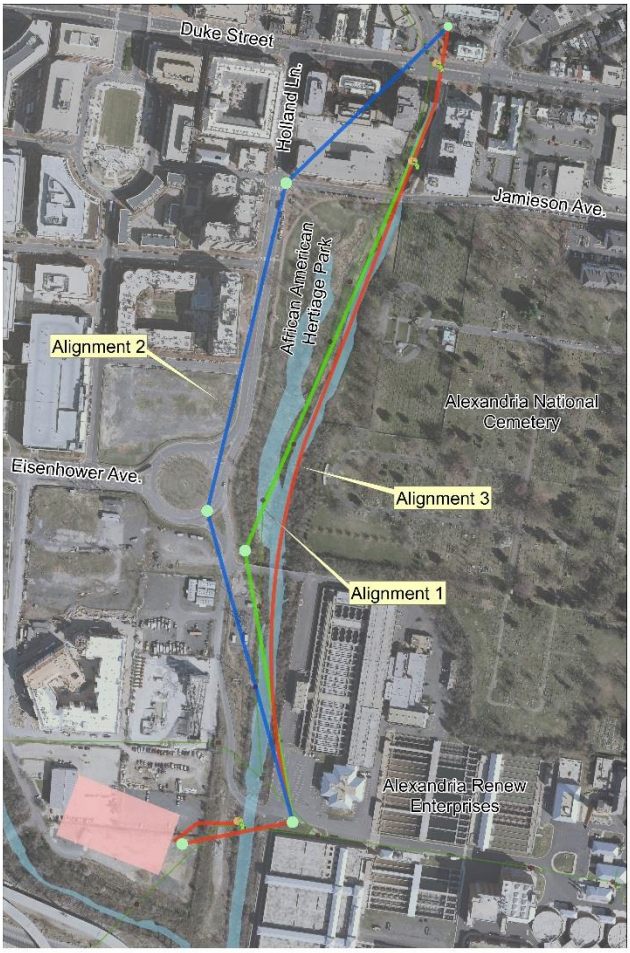
5.1 Alignments and Site Evaluation

The LTCPU evaluates the project locations available to implement 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.

5.1.1 CSO-003/004 Tunnel Alignments

The three potential tunnel alignments for CSO-003/004 are presented in Figure 5-1 below.

Figure 5-1
CSO-003/004 Tunnel Alignments



Based on the evaluation, Alignment 3 is the preferred alignment for CSO-003/004. Alignment 1 has been retained in the final LTCPU should issues arise with Alignment 3 during design. Alignment 2 is eliminated from further consideration because it passes underneath several buildings adding unnecessary risk and cost.

5.1.2 CSO-002 Storage Tanks

Four alternative storage tank locations located near the southern end of Royal Street were evaluated as presented in Figure 5-2.

Figure 5-2
CSO-002 Storage Tank Sites

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

5.2 Infrastructure Sizing Analysis

In addition to choosing the location of the tunnels and storage tanks, the LTCPU also evaluates 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 EPA's Combined Sewer Overflow Control Policy. To assess the additional potential benefit by providing larger tunnels and tanks the following are assessed:

- Number of combined sewer overflows per year
- Total average annual overflow volume
- Percent CSO Capture
- Potential Recreational Benefit

5.2.1 Overflow Evaluation

Table 5-1 summarizes the physical characteristics for the tunnel sizes of the CSO-003/004 tunnel alignment as well as the impacts on the overflows.

Table 5-1
CSO-003/004 Tunnel Diameter Summary for a Typical Year (1984)

Tunnel Diameter (ft)	Tunnel Volume (MG)	Number of Overflows[1]	Volume of Overflows (MG)	Overflow Reduction[2] (%)	Flow Capture[3] (%)	Capital Costs[4] ($M)
N/A	Current Conditions (no tunnel)	67	29.1	-	75%	-
8-ft	1.0	5	2.9	90%	98%	$60 - $90
10-ft	1.6	3	1.1	96%	99%	$80 - $120
12-ft	2.3	0	0	100%	100%	$90 - $135

[1] Acceptable range 4-6 or less under the National CSO Policy
[2] No Criteria under the National CSO Policy
[3] Minimum 85% capture under the National CSO Policy
[4] The Net Present Worth is estimated based on a 20 year period and a 3.0% discount rate. The NPW includes the capital costs and annual O&M. These are planning level costs and could be as much as 50% more.

Table 5-2 summarizes the physical characteristics as well as the impacts on the overflows at CSO-002 for three tank sizes during the typical year.

