CSS Long Term Control Plan Update

Alignments and Site Evaluation

City of Alexandria, VA
Department of Transportation and Environmental Services

FINAL – June 2016

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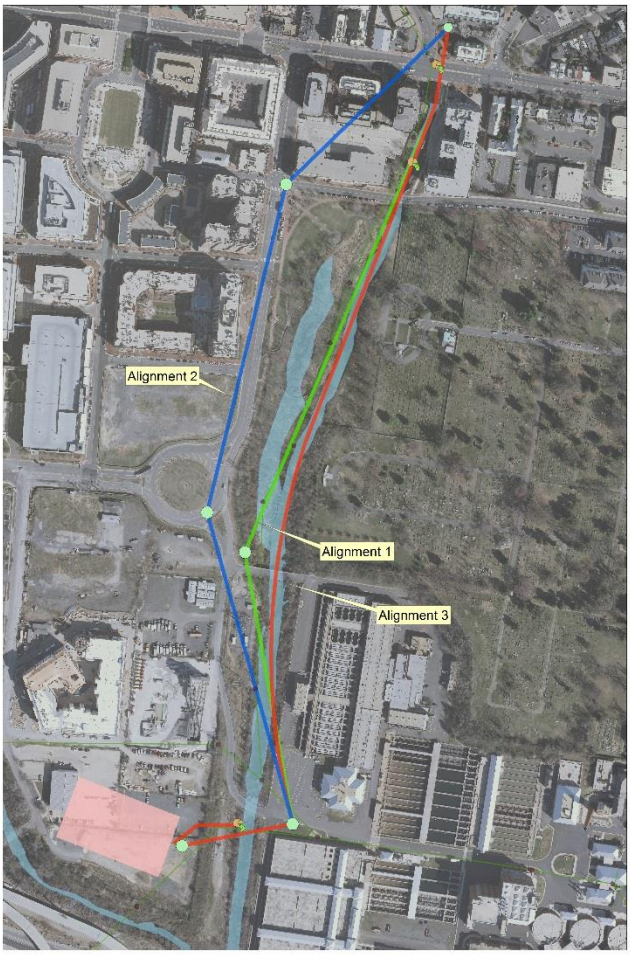
Executive Summary

The purpose of this document is to evaluate the project locations available to implement infrastructure for CSO-003/004 and CSO-002 proposed in previous technical memoranda as part of the Long Term Control Plan Update (LTCPU). This technical memorandum evaluates three tunnel alignments to address CSO-003/004, three tunnel alignments to address CSO-002, and four storage tank sites to address CSO-002.

CSO-003/004 Tunnel Alignments

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

Figure ES-1
CSO-003/004 Tunnel Alignments



Based on the evaluation criteria as described in the Alignment and Siting Evaluation Criteria Technical Memorandum dated October 16, 2015, the following weighted ratings were developed.

Table ES-1
CSO-003/004 Alignments Weighted Ratings

Alignment	Weighted Rating
Alignment 1	3.45
Alignment 2	2.45
Alignment 3	4.10

Based on these ratings, Alignment 3 is the preferred alignment for CSO-003/004 primarily because it eliminates one of the shafts and does not impact private or park property. Alignment 1 will be retained in the final LTCPU should issues arise with Alignment 3 during design. Alignment 2 will be eliminated from further consideration 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.

CSO-002 Tunnel Alignments

Three potential alignments were evaluated for CSO-002. Each of these three alignments consisted of a longer tunnel connected to the CSO-003/004 tunnel and a shorter tunnel separate from the CSO-003/004 tunnel. The connected tunnel would allow for a single dewatering pump station at the Alexandria Renew Enterprises (AlexRenew) Water Resources Recovery Facility (WRRF), however it would require complex hydraulic design to prevent bacteria load from being transferred from CSO-002 to Hooffs Run. Figure ES-2 and Figure ES-3 present the connected and separate tunnel alignments.

Figure ES-2
CSO-002 Connected Tunnel Alignments

Figure ES-3
CSO-002 Separate Tunnel Alignments

Based on the evaluation criteria as described in the Alignment and Siting Evaluation Criteria Technical Memorandum dated October 16, 2015, the following weighted ratings were developed.

Table ES-2
CSO-002 Alignments Weighted Ratings

Alignment	Weighted Rating
Alignment 1	3.80
Alignment 2	3.30
Alignment 3	3.65

Based on these ratings, Alignment 1 is the preferred alignment should a tunnel for CSO-002 be considered. Alignment 2 and Alignment 3 will be eliminated from further consideration.

CSO-002 Storage Tanks

Four alternative storage tank locations were evaluated to site a 2.0 million gallon storage tank presented in Figure ES-4 below.

Figure ES-4
CSO-002 Storage Tank Sites

Based on the evaluation criteria as described in the Alignment and Siting Evaluation Criteria Technical Memorandum dated October 16, 2015, the following weighted ratings were developed.

Table ES-3
CSO-002 Storage Tanks Weighted Rating

Alternative	Weighted Rating
Tank 1	4.10
Tank 2	4.20
Tank 3	4.25
Tank 4	3.85

Due to the ratings being so close to each other and the anticipated phasing of construction for the CSO-003/004 infrastructure and the CSO-002 infrastructure, all storage tank sites will be retained in the LTCPU. Following the construction of the CSO-003/004 tunnel the tank sites will be evaluated in depth and a final storage tank site will be recommended.

CSO-002 Tunnels vs Storage Tanks

While this technical memorandum evaluates preferred tunnel alignments and tank sites for CSO-002, the final LTCPU will only implement one of these. By just looking at the weighted ratings for tunnels and tanks, all of the storage tank alternatives have a higher rating than tunnel Alignment 1. This is primarily due to the cost and complexity of constructing a tunnel instead of a storage tank, however there are other factors that make storage tanks more desirable than tunnels for CSO-002.

- Public Disruption – Disruption to the residents is a very important factor to consider when selecting tunnels vs. tanks. Tunnels would require construction at every location there is a shaft, so there would need be multiple construction areas throughout Old Town. Whereas a storage tank only requires construction at one location limiting disruption to the residents.
- Duration of Construction – Not only would tunnels require construction at multiple locations throughout Old Town, the tunnel construction could potentially take significantly longer than construction of a storage tank.

Recommendation

Based on the weighted ratings and the additional disruption of constructing a tunnel, storage tanks will be retained as the solution for CSO-002 in the LTCPU, tunnels will be eliminated from further consideration. The LTCPU will recommend Alignment 3 as the preferred alignment to address CSO-003/004 and all storage tank alternatives will be retained to address CSO-002.

Section 1 Introduction

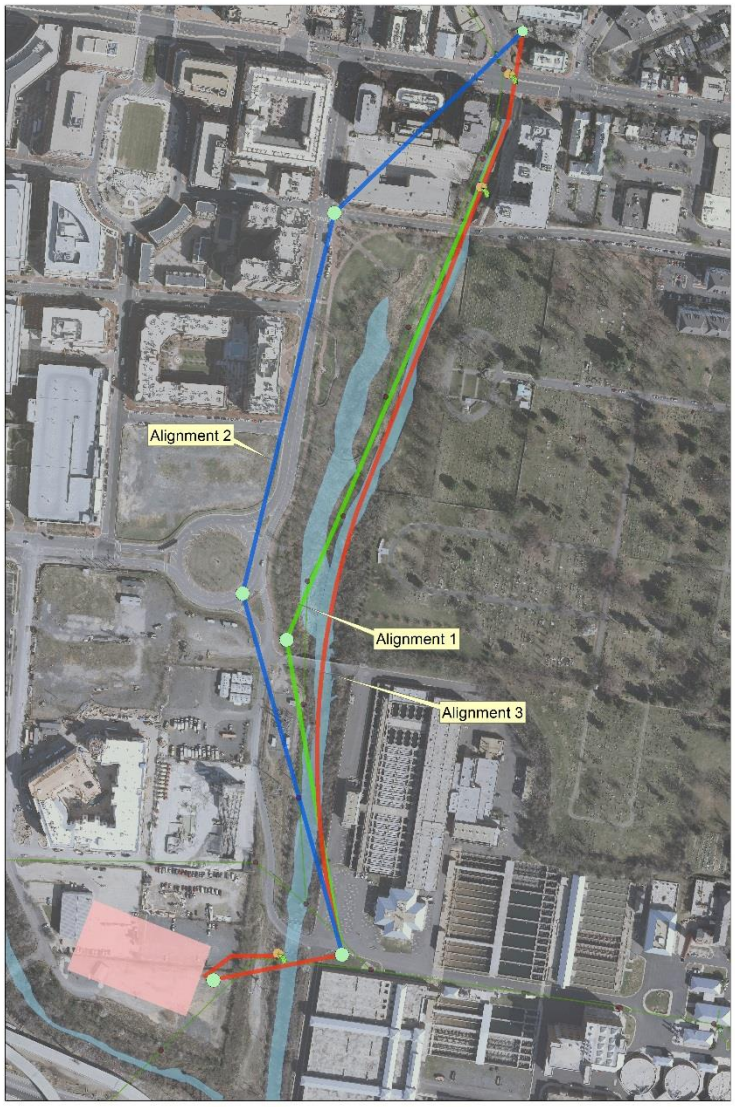
The City of Alexandria is in the process of performing a Long Term Control Plan Update (LTCPU) to address the Hunting Creek Total Maximum Daily Load (TMDL) issued by the Virginia Department of Environmental Quality (VDEQ) on November 2, 2010. The LTCPU will address the Hunting Creek TMDL by implementing a deep CSO storage tunnel to address the City's CSO-003 and CSO-004 and by implementing either a deep storage tunnel or an underground storage tank to address the City's CSO-002. The purpose of this technical memorandum is to propose, evaluate, and recommend potential storage tunnel alignments and tank sites that will be carried forward through the LTCPU process.

Section 2 CSO-003/004 Tunnel Alignment Alternatives

2.1 CSO-003/004 Alignment Descriptions

Three tunnel alignment alternatives have been proposed to capture and store overflows from CSO-003 and CSO-004, both which discharge into Hooffs Run. For the purposes of this evaluation all tunnels are assumed to be sized at 8-ft in diameter, which is the minimum size need in order to reduce combined sewer overflow discharges to 4-6 per year for the typical year of 1984. A separate technical memorandum will evaluate alternative sizing. These three alternatives are shown in Figure 2-1.

Figure 2-1
CSO-003/004 Tunnel Alignment Alternatives



2.1.1 CSO-003/004 Tunnel Alignments Common Elements

The following elements are common to all three tunnel alignments and will not be used to differentiate between the three in the subsequent evaluation:

- CSO-003 Diversion Structure
- CSO-004 Diversion Structure
- Odor Control
- Upstream Dropshaft
- AlexRenew Dropshaft
- Hydraulic Grade Line (HGL) Control Structure
- Screening
- Wet Weather Pump Station
- Wet Weather Pump Station Dropshaft
- Relocated CSO-004

All of these elements are described in detail in the *Alternatives Evaluation: Tunnels Technical Memorandum* dated October 2015. The sections below describe the unique elements of each alignment.

2.1.2 CSO-003/004 Tunnel Alignment 1

This alignment consists of an 8-ft diameter tunnel that begins at the upstream dropshaft which would be 20-ft in diameter. At this point the tunnel is approximately 80 feet underground. The tunnel continues south underneath Hooffs Run through the Alexandria African American Heritage Park to a turning dropshaft located inside the park just northeast of the intersection of Holland Lane and the entrance to Alexandria Renew Enterprises (AlexRenew). From the turning dropshaft, the 8-ft tunnel continues straight southeast to the AlexRenew dropshaft. The total length of this alignment is approximately 2,750 feet. This alignment does not pass underneath any buildings or structures, however it does pass adjacent to a Dominion Virginia Power high voltage electrical easement as well as a substation. Refer to Figure 2-1 for a representation of the alignment.

2.1.3 CSO-003/004 Tunnel Alignment 2

Alignment 2 is an 8-ft diameter tunnel that begins at the upstream dropshaft which would be 20-ft in diameter. The tunnel continues straight southwest to a second dropshaft located in the intersection of Holland Lane and Jamison Avenue. This dropshaft is approximately 85 feet deep and 30 feet in diameter. This portion of the alignment passes underneath several buildings and a parking garage. The alignment then continues due south to a third dropshaft approximately 100 feet deep and 30 feet in diameter located in the southern portion of the Eisenhower traffic circle. The dropshaft is shown in the traffic circle because there are plans under development to remove the traffic circle and put in a T-type intersection. This dropshaft is sited so that it will not interfere with the future T-type intersection. The 8-ft tunnel then continues southeast underneath the Dominion Virginia Power substation to the AlexRenew dropshaft. The total length of this alignment is 2,925 feet. Refer to Figure 2-1 for a representation of the alignment.

2.1.4 CSO-003/004 Tunnel Alignment 3

Alignment 3 is an 8-ft diameter tunnel that begins heading south out of the upstream dropshaft which would be 20-ft in diameter. It continues straight under Hooffs Run for approximately 1,325 feet as which point it starts to bend southeast with a 3,000-ft bend radius. The tunnel then ends at the AlexRenew dropshaft. The total length of this alignment is approximately 2,700 feet. This alignment does not pass under any buildings or structures and does not traverse under the African American Heritage Park or the cemeteries. Refer to Figure 2-1 for a representation of the alignment.

2.1.5 Upstream Dropshaft Location

With all of the proposed alignments for the CSO-003/004 tunnel an upstream dropshaft location needed to be determined to divert the flows from CSO-003 and CSO-004 into the tunnel. For the upstream dropshaft, four locations were considered in the vicinity of the CSO-003 and CSO-004 outfalls as shown in Figure 2-2:

- Location 1 – In the middle of Daingerfield Road near Duke Street
- Location 2 – In the middle of Duke Street
- Location 3 – In the middle of Peyton Street
- Location 4 – In the parking lot of 1501 Duke Street

Figure 2-2
Potential Upstream Dropshaft Locations

2.1.5.1 Location 1 – Daingerfield Road

As shown in Figure 2-2, the Daingerfield Road location would be located in the City right-of-way and does not prohibit traffic on Duke Street. However, during construction the dropshaft and required laydown area would restrict vehicle access to 1501 Duke Street, 1601 Duke Street, 200 Daingerfield Road, and 205 Daingerfield Road. The major issue with this location is that Hooffs Run is contained in a 30-ft x 15-ft boxed culvert that runs underneath Daingerfield Road. The only way for this to be feasible would be to move Hooffs Run which is impractical and would be substantially more disruptive than only the dropshaft. A dropshaft at this location is not recommended.

2.1.5.2 Location 2 – Duke Street

As shown in Figure 2-2, the Duke Street location would be located entirely in the City's right-of-way. It has the advantage that it minimizes the amount of new piping for CSO-003 and CSO-004 that needs to be constructed to convey flow from the CSOs into the dropshaft. During construction of this dropshaft, Duke Street would need to be completely closed to traffic for a period of 2 to 3 years. This would disrupt traffic as Duke Street is a major thoroughfare in the City. It would also negatively impact businesses and

be extremely disruptive to residents in the area as drivers attempt to find alternate routes around the closure. Additionally, once construction is completed, portions of Duke Street would need to be closed to conduct maintenance and cleaning on the structure several times a year. A dropshaft at this location is not recommended due to the impact on the City's traffic, businesses, and residents.

2.1.5.3 Location 3 – Peyton Street

As shown in Figure 2-2, the Peyton Street location would be located in the City's right-of-way and does not prohibit traffic on Duke Street. If this were selected as the upstream dropshaft location, a new turning dropshaft would need to be constructed in the area of Location 1, Location 2, or Location 4. The turning dropshaft is required because the tunnel would need to turn almost 90 degrees so that the alignment would continue south under Hooffs Run without tunneling under buildings. This turning dropshaft would need to be located at one of the other three locations discussed in this section, so it is a needless added cost and complexity to have a dropshaft located in Peyton Street. It is recommended the dropshaft at this location be eliminated from further consideration.

2.1.5.4 Location 4 – 1501 Duke Street

As shown in Figure 2-2, the 1501 Duke Street location is located on private property. The dropshaft would be located in the northwest corner of the parking lot behind the building. Based on site plans and information obtained from utility companies, there are no significant utilities located under the parking lot. During construction the parking lot will be taken for the dropshaft and construction laydown area, however the building can remain open to tenants. Alternative means for parking would need to be provided. Following construction, the parking lot would be restored and parking would be allowed on top of the dropshaft itself. There would be times throughout the year when access will be required to the dropshaft in order to perform maintenance and cleaning. Of the four locations a dropshaft at this location will have the least impact on traffic, surrounding businesses, and residents. Itis recommended as the upstream dropshaft location for the CSO-003/004 tunnel alignments.

2.2 Evaluation Criteria

The alternatives above are evaluated against the criteria described in the *Alignment and Siting Evaluation Criteria Technical Memorandum* dated October 16, 2015. They will be rated on a scale of 1 to 5 with 1 being the least desirable and 5 being the most desirable.

2.2.1 Estimated Cost

Conceptual level cost estimates for all three 8-ft tunnel alignments were developed and are presented in Attachment A. For all of the cost estimates a cost for the wet weather pump station, as described in the *Alternatives Evaluation: Tunnels Technical Memorandum* dated October 2015, is included. The table below presents the estimated costs and the corresponding rating.

Alignment	20 Year NPW Cost ($M)	Cost Rating
Alignment 1	$68.7	3
Alignment 2	$77.0	2
Alignment 3	$63.0	4

2.2.2 Utilities

For the alignments the location of utilities was obtained from each public utility where applicable. This information was digitized and overlaid on the alignments. Since the tunnel will be 70 to 100 feet underground it will have no impact on the utilities, however the location of the dropshafts could have a significant impact on vital infrastructure. Therefore, alignments with dropshafts that conflict with existing utilities will receive a lower score. Alignments that do not conflict with any utilities will receive a 5. See the table below for a brief description of the potential conflicts and rating for each alignment.

Alignment	Potential Conflicts	Utilities Rating
Alignment 1	Turning dropshaft located between 230kV lines and Commonwealth Interceptor	3
Alignment 2	Both intermediate dropshafts are located close to 230kV lines	2
Alignment 3	No known utility conflicts	5

2.2.3 Right-of-Way and Easements

- Alignment 1 is located underneath Hooffs Run, in the African American Heritage Park, and on the AlexRenew plant site. A subterranean easement may be required through the African American Heritage Park, which is owned and operated by the City of Alexandria. Other than the upstream dropshaft, the remaining alignment is located in the City right-of-way.
- Alignment 2 starts by heading southwest underneath several buildings, it then proceeds down Holland Lane (City right-of-way), underneath a Dominion Virginia Power substation, and finally to the AlexRenew plant site. Subterranean easements will be required where the alignment travels under buildings and private and privately owned parcels.
- Alignment 3 is located underneath Hooffs Run and on the AlexRenew plant site. Other than the upstream dropshaft, this entire alignment is located in the City right-of-way.

The table below presents the ratings for the three alignments.

Alignment	Right-of-Way Rating
Alignment 1	3
Alignment 2	1
Alignment 3	5

2.2.4 Property Acquisition

For all three alignments property will need to be acquired for the upstream dropshaft. Other than that all the other dropshafts are located either in the City right-of-way or on the AlexRenew plant site. This criterion cannot be used to differentiate the three alignments. All three alignments received a Property Acquisition Rating of 4.

2.2.5 Residential and Archaeological Impacts

- Alignment 1 has a dropshaft located in the periphery of the African American Heritage Park. Although this is not desirable, in a letter dated October 6, 2015, Alexandria Archaeology has stated "*the proposed new sewer tunnel will have no impact to any archaeological resources*."
- Alignment 2 has 1 turning dropshaft located in the intersection of Holland Lane and Jamison Avenue. The other turning dropshaft is locate adjacent to the future T-intersection. There is the potential to close multiple lanes of traffic during construction.
- Alignment 3 does not have any known impacts on residential buildings, traffic, or archaeological resources.

The table below presents the ratings for the three alignments.

Alignment	Residential and Archaeological Impact Rating
Alignment 1	4
Alignment 2	2
Alignment 3	5

2.2.6 Geotechnical Conditions

All three alignment are located relatively close to each other. Without performing a detailed boring investigation of each alignment it is assumed that the geological conditions are the same. This criterion cannot be used as a differentiator. All three alignments received a Geotechnical Condition Rating of 4. Geotechnical investigations are planned after a preferred alignment is selected.

2.2.7 Construction Risk

- Alignment 1 does not pass underneath any buildings or structures.
- Alignment 2 passes underneath several buildings, a parking garage, and a Dominion Virginia Power substation.
- Alignment 3 does not pass underneath any buildings or structures; however, it is a curved alignment meaning that construction of such an alignment will be more complex and require more skilled contractors. Potentially, this added complexity will actually reduce the risk as the procurement can logically require more skilled contractors.

The table below presents the ratings for the three alignments.

Alignment	Construction Risk Rating
Alignment 1	4
Alignment 2	2
Alignment 3	5

2.2.8 Permitting

All three alignments will require relocating CSO-004 to the vicinity of the AlexRenew plant. This will require modifying the City's existing combined sewer system permit.

- Alignment 1 generally follows the existing Hooffs Run and will require construction of a larger turning shaft within 30 feet of Hooffs Run along its banks. Since this alignment passes underneath the tidal portion of Hooffs Run, it will fall under the jurisdiction of the Virginia Marine Resources Commission (VMRC). The turning dropshaft may require permits from the U.S. Army Corp of Engineers (COE) and/or the Virginia Department of Environmental Quality (VDEQ) because it may involve disturbance of jurisdictional wetlands within the Hooffs Run floodplain.
- Alignment 2 passes underneath several buildings, a parking garage, and a Dominion Virginia Power (DVP) substation. This alignment would require easements from the properties that the alignment passes under including building owners and DVP. This alignment also passes underneath the tidal portion of Hooffs Run where VMRC has jurisdiction.
- Alignment 3 is anticipated to have fewer permitting impacts, as it requires fewer shafts. Since this alignment passes underneath the tidal portion of Hooffs Run, it will fall under the jurisdiction of the VMRC.