Table 5-2
CSO-002 Tank Volume Summary for a Typical Year (1984)

Tank Volume (MG)	Number of Overflows	Volume of Overflows (MG)	Overflow Reduction (%)	Flow Capture (%)	Capital Costs ($M)
Current Conditions (no tank)	48	35.8	-	58%	-
2.0	6	5.7	84%	93%	$30 - $45
3.0	2	3.1	91%	96%	$35 - $53
4.0	1	1.9	95%	98%	$47 - $70

Based on the information evaluated in the tables as well as feedback received from the public, technical review panel, and the CSS Stakeholder Group, the LTCPU is recommending a 10-foot diameter tunnel (1.6 million gallons) for CSO-003/004 and a 3.0 million gallon tank for CSO-002.

This tunnel and tank size was evaluated against a more recent climate period (2004-2013), which was a very "wet" climate period. Even during this wet climate period, the proposed infrastructure still meets the requirements of the CSO Control Policy presumption approach. This larger sized infrastructure will help to accommodate future climate change. Some public input has called for more control to reduce the frequency of overflows further than proposed, others have called for the minimum controls required to meet what's required under the EPA CSO Control Policy. The stakeholder and the technical review groups generally supported the planned sizing.

5.2.2 Potential Recreational Benefit

As noted above, the level of bacteria controls called for in the Hunting Creek TMDL for stormwater, wildlife, and CSO to meet the TMDL waste load allocations are very high. While there are CSO technologies for obtaining relatively high CSO controls, controls for the other sources (stormwater and wildlife) needed to meet water quality standards are not available/obtainable. While the CSO controls provide substantial water quality and aesthetic benefit, CSO controls larger than the above recommendation proposed by the City are not expected to provide measurable recreational benefit when judged by the VDEQ water quality standards.

ES-6 Recommended Plan

6.1 Store and Treat – Primary Strategy

Based on the evaluations performed for the Long Term Control Plan Update, a 10-foot diameter (1.6 million gallon) tunnel should be implemented to address CSO-003/004 and a 3.0 million gallon storage tank should be implemented to address CSO-002. Based on a conceptual engineer's estimate it is anticipated that the CSO-003/004 tunnel would cost $80 - $120 million and the CSO-002 storage tank would cost $35 - $53 million for a total of $115 to $173 million. These are planning level estimates. Based on the needs of the City and synergy with other sewer projects in the City and for AlexRenew, it is recommended that the CSO-003/004 tunnel be constructed first and the CSO-002 storage tank be constructed following completion and a performance evaluation of the CSO-003/004 tunnel.

6.2 Green Infrastructure – Complementary Strategy

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 permit cycle, anticipated to occur from 2018-2023, $1 – $2 million will be expended on City-led green infrastructure projects throughout the City. 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 money will be spent on green infrastructure in future permit cycles.

6.3 Targeted Sewer Separation – Complementary Strategy

While separating the entire combined sewer system would provide a path to meet the goals of the Hunting Creek TMDL, it would be extremely burdensome on the residents of Alexandria both in terms of cost and disruption during construction. However, sewer separation is still part of the LTCPU as a complementary strategy. The City already has a requirement for developers to separate their flows as they redevelop parts of the combined sewer system. The LTCPU will incorporate the Area Reduction Plan as a path to further reducing the bacteria load in the remaining CSOs following the construction of the store and treat infrastructure. Over time as the combined sewer system area is redeveloped, sewer separation will help to reduce the bacteria discharged from the combined sewer system even further.

6.4 Other Potential Strategies

One example of other strategies that could be implemented are real-time controls (RTC). Real-time controls are methods of reducing overflows by making adjustments to the system dynamically as flows in the system are changing. Typically this is done using pumps, gates, and inflatable dams installed at or near the existing overflows and operated during storm events. Real-time controls can be used to compliment the infrastructure proposed and can be used to reduce overflows even further. Other potential strategies could be incentives for private property owners to implement stormwater controls on their

property or rebates for low flow fixtures or people who utilize rain barrels. These will be fully evaluated as the planning and designs progress.

6.5 CSO-001 Strategy

There is no regulatory requirement to reduce overflows at CSO-001 (Pendleton). As part of the LTCPU, a two-phased strategy for CSO-001 to address the overflows is proposed:

- CSO-001 Phase I – Continue sewer separation and implement Green Infrastructure in the Pendleton sewershed to reduce overflows at CSO-001 over time.
- CSO-001 Phase II – Reassess the level of control following substantial completion of other CSO projects (CSO-002/003/004), performance of CSO-001 Phase I, and future regulatory requirements.

The City will assess the need for store and treat infrastructure after completion of the CSO-002 and CSO-003/004 projects.