Alignment	Permitting
Alignment 1	3
Alignment 2	2
Alignment 3	4

2.2.9 Rating and Recommendation

Table 2-1 presents a weighted rating for the three alignments based on the ratings above and the weightings developed in the *Alignment and Siting Evaluation Criteria Technical Memorandum*. A table containing a summary of the ratings above, weightings, and a weighted rating can be found in Attachment B.

Table 2-1
CSO-003/004 Alignments Weighted Ratings

Alignment	Weighted Rating
Alignment 1	3.45
Alignment 2	2.45
Alignment 3	4.10

Based on the weighted ratings it is recommended that Alignment 3 be carried on for further development and the other two alignments be eliminated from further consideration.

Section 3 CSO-002 Tunnel Alignment Alternatives

3.1 CSO-002 Alignment Descriptions

Three tunnel alignment alternatives have been proposed to capture and store overflows from CSO-002. For the purposes of this evaluation all tunnels are assumed to be sized at 8-ft in diameter, a separate technical memorandum will evaluate alternative sizing. These three alternatives are shown in Figure 3-1 below.

Figure 3-1
CSO-002 Tunnel Alignment Alternatives

All three tunnels shown in Figure 3-1 are connected to the CSO-003/004 tunnel, this allows for a single dewatering pump station to dewater the entire tunnel system. While this seems to be an elegant solution, having a connected tunnel system will require complex hydraulic design to prevent bacteria load from being transferred from CSO-002 to Hooffs Run during an overflow. For more information on this complexity see the *Alternatives Evaluation: Tunnels Technical Memorandum* dated October 2015.

Rather than having one connected tunnel system, there is a possibility to have two separate tunnel systems: one for CSO-003/004 and another for CSO-002 as shown in Figure 3-2. These tunnels are assumed to be 14-feet in diameter, a separate technical memorandum will evaluate alternative sizing.

Figure 3-2
CSO-002 Separate Tunnel Alignment Alternatives

3.1.1 CSO-002 Tunnel Alignments Common Elements

The following elements are common to all three tunnel alignments and will not be used to differentiate between the three in the subsequent evaluation:

- CSO-002 Diversion Structure
- Odor Control
- Upstream Dropshaft
- AlexRenew Dropshaft
- HGL Control Structure
- Screening

All of these elements are described in detail in the *Alternatives Evaluation: Tunnels Technical Memorandum* dated October 2015. The sections below describe the unique elements of each alignment.

3.1.2 CSO-002 Tunnel Alignment 1

This alignment consists of an 8-ft diameter tunnel that begins at the 20-ft diameter upstream dropshaft at the intersection of Royal Street and Green Street. At this point the tunnel is approximately 80 feet underground. The tunnel continues west underneath Green Street to a 25-ft diameter intermediate dropshaft at of the intersection of Green Street and South Patrick Street. From the intermediate dropshaft, the 8-ft tunnel continues straight west underneath the AlexRenew screening building and to the AlexRenew dropshaft. The total length of this alignment is approximately 4,100 feet. This alignment passes underneath the AlexRenew screen building and a Dominion Virginia Power substations just to the east of the screen building. A majority of the alignment is within the City right-of-way and does not pass under private property. Refer to Figure 3-1 for a representation of the alignment.

3.1.3 CSO-002 Tunnel Alignment 2

Alignment 2 is an 8-ft diameter tunnel that begins at the 20-ft diameter upstream dropshaft at the southern end of Royal Street. The tunnel continues straight west underneath St. Mary's Cemetery, Contraband and Freedmen Memorial Cemetery, and parallel to Interstate 495 to a second dropshaft located in the VDOT right-of-way among the entrance and exit ramps for I-495 and US Route 1. This dropshaft is approximately 85 feet deep and 25 feet in diameter. The alignment continues west to a turning dropshaft located at the southwest corner of the AlexRenew site. This dropshaft is 95 feet deep and 30 feet in diameter. From this shaft the alignment runs due north to the AlexRenew dropshaft. A majority of this alignment is in VDOT right-of-way or underneath private property. The total length of this alignment is 4,700 feet. Refer to Figure 3-1 for a representation of the alignment.

3.1.4 CSO-002 Tunnel Alignment 3

Alignment 3 is an 8-ft diameter tunnel that begins heading west out of a 20-ft diameter upstream dropshaft at the intersection of Royal Street and Franklin Street. It continues west underneath Franklin Street to a 25-ft diameter intermediate dropshaft located at the intersection of Franklin Street and South Patrick Street. The tunnel continues west under several cemeteries and ends at an intermediate dropshaft at the intersection of Holland Lane and the entrance to the AlexRenew plant. The total length of this alignment is approximately 4,400 feet. A majority of this alignment is located in the City right-of-way, however a significant portion passes beneath four different cemeteries. Refer to Figure 3-1 for a representation of the alignment.

3.2 Evaluation Criteria

The alternatives above are evaluated against the criteria described in the *Alignment and Siting Evaluation Criteria Technical Memorandum* dated October 16, 2015. They will be rated on a scale of 1 to 5 with 1 being the least desirable and 5 being the most desirable.

3.2.1 Estimated Cost

Detailed cost estimates for all three 8-ft tunnel alignments were developed and are presented in Attachment C. It is important to note that these cost estimates do not include a dropshaft, HGL control

structure, or wet weather pump stations as it is assumed that those items will be constructed as part of the CSO-003/004 tunnel. The cost estimates assume a similar length and volume for the basis of the comparison. The table below presents the estimated costs and the corresponding rating.

Alignment	20 Year NPW Cost ($M)	Cost Rating
Alignment 1	$58.5	4
Alignment 2	$56.3	4
Alignment 3	$57.6	4

3.2.2 Utilities

For the alignments the location of utilities was obtained from each public utility where applicable. This information was digitized and overlaid on the alignments. Since the tunnel will be 70 to 100 feet underground it will have no impact on the utilities, however the location of the dropshafts could have a significant impact on infrastructure. Therefore, alignments with dropshafts that conflict with existing utilities will receive a lower score. Alignments that do not conflict with any utilities will receive a 5. See the table below for a brief description of the potential conflicts and rating for each alignment.

Alignment	Potential Conflicts	Utilities Rating
Alignment 1	No known utility conflicts	5
Alignment 2	Major utility conflicts on the southwest corner of the AlexRenew site	1
Alignment 3	No known utility conflicts	5

3.2.3 Right-of-Way and Easements

- Alignment 1 runs beneath Green Street in the City right-of-way. It continues underneath the Lee Recreation Center property and finally under the AlexRenew plant. The entire alignment is within the City right-of-way or on the AlexRenew site.
- Alignment 2 starts in the VDOT right-of-way adjacent to the Woodrow Wilson Bridge. It passes underneath the St. Mary's Cemetery and the Freedmen Memorial Cemetery and continues in the VDOT right-of-way until it reaches the AlexRenew site. Subterranean easements will be required under each of the cemeteries. While these type of easements have been acquired from cemeteries on other CSO tunnel projects, it is not desirable and can be difficult.
- Alignment 3 is located underneath Franklin Street and heads west until it passes beneath several public and private cemeteries. The tunnel then ends at a dropshaft in the African American Heritage Park

The table below presents the ratings for the three alignments.

Alignment	Right-of-Way Rating
Alignment 1	5
Alignment 2	1
Alignment 3	2

3.2.4 Property Acquisition

- Alignment 1: No property acquisition required.
- Alignment 2: Potential property acquisition required in the VDOT right-of-way.
- Alignment 3: Potential property acquisition required for tunnel alignment under cemeteries.

Alignment	Property Acquisition Rating
Alignment 1	5
Alignment 2	3
Alignment 3	3

3.2.5 Residential and Archaeological Impacts

- Alignment 1 has two dropshafts located in street intersections in a residential neighborhood. There will be disruption to residents during construction.
- Alignment 2 dropshafts are located in the VDOT right-of-way or on the AlexRenew site. However, the only access to the upstream dropshaft is through a residential neighborhood. While the construction itself may not be disruptive, the construction traffic may be disruptive.
- Alignment 3 has a dropshaft located in the periphery of the African American Heritage Park. Although this is not desirable, Alexandria Archaeology has stated "*the proposed new sewer tunnel will have no impact to any archaeological resources*." Additionally, it also has two dropshafts located in street intersections in a residential neighborhood. There will be disruption to traffic and the residents during construction. Finally, a new diversion sewer will need to be constructed along Royal Street to convey the CSO northward to the upstream dropshaft. This will shut down several blocks of Royal Street during construction and will be extremely disruptive to the residents.

The following below presents the ratings for the three alignments.

Alignment	Residential and Archaeological Impact Rating
Alignment 1	2
Alignment 2	3
Alignment 3	2

3.2.6 Geotechnical Conditions

All three alignment are located relatively close to each other. Without performing a detailed boring investigation of each alignment it is assumed that the geological conditions are the same. This criterion cannot be used as a differentiator. All three alignments received a Geotechnical Condition Rating of 4.

3.2.7 Construction Risk

- Alignment 1 passes underneath the AlexRenew screen building which was built in the 1950s and is supported by piles.
- Alignment 2 passes underneath several entrance and exit ramps for the I-495, Route 1 interchange.
- Alignment 3 does not pass underneath any buildings or structures.

The table below presents the ratings for the three alignments.

Alignment	Construction Risk Rating
Alignment 1	2
Alignment 2	2
Alignment 3	5

3.2.8 Permitting

None of the alignments are relocating the outfall and they are generally located in the City right-of-way. It is not anticipated that a significant permitting effort will be required, therefore this criterion cannot be used as a differentiator. All three alignments received a Permitting Rating of 4.

3.2.9 Rating and Recommendation

Table 3-1 presents a weighted rating for the three alignments based on the ratings above and the weightings developed in the *Alignment and Siting Evaluation Criteria Technical Memorandum*. A table containing a summary of the ratings above, weightings, and a weighted rating can be found in Attachment D.

Table 3-1
CSO-002 Alignments Weighted Ratings

Alignment	Weighted Rating
Alignment 1	3.80
Alignment 2	3.30
Alignment 3	3.65

Based on the weighted ratings it is recommended that Alignment 1 be carried on for further development and the other two alignments be eliminated from further consideration.

Section 4 CSO-002 Tank Alternatives

4.1 CSO-002 Tank Descriptions

Four tank alternatives have been proposed to capture and store overflows from CSO-002. For the purposes of this evaluation all tanks are assumed to be sized for 2 million gallons of storage, a separate technical memorandum will evaluate alternative sizing. These four alternatives are shown in Figure 4-1 below.

Figure 4-1
CSO-002 Tank Alternatives

4.1.1 CSO-002 Tank Common Elements

The following elements are common to all four tank alternatives and will not be used to differentiate between the four in the subsequent evaluation:

- All tanks when full will have 3 feet of head space
- All tanks will be able to hold at a minimum 2 million gallons
- CSO-002 Diversion Structure
- Screening

- Dewatering Pump Station – following a wet weather event the tanks will be dewatered back to the Potomac Interceptor at a rate of 2 MGD.
- Odor Control
- Tipping Buckets (for cleaning)
- Tanks will be constructed on piles due to the poor soils in the area

These elements are described in detail in the *Alternatives Evaluation: Storage Tanks Technical Memorandum* dated October 2015. The sections below describe the unique elements of each alignment.

4.1.2 CSO-002 Tank Alternative 1

CSO-002 Tank Alternative 1 is located on private property (Bridgeyard Apartments, previously known as Hunting Pointe) and within a resource protection area (RPA). New piping will need to be constructed from the existing CSO-002 to the tank and a new overflow pipe will need to be constructed from the tank to the receiving water. The tank is 140 feet long and 100 feet wide and 20 feet deep, with the top of the tank located just below the ground surface. This could allow for some public amenity to be constructed on top; the amenity would need to be coordinated with the land owner. A site plan as well as a plan and profile can be found in Attachment E.

4.1.3 CSO-002 Tank Alternative 2

Tank Alternative 2 is located in the cul-de-sac and the southernmost end of Royal Street. This tank is located completely within the City right-of-way, although during construction there will be restricted public access to Jones Point Park. The tank is 140 feet long and 100 feet with the ability to store CSO 20 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. It is important that once constructed the tank does not limit access to Jones Point Park or access to the facilities located underneath the Woodrow Wilson Bridge. A site plan as well as a plan and profile can be found in Attachment E.

4.1.4 CSO-002 Tank Alternative 3

Tank Alternative 3 is located directly on the end of the existing CSO-002 outfall and in the embayment itself. This tank relocates the overflow location farther out into the embayment. While permitting such a tank could be challenging, this type of tank as many advantages. First, the tank is not located on any known private property, City street, or national park. Second, the tank can be designed in such a way that public amenities could be placed on top. Third, the tank allows the City to improve waterfront access for the public and persons in the national park. Finally, as part of the construction, there is an opportunity to make improvements to the embayment and shoreline that would otherwise be very disruptive. The tank will be 290 feet long, 50 feet wide, and store flow 20 feet deep. A site plan as well as a plan and profiles can be found in Attachment E.

4.1.5 CSO-002 Tank Alternative 4

Tank Alternative 4 is not designed as a traditional tank. This alternative utilizes the alignment of the Jones Point Park road as the basis for the tank shape. The tank is 45 feet wide and 933 feet long with a

storage depth of 7 feet and a head space of 3 feet. This tank could be constructed as a series of side-by-side box culverts rather than cast in place concrete. The shallow depths also makes excavation and construction much easier than the other deep tanks. In order to construct such a tank, the City will need to negotiate with the National Park Service. A site plan as well as a plan and profile can be found in Attachment E.

4.2 Evaluation Criteria

The alternatives above are evaluated against the criteria described in the *Alignment and Siting Evaluation Criteria Technical Memorandum* dated October 16, 2015. They will be rated on a scale of 1 to 5 with 1 being the least desirable and 5 being the most desirable.

4.2.1 Estimated Cost

Detailed cost estimates for all four 2 million gallon tank alternatives were developed and are presented in Attachment F. The table below presents the estimated costs and the corresponding rating.

Alternative	20 Year NPW Cost ($M)	Cost Rating
Tank 1	$32.9	5
Tank 2	$29.3	5
Tank 3	$34.9	5
Tank 4	$17.9	5

4.2.2 Utilities

For the tank alternatives the location of utilities was obtained from each public utility where applicable. This information was digitized and overlaid on the tank sites. Tanks that conflict with existing utilities will receive a lower score. Tanks that do not conflict with any utilities will receive a 5. See the table below for a brief description of the potential conflicts and rating for each alternative.

Alternative	Potential Conflicts	Utilities Rating
Tank 1	No known utility conflicts	5
Tank 2	No known utility conflicts	5
Tank 3	No known utility conflicts	5
Tank 4	No known utility conflicts	5

4.2.3 Right-of-Way and Easement

- Tank 1 is located on private property and not in the City right-of-way.

- Tank 2 is located in the cul-de-sac and the southernmost end of Royal Street. It is entirely within the City right-of-way, however, it could still require either temporary construction easement or permanent access easement from the National Park Service
- Tank 3 is located in the Hunting Creek embayment. While this is not part of the City right-of-way, it is Virginia waters and would not require easements on private property.
- Tank 4 is located entirely in Jones Point Park. The City would have to work with the National Park Service to obtain easements for construction and maintenance.

The table below presents the ratings for the four tank alternatives

Alternative	Right-of-Way Rating
Tank 1	2
Tank 2	4
Tank 3	4
Tank 4	2

4.2.4 Property Acquisition

- Tank 1: Private property will need to be acquired.
- Tank 2: No private property acquisition required.
- Tank 3: No private property acquisition required.
- Tank 4: It may not be possible to acquire National Park Service land, however easements will be required. Acquiring an easement from NPS is a lengthy process and easements have to be renewed every 5 years. Additionally, NPS requires a payment for the land as well as a payment for the easement application every 5 years. There is more cost and time impacts associated with constructing a tank on NPS property then there is on private property.

Alternative	Property Acquisition Rating
Tank 1	3
Tank 2	5
Tank 3	5
Tank 4	2

4.2.5 Residential and Archaeological Impacts

- Tank 1 will be disruptive to the residents of the Bridgeyard Apartments during construction.
- Tank 2 will disrupt access to Jones Point Park during construction and there will be heavy construction traffic through a residential neighborhood.
- Tank 3 will be disruptive to the residents of the Bridgeyard Apartments during construction.

- Tank 4 will disrupt access to Jones Point Park during construction and there will be heavy construction traffic through a residential neighborhood.

The table below presents the ratings for the four tank alternatives.

Alternative	Residential and Archaeological Impact Rating
Tank 1	3
Tank 2	2
Tank 3	3
Tank 4	3

4.2.6 Geotechnical Conditions

All four tank alternatives are located relatively close to each other. Without performing a detailed boring investigation of each tank it is assumed that the geological conditions are the same. This criterion cannot be used as a differentiator. All four tank alternatives received a Geotechnical Condition Rating of 3.

4.2.7 Construction Risk

- Tank 1 is located partially in a parking lot and partially in a grassy area.
- Tank 2 is located in a cul-de-sac at the end of Royal Street. Construction around the Royal Street box culvert will be difficult.
- Tank 3 is located in an embayment and a CSO diversion will be needed until the tank is complete.
- Tank 4 is located underneath a park road. The contractor will need to take care to limit the impacts of construction to the surrounding park.

The table below presents the ratings for the three alignments.

Alternative	Construction Risk Rating
Tank 1	5
Tank 2	3
Tank 3	2
Tank 4	4

4.2.8 Permitting

- Tank 1 is located on private property and within a resource protection area (RPA). The City will have to work with VDEQ to permit the tank within the RPA.

- Tank 2 is located entirely within the City right-of-way, it is not anticipated that permitting this alternative will require a significant effort.
- Tank 3 is located in the Hunting Creek embayment. The City will have to work closely with VDEQ to reclaim part of the embayment for the tank. This will require more effort than permitting a tank in the RPA.
- Tank 4 is located entirely on National Park Service property. While permits from VDEQ may not require a significant effort, there will be a lot of effort expended working with National Park Service.

Alternative	Permitting Rating
Tank 1	4
Tank 2	5
Tank 3	3
Tank 4	3

4.2.9 Rating and Recommendation

Table 4-1 presents a weighted rating for the four tank alternatives based on the ratings above and the weightings developed in the *Alignment and Siting Evaluation Criteria Technical Memorandum*. A table containing a summary of the ratings above, weightings, and a weighted rating can be found in Attachment G.

Table 4-1
CSO-002 Tank Alternatives Weighted Ratings

Alternative	Weighted Rating
Tank 1	4.10
Tank 2	4.20
Tank 3	4.25
Tank 4	3.85

Due to the ratings being so close to each other and the anticipated phasing of construction for the CSO-003/004 infrastructure and the CSO-002 infrastructure, all storage tank sites will be retained in the LTCPU. Following the construction of the CSO-003/004 tunnel the tank sites will be evaluated in depth and a final storage tank site will be recommended.

Attachment A

CSO-003/004 Tunnel Cost Estimates

COA LTCPU
T1-8-ft

Alternative T1-8-ft Diameter Tunnel
Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Item	QTY	Units	Unit Cost	Total	Comments
003/004 Tunnel					
8' Tunnel from Dangerfield Road to NMF	**2,750**	LF	$3,600	$9,900,000	Guidance From Jacobs
Shaft 1 (15' diameter)	**75**	VLF	$26,000	$1,950,000	Guidance From Jacobs
Shaft 2 (20' diameter)	**80**	VLF	$32,000	$2,560,000	Guidance From Jacobs
Shaft 3 (20' diameter)	**90**	VLF	$32,000	$2,880,000	Guidance From Jacobs
Shaft 4 (15' diameter)	**100**	VLF	$26,000	$2,600,000	Guidance From Jacobs
8' Tunnel from CI to NMF	**400**	LF	$3,600	$1,440,000	Guidance From Jacobs
Diversion Structures	**2**	EA	$600,000	$1,200,000	Local Project Data (K&W)
48'' Sewer	**300**	LF	$1,200	$360,000	DC LTCP
				$22,890,000	
Facilities					
Odor Control	**1**	EA	$500,000	$500,000	Allowance
Dewatering PS	1.0	MGD	Equation	$650,000	Cost Curve
Wet Weather PS	**1**	LS	$7,100,000	$7,100,000	TO-16 Estimate
Climber Screens	**1**	LS	$2,000,000	$2,000,000	Allowace
				$10,250,000	
Subtotal				*$33,140,000*	
Construction Contingency	35%			$11,599,000	
Construction Subtotal				$44,739,000	
Planning, Design, Construction Management, Administration, and Permitting	35%			$15,658,650	
Land Acquisition	14,520	SF	$125	$1,815,000	
Easements	3,000	SF	$38	$112,500	
				$1,927,500	
Total Project				**$62,325,150**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	15.3	MGY	$ 6.44	$ 98,468	$6.44/1,000 Gallons
Pumping Costs	8,102	kw-hrs	$ 0.08	$ 648.2	
Annual Volume	**15.3**	MGY			
Total Dynamic Head	**90**	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tunnel Volume x 4)	400	TG	$ 4.00	$ 1,600	
Labor Costs	576	Hrs	$ 50.00	$ 28,800	
Monthly Inspections (12@16hrs/each)	**192**	Hrs			
Quarterly Cleaning (4@96hrs/each)	**384**	Hrs			
Maintenance Costs					
Percentage of Construction	1.00%			$ 447,390	DC LTCP Assumption
Annual O&M				$ 576,906	
Net Present Worth				**$ 8,582,901**	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	15.3	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	8225	lbs/yr	$80	$ 657,996	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	367	lbs/yr	$6,000	$ 2,203,521	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	77	lbs/yr	$25,000	$ 1,912,779	
Net Present Worth				$ 2,203,521	