6.6 Budget

A summary of the planning level capital costs for the Long Term Control Plan Update is included in Table 6-1. All costs presented are in 2015 dollars. The LTCPU projects will likely be funded through the issuance of bonds which are paid back through the sanitary sewer rates, although the City is continuing to explore additional financing and delivery opportunities. 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 as shown in Figure 6-1.

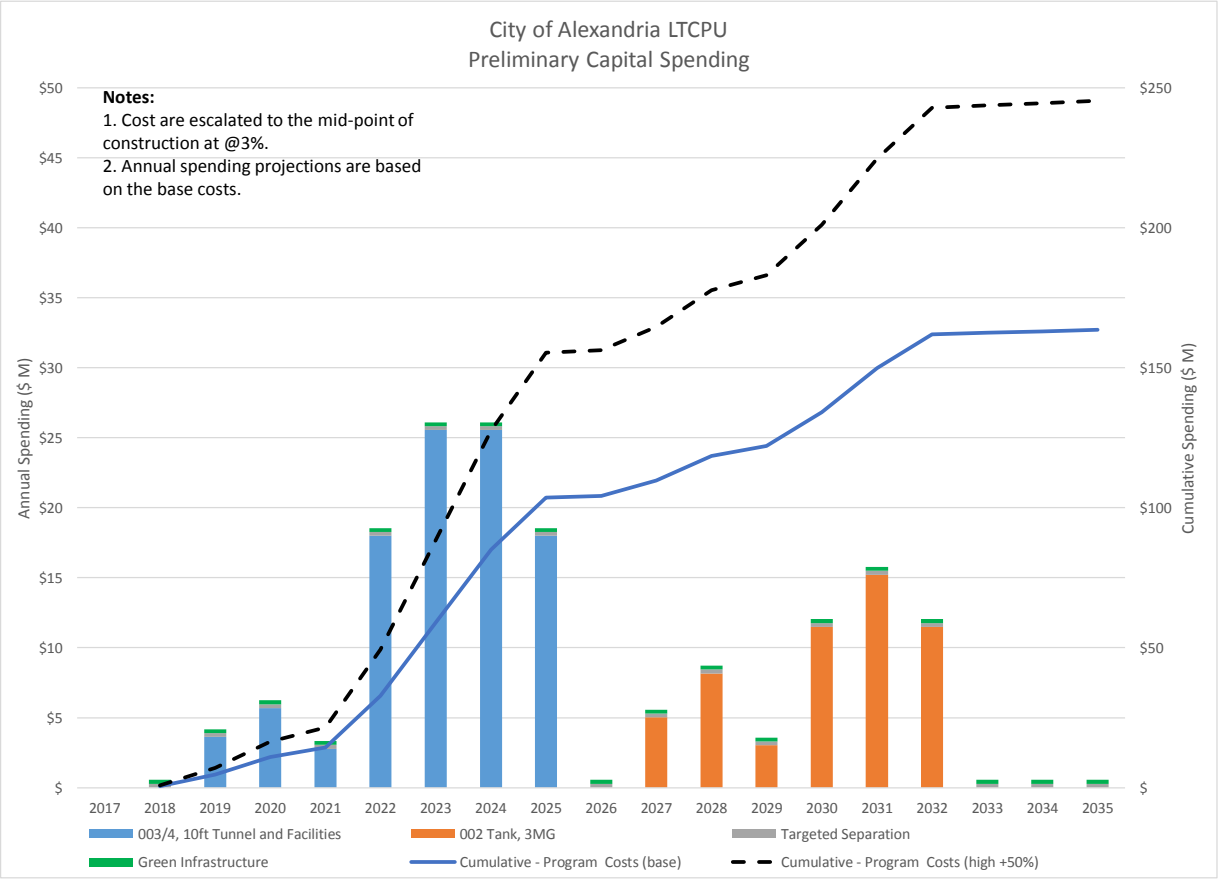
Table 6-1
Preliminary LTCPU Capital Costs[5]

	Capital Costs ($M)
003/004 CSO Storage and Facilities	$80 - $120
002 CSO Storage and Facilities	$35 - $53
Green Infrastructure	$5 - $7.5
Targeted Sewer Separation	$5 - $7.5

[5] Costs are planning level cost estimates reported in 2016 dollars.