COA LTCPU
T2-8-ft

Alternative T2-8-ft Diameter Tunnel
Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Item	QTY	Units	Unit Cost	Total	Comments
003/004 Tunnel					
8' Tunnel from Dangerfield Road to NMF	**2,925**	LF	$3,600	$10,530,000	Guidance From Jacobs
Shaft 1 (15' diameter)	**75**	VLF	$26,000	$1,950,000	Guidance From Jacobs
Shaft 2 (20' diameter)	**80**	VLF	$32,000	$2,560,000	Guidance From Jacobs
Shaft 3 (20' diameter)	**90**	VLF	$32,000	$2,880,000	Guidance From Jacobs
Shaft 4 (20' diameter)	**100**	VLF	$32,000	$3,200,000	Guidance From Jacobs
Shaft 5 (15' diameter)	**100**	VLF	$26,000	$2,600,000	Guidance From Jacobs
8' Tunnel from CI to NMF	**400**	LF	$3,600	$1,440,000	Guidance From Jacobs
Diversion Structures	**2**	EA	$600,000	$1,200,000	Local Project Data (K&W)
48" Sewer	**300**	LF	$1,200	$360,000	DC LTCP
				$26,720,000	
Facilities					
Odor Control	**1**	EA	$500,000	$500,000	Allowance
Dewatering PS	1.0	MGD	Equation	$650,000	Cost Curve
Wet Weather PS	**1**	LS	$7,100,000	$7,100,000	TO-16 Estimate
Climber Screens	**1**	LS	$2,000,000	$2,000,000	Allowace
				$10,250,000	
Subtotal				*$36,970,000*	
Construction Contingency	35%			$12,939,500	
Construction Subtotal				$49,909,500	
Planning, Design, Construction Management, Administration, Permitting and Easements	35%			$17,468,325	
Land Acquisition	14,520	SF	$125	$1,815,000	
Easements	18,000	SF	$38	$675,000	
				$2,490,000	
Total Project				**$69,867,825**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	15.3	MGY	$ 6.44	$ 98,532	$6.44/1,000 Gallons
Pumping Costs	8,107	kw-hrs	$ 0.08	$ 648.6	
Annual Volume	**15.3**	MGY			
Total Dynamic Head	**90**	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tunnel Volume x 4)	400	TG	$ 4.00	$ 1,600	
Labor Costs	576	Hrs	$ 50.00	$ 28,800	
Monthly Inspections (12@16hrs/each)	**192**	Hrs			
Quarterly Cleaning (4@96hrs/each)	**384**	Hrs			
Maintenance Costs					
Percentage of Construction	1.00%			$ 499,095	DC LTCP Assumption
Annual O&M				$ 628,676	
Net Present Worth				**$ 9,353,105**	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	15.3	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	8230	lbs/yr	$80	$ 658,426	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	367	lbs/yr	$6,000	$ 2,204,963	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	77	lbs/yr	$25,000	$ 1,914,030	
Net Present Worth				$ 2,204,963	

COA LTCPU
T3-8-ft

Alternative T3-8-ft Diameter Tunnel
Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Item	QTY	Units	Unit Cost	Total	Comments
003/004 Tunnel					
8' Tunnel from Dangerfield Road to NMF	**2,700**	LF	$3,600	$9,720,000	Guidance From Jacobs
Shaft 1 (15' diameter)	**75**	VLF	$26,000	$1,950,000	Guidance From Jacobs
Shaft 2 (20' diameter)	**90**	VLF	$32,000	$2,880,000	Guidance From Jacobs
Shaft 3 (15' diameter)	**100**	VLF	$26,000	$2,600,000	Guidance From Jacobs
8' Tunnel from CI to NMF	**400**	LF	$3,600	$1,440,000	Guidance From Jacobs
Diversion Structures	**2**	EA	$600,000	$1,200,000	Local Project Data (K&W)
48" Sewer	**300**	LF	$1,200	$360,000	DC LTCP
				$20,150,000	
Facilities					
Odor Control	**1**	EA	$500,000	$500,000	Allowance
Dewatering PS	1.0	MGD	Equation	$650,000	Cost Curve
Wet Weather PS	**1**	LS	$7,100,000	$7,100,000	TO-16 Estimate
Climber Screens	**1**	LS	$2,000,000	$2,000,000	Allowace
				$10,250,000	
Subtotal				*$30,400,000*	
Construction Contingency	35%			$10,640,000	
Construction Subtotal				$41,040,000	
Planning, Design, Construction Management, Administration, Permitting and Easements	35%			$14,364,000	
Land Acquisition	14,520	SF	$125	$1,815,000	
Easements			$38	$0	
Total Project				**$57,219,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	15.3	MGY	$ 6.44	$ 98,468	$6.44/1,000 Gallons
Pumping Costs	8,102	kw-hrs	$ 0.08	$ 648.2	
Annual Volume	**15.3**	MGY			
Total Dynamic Head	**90**	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tunnel Volume x 4)	400	TG	$ 4.00	$ 1,600	
Labor Costs	576	Hrs	$ 50.00	$ 28,800	
Monthly Inspections (12@16hrs/each)	**192**	Hrs			
Quarterly Cleaning (4@96hrs/each)	**384**	Hrs			
Maintenance Costs					
Percentage of Construction	1.00%			$ 410,400	DC LTCP Assumption
Annual O&M				$ 539,916	
Net Present Worth				**$ 8,032,583**	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	15.3	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	8225	lbs/yr	$80	$ 657,996	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	367	lbs/yr	$6,000	$ 2,203,521	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	77	lbs/yr	$25,000	$ 1,912,779	
Net Present Worth				$ 2,203,521	

Attachment B

CSO-003/004 Tunnel Ratings, Weightings, and Weighted Scores

Weighting		40%	5%	5%	10%	10%	15%	10%	5%	100%	
Alignment	Estimated Cost	Cost Rating	Utilities	Right-of-Way	Property Acquisition	Residential and Archaeological Impacts	Geotechnical Conditions	Construction Risk	Permitting	Weighted Score	Rank
Alignment 1	$68.7	3	3	3	4	4	4	4	3	3.45	2
Alignment 2	$77.0	2	2	1	4	2	4	2	2	2.45	3
Alignment 3	$63.0	4	5	5	4	5	4	3	4	4.1	1

Attachment C

CSO-002 Tunnel Cost Estimates

COA LTCPU
T5-8-ft

Alternative T5-8-ft Diameter Tunnel
Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By:

Item	QTY	Units	Unit Cost	Total	Comments
002 Tunnel					
8' Tunnel from Dangerfield Road to NMF	**5,000**	LF	$3,600	$18,000,000	Guidance From Jacobs
Shaft 1 (20' diameter)	**100**	VLF	$32,000	$3,200,000	Guidance From Jacobs
Shaft 2 (15' diameter)	**80**	VLF	$26,000	$2,080,000	Guidance From Jacobs
Shaft 3 (20' diameter)	**70**	VLF	$32,000	$2,240,000	Guidance From Jacobs
8' Tunnel from CI to NMF	**0**	LF	$3,600	$0	Guidance From Jacobs
Diversion Structures	**1**	EA	$600,000	$600,000	Local Project Data (K&W)
48" Sewer	**0**	LF	$1,200	$0	DC LTCP
				$26,120,000	
Facilities					
Odor Control	**1**	EA	$500,000	$500,000	Allowance
Dewatering PS	1.9	MGD	Equation	$940,000	Cost Curve
Climber Screens	**1**	LS	$2,000,000	$2,000,000	Allowace
				$3,440,000	
Subtotal				*$29,560,000*	
Construction Contingency	35%			$10,346,000	
Construction Subtotal				$39,906,000	
Planning, Design, Construction Management, Administration, Permitting and Easements	35%			$13,967,100	
Land Acquisition	0	SF	$75	$0	
Easements		SF	$23		
Total Project				**$53,873,100**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	36.8	MGY	$ 6.44	$ 236,992	$6.44/1,000 Gallons
Pumping Costs	19,500	kw-hrs	$ 0.08	$ 1,560.0	
Annual Volume	**36.8**	MGY			
Total Dynamic Head	**90**	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tunnel Volume x 4)	760	TG	$ 4.00	$ 3,040	
Labor Costs	576	Hrs	$ 50.00	$ 28,800	
Monthly Inspections (12@16hrs/each)	**192**	Hrs			
Quarterly Cleaning (4@96hrs/each)	**384**	Hrs			
Maintenance Costs					
Percentage of Construction	1.00%			$ 399,060	DC LTCP Assumption
Annual O&M				$ 669,452	
Net Present Worth				**$ 9,959,755**	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	36.8	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	19796	lbs/yr	$80	$ 1,583,666	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	884	lbs/yr	$6,000	$ 5,303,439	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	184	lbs/yr	$25,000	$ 4,603,680	
Net Present Worth				$ 5,303,439	

COA LTCPU
T6-8-ft

Alternative T6-8-ft Diameter Tunnel
Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By:

Item	QTY	Units	Unit Cost	Total	Comments
002 Tunnel					
8' Tunnel from Dangerfield Road to NMF	**4,700**	LF	$3,600	$16,920,000	Guidance From Jacobs
Shaft 1 (20' diameter)	**0**	VLF	$32,000	$0	Guidance From Jacobs
Shaft 2 (20' diameter)	**100**	VLF	$32,000	$3,200,000	Guidance From Jacobs
Shaft 3 (15' diameter)	**80**	VLF	$26,000	$2,080,000	Guidance From Jacobs
Shaft 4 (20' diameter)	**70**	VLF	$32,000	$2,240,000	Guidance From Jacobs
8' Tunnel from CI to NMF	**0**	LF	$3,600	$0	Guidance From Jacobs
Diversion Structures	**1**	EA	$600,000	$600,000	Local Project Data (K&W)
48" Sewer	**0**	LF	$1,200	$0	DC LTCP
				$25,040,000	
Facilities					
Odor Control	**1**	EA	$500,000	$500,000	Allowance
Dewatering PS	1.8	MGD	Equation	$910,000	Cost Curve
Climber Screens	**1**	LS	$2,000,000	$2,000,000	Allowace
				$3,410,000	
Subtotal				*$28,450,000*	
Construction Contingency	35%			$9,957,500	
Construction Subtotal				$38,407,500	
Planning, Design, Construction Management, Administration, Permitting and Easements	35%			$13,442,625	
Land Acquisition	0	SF	$75	$0	
Easements		SF	$23		
Total Project				**$51,850,125**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	36.8	MGY	$ 6.44	$ 236,992	$6.44/1,000 Gallons
Pumping Costs	19,500	kw-hrs	$ 0.08	$ 1,560.0	
Annual Volume	**36.8**	MGY			
Total Dynamic Head	**90**	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tunnel Volume x 4)	720	TG	$ 4.00	$ 2,880	
Labor Costs	576	Hrs	$ 50.00	$ 28,800	
Monthly Inspections (12@16hrs/each)	**192**	Hrs			
Quarterly Cleaning (4@96hrs/each)	**384**	Hrs			
Maintenance Costs					
Percentage of Construction	1.00%			$ 384,075	DC LTCP Assumption
Annual O&M				$ 654,307	
Net Present Worth				**$ 9,734,436**	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	36.8	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	19796	lbs/yr	$80	$ 1,583,666	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	884	lbs/yr	$6,000	$ 5,303,439	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	184	lbs/yr	$25,000	$ 4,603,680	
Net Present Worth				$ 5,303,439	

COA LTCPU
T7-8-ft

Alternative T7-8-ft Diameter Tunnel
Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By:

Item	QTY	Units	Unit Cost	Total	Comments
002 Tunnel					
8' Tunnel from Dangerfield Road to NMF	**4,400**	LF	$3,600	$15,840,000	Guidance From Jacobs
Shaft 1 (15' diameter)	**80**	VLF	$26,000	$2,080,000	Guidance From Jacobs
Shaft 2 (20' diameter)	**75**	VLF	$32,000	$2,400,000	Guidance From Jacobs
Shaft 3 (20' diameter)	**70**	VLF	$26,000	$1,820,000	Guidance From Jacobs
8' Tunnel from CI to NMF	**0**	LF	$3,600	$0	Guidance From Jacobs
Diversion Structures	**1**	EA	$600,000	$600,000	Local Project Data (K&W)
48" Sewer	**0**	LF	$1,200	$0	DC LTCP
				$22,740,000	
Facilities					
Odor Control	**1**	EA	$500,000	$500,000	Allowance
Dewatering PS	1.7	MGD	Equation	$880,000	Cost Curve
Climber Screens	**1**	LS	$2,000,000	$2,000,000	Allowace
				$3,380,000	
Subtotal				*$26,120,000*	
Construction Contingency	35%			$9,142,000	
Construction Subtotal				$35,262,000	
Planning, Design, Construction Management, Administration, Permitting and Easements	35%			$12,341,700	
Land Acquisition	0	SF	$75	$0	
Easements		SF	$23		
Total Project				**$47,603,700**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	36.8	MGY	$ 6.44	$ 236,992	$6.44/1,000 Gallons
Pumping Costs	19,500	kw-hrs	$ 0.08	$ 1,560.0	
Annual Volume	**36.8**	MGY			
Total Dynamic Head	**90**	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tunnel Volume x 4)	680	TG	$ 4.00	$ 2,720	
Labor Costs	576	Hrs	$ 50.00	$ 28,800	
Monthly Inspections (12@16hrs/each)	**192**	Hrs			
Quarterly Cleaning (4@96hrs/each)	**384**	Hrs			
Maintenance Costs					
Percentage of Construction	1.00%			$ 352,620	DC LTCP Assumption
Annual O&M				$ 622,692	
Net Present Worth				**$ 9,264,085**	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	36.8	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	19796	lbs/yr	$80	$ 1,583,666	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	884	lbs/yr	$6,000	$ 5,303,439	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	184	lbs/yr	$25,000	$ 4,603,680	
Net Present Worth				$ 5,303,439	

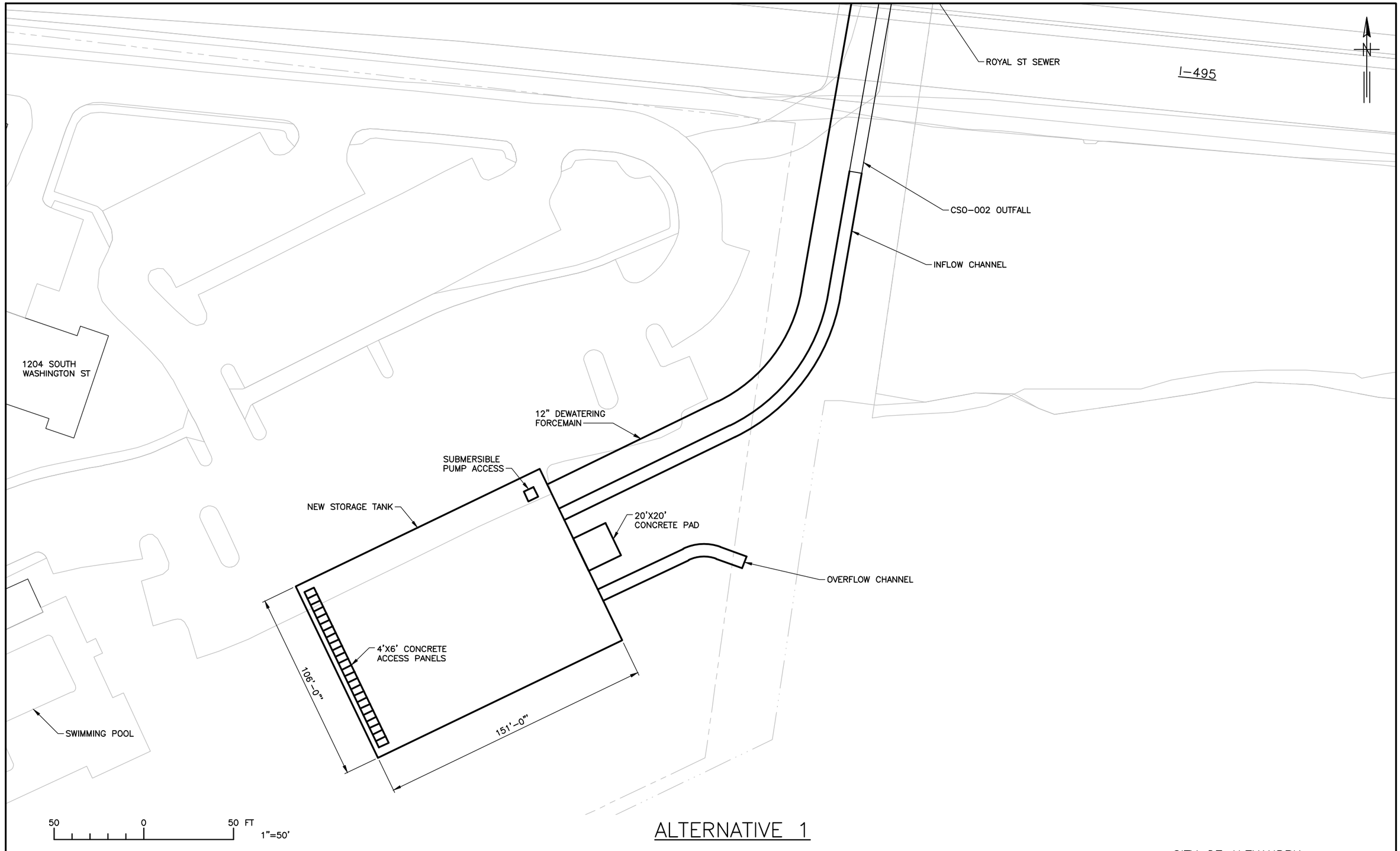
Attachment D

CSO-002 Tunnel Ratings, Weightings, and Weighted Scores

Weighting		40%	5%	5%	10%	10%	15%	10%	5%	100%	
Alignment	Estimated Cost	Cost Rating	Utilities	Right-of-Way	Property Acquisition	Residential and Archaeological Impacts	Geotechnical Conditions	Construction Risk	Permitting	Weighted Score	Rank
Alignment 1	$58.5	4	5	5	5	2	4	2	4	3.8	1
Alignment 2	$56.3	4	1	1	3	3	4	2	4	3.3	3
Alignment 3	$57.6	4	5	2	3	2	4	4	4	3.65	2