Total Costs	$125 - $188

Figure 6-1
Preliminary Spending Projection



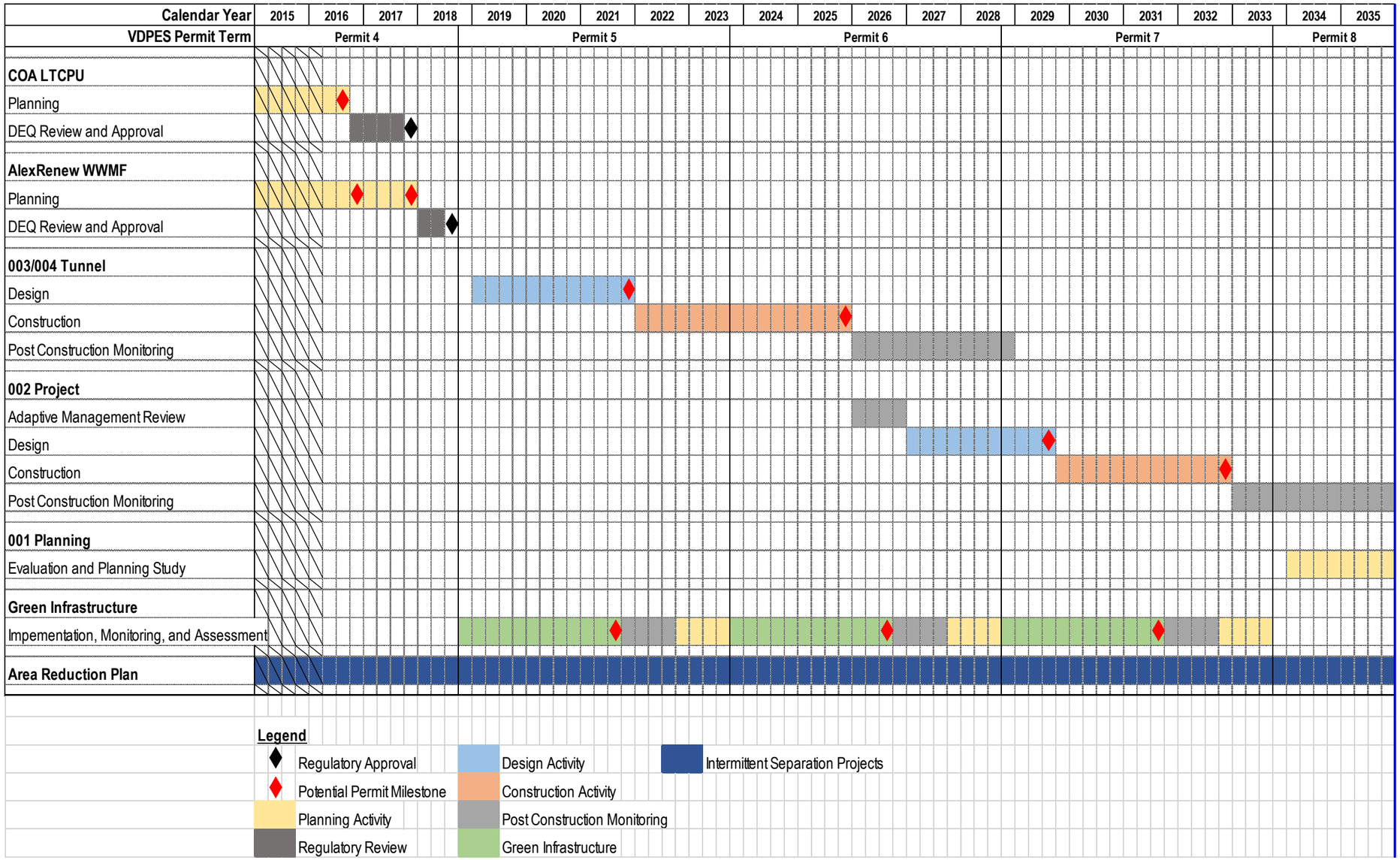
6.7 Implementation

It is anticipated that the infrastructure projects would be constructed in phases rather than all at once. 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 Figure 6-2.

6.8 Post Construction Monitoring

The LTCPU implementation will include post construction monitoring for the CSO controls constructed. The monitoring data will be used to assess the effectiveness of projects in meeting program goals. Results of post construction monitoring for green infrastructure will also form an integral part of the adaptive management approach the LTCPU.

Figure 6-2
Preliminary Implementation Schedule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VDPES Permit Term
Permit 4
Permit 5
Permit 6
Permit 7
Permit 8
COA LTCPU
Planning
DEQ Review and Approval
AlexRenew WWMF
Planning
DEQ Review and Approval
003/004 Tunnel
Design
Construction
Post Construction Monitoring
002 Project
Adaptive Management Review
Design
Construction
Post Construction Monitoring
001 Planning
Evaluation and Planning Study
Green Infrastructure
Impementation, Monitoring, and Assessment
Area Reduction Plan
Legend
Regulatory Approval
Potential Permit Milestone
Planning Activity
Regulatory Review
Design Activity
Construction Activity
Post Construction Monitoring
Green Infrastructure
Intermittent Separation Projects

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