Attachment E

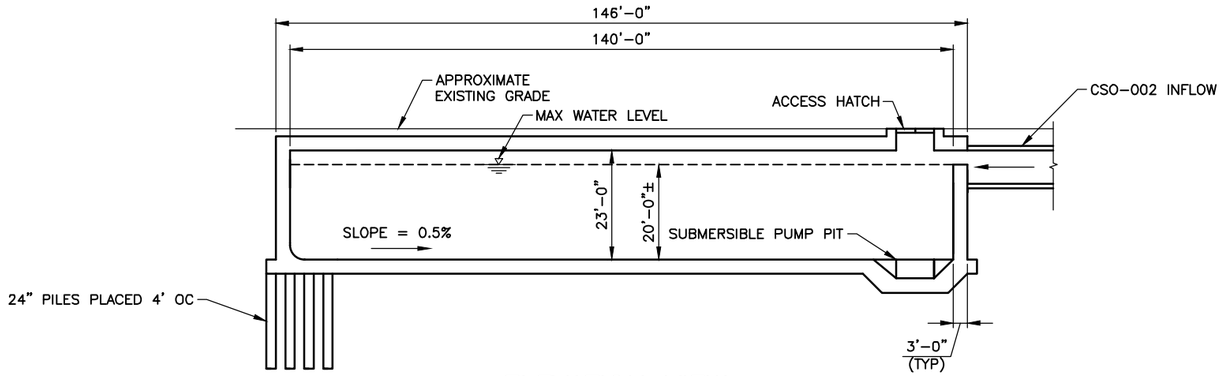
CSO-002 Tanks Plan and Profile



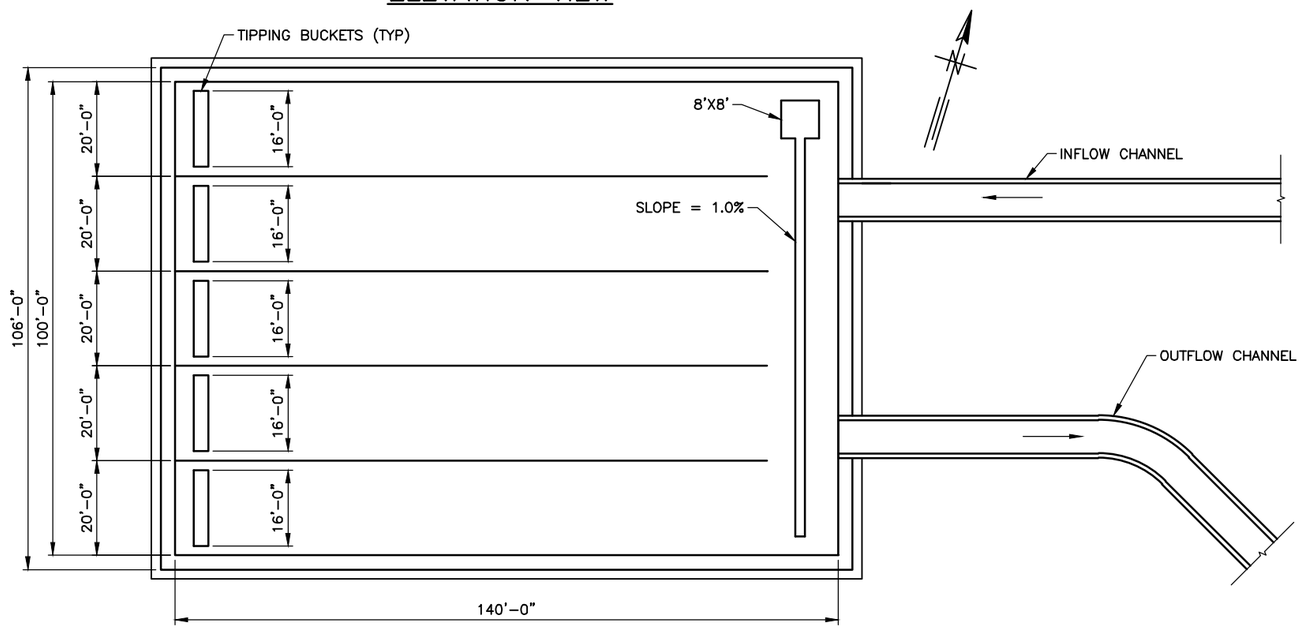
ALTERNATIVE 1

GREELEY AND HANSEN

CITY OF ALEXANDRIA
CSO-002 STORAGE ALTERNATIVES
NOVEMBER 2015



ELEVATION VIEW



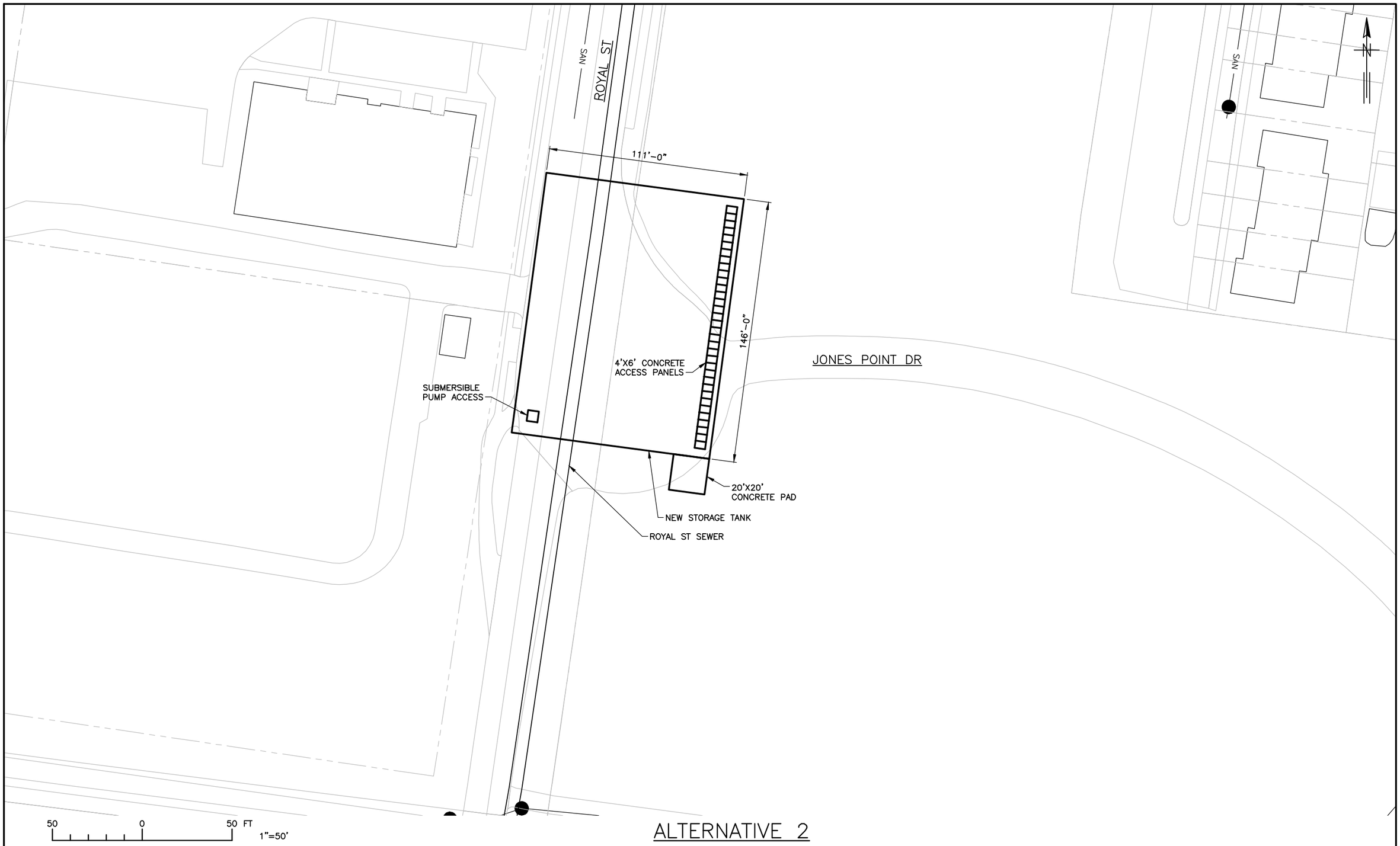
PLAN VIEW

32 0 32 FT
1/32"=1'–0"

ALTERNATIVE 1

GREELEY AND HANSEN

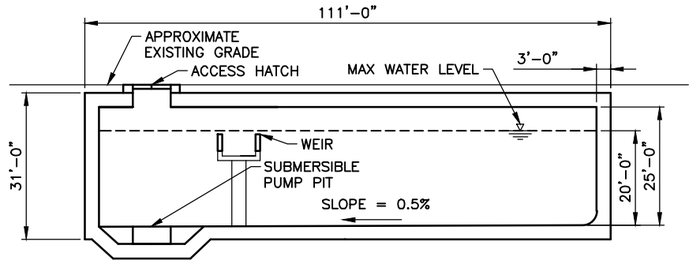
CITY OF ALEXANDRIA
CSO–002 STORAGE ALTERNATIVES
NOVEMBER 2015



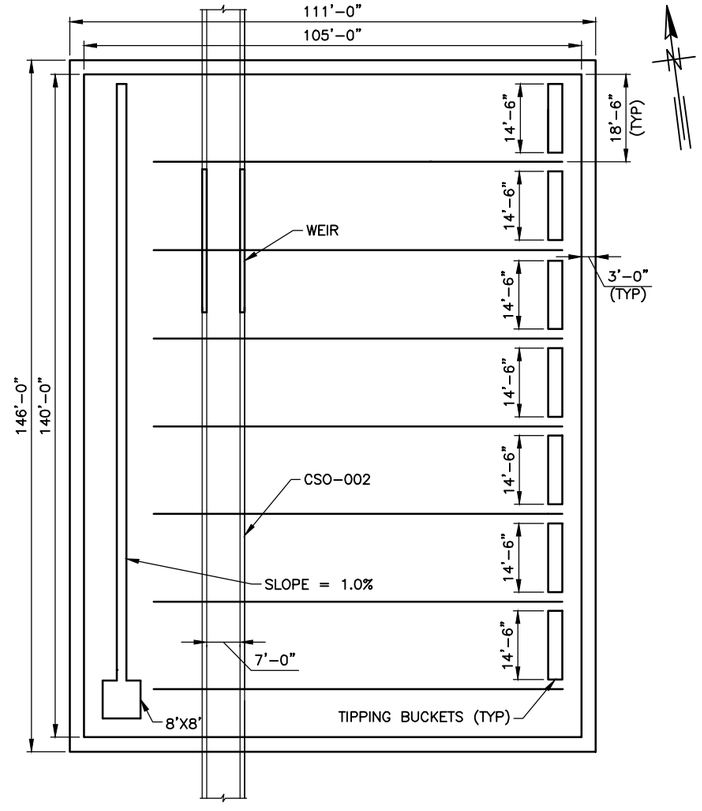
ALTERNATIVE 2

GREELEY AND HANSEN

CITY OF ALEXANDRIA
CSO-002 STORAGE ALTERNATIVES
NOVEMBER 2015



ELEVATION VIEW



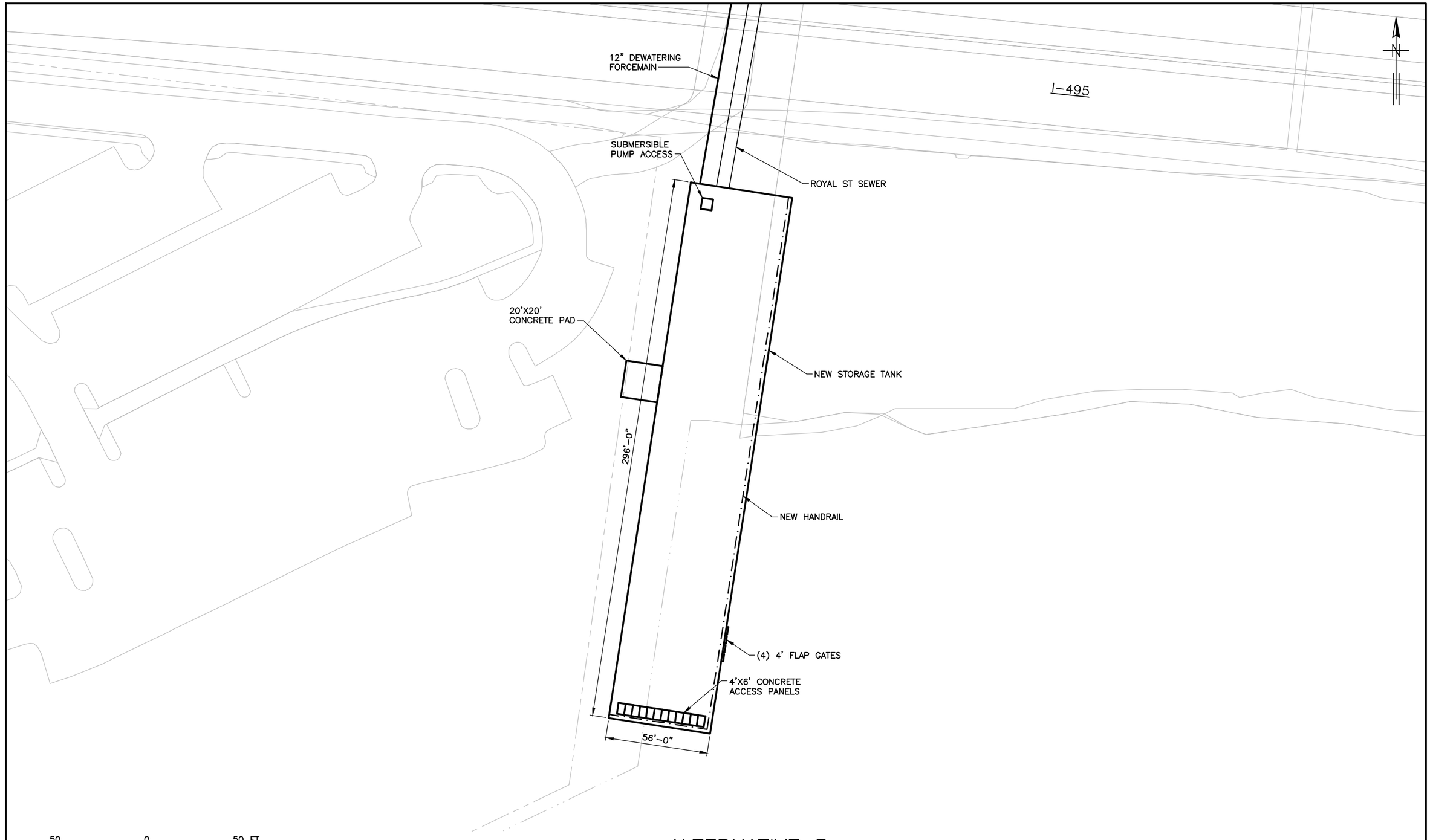
PLAN VIEW

32 0 32 FT
1/32"=1'–0"

ALTERNATIVE 2

GREELEY AND HANSEN

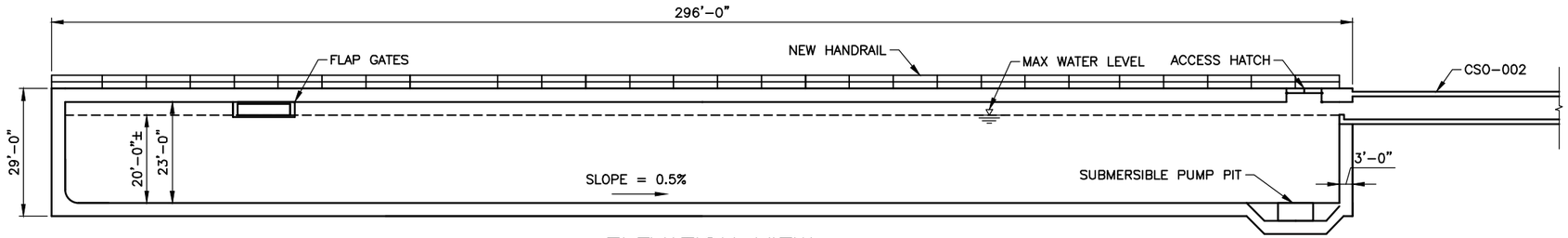
CITY OF ALEXANDRIA
CSO–002 STORAGE ALTERNATIVES
NOVEMBER 2015



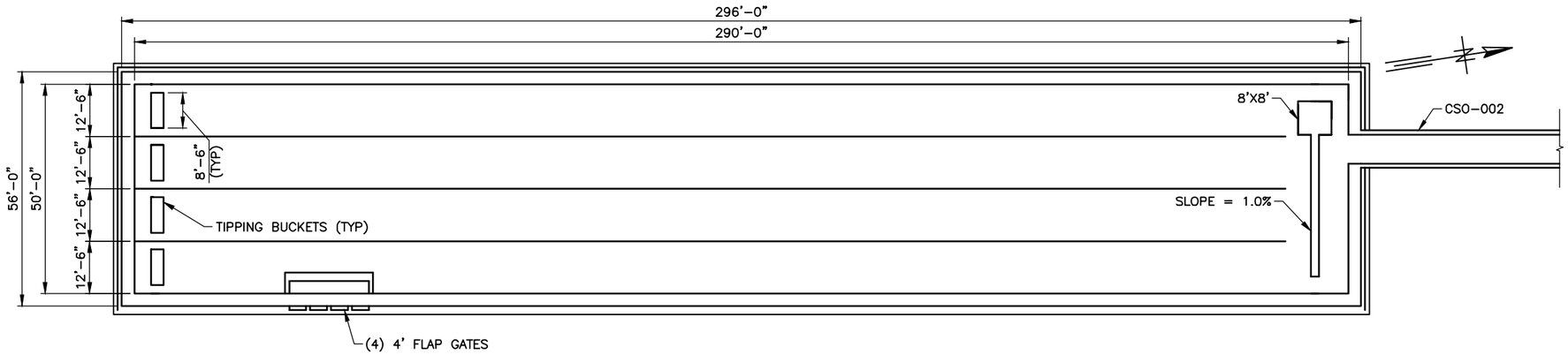
ALTERNATIVE 3

GREELEY AND HANSEN

CITY OF ALEXANDRIA
CSO-002 STORAGE ALTERNATIVES
NOVEMBER 2015



ELEVATION VIEW



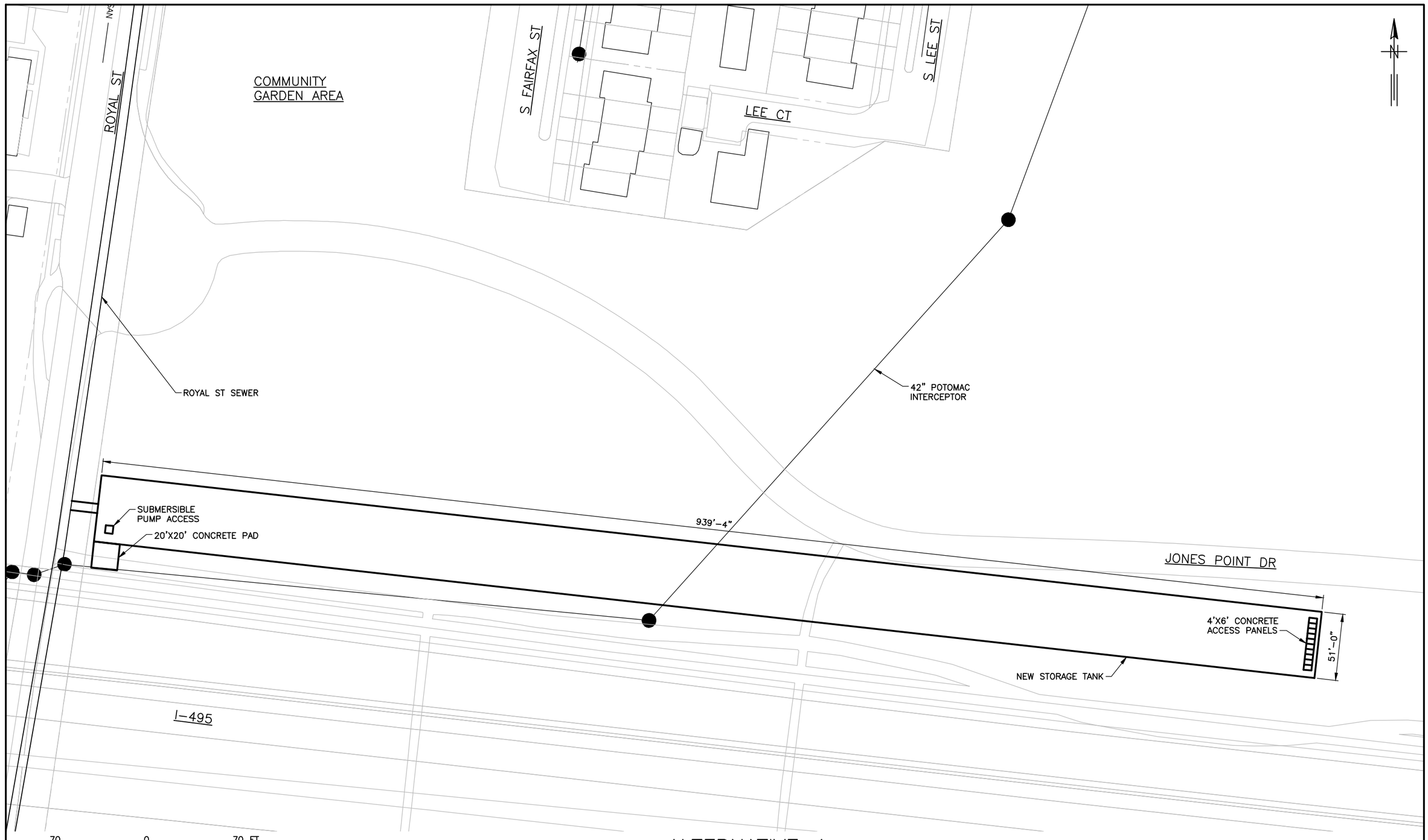
PLAN VIEW

32 0 32 FT
1/32"=1'–0"

ALTERNATIVE 3

GREELEY AND HANSEN

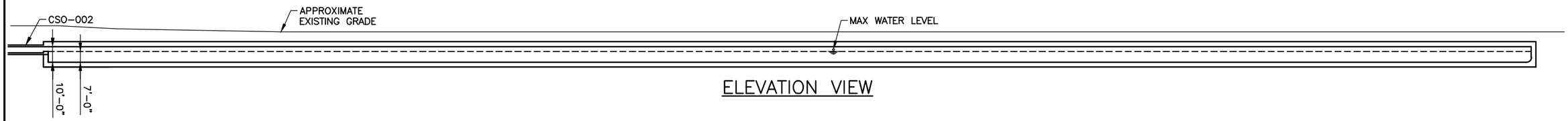
CITY OF ALEXANDRIA
CSO–002 STORAGE ALTERNATIVES
NOVEMBER 2015



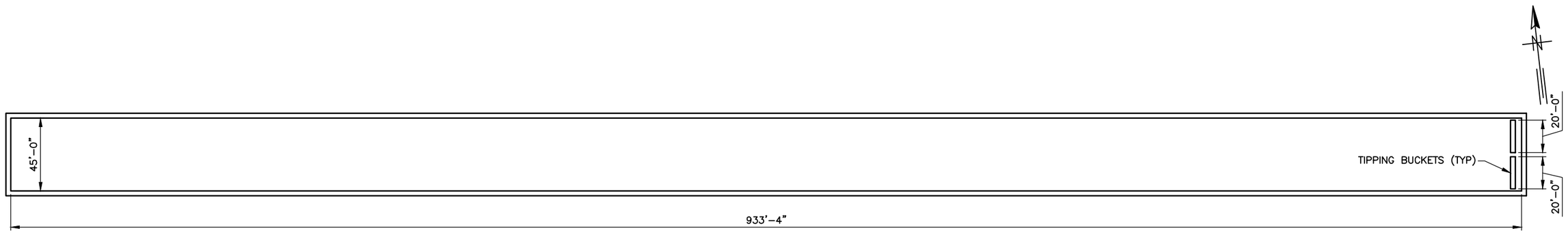
ALTERNATIVE 4

GREELEY AND HANSEN

CITY OF ALEXANDRIA
CSO-002 STORAGE ALTERNATIVES
NOVEMBER 2015



ELEVATION VIEW



PLAN VIEW

64 0 64 FT
1/64"=1'-0"

ALTERNATIVE 4

GREELEY AND HANSEN

CITY OF ALEXANDRIA
CSO-002 STORAGE ALTERNATIVES
NOVEMBER 2015

Attachment F

CSO-002 Tanks Cost Estimates

COA LTCPU
Alternative 1 - 2.0 MG

Date: 16-Nov-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
002 Tank - Alternative 1					
Below Grade Storage Tank	2.0	MG	Equation	$11,970,000	Cost Curve
Pump Station	2.0	MGD	Equation	$800,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$12,770,000	
Facilities					
Odor Control	1	EA	$300,000	$300,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$750,000	$750,000	Allowance
				$1,650,000	
Subtotal				*$14,420,000*	
Construction Contingency	35%			$5,050,000	
Construction Subtotal				*$19,470,000*	
Planning, Design, CM, Administration,	35%			$6,810,000	
Land Acquisition	48,000	SF	$75	$3,600,000	(L+100) x (W+100)
Total Project				**$29,880,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	36.8	MGY	$ 6.44	$ 236,992	$6.44/1,000 Gallons
Pumping Costs	6,500	kw-hrs	$ 0.08	$ 520	
Annual Volume	36.8	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	800	TG	$ 4.00	$ 3,200	
Labor Costs	574.5	Hrs	$ 50.00	$ 28,725	
Daily Check (365@0.5hrs/each)	182.5	Hrs			
Weekly Inspections (52@2hrs/each)	104	Hrs			
Monthly Inspections (12@8hrs/each)	96	Hrs			
Quarterly Cleaning (4@48hrs/each)	192	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 292,050	DC LTCP Assumption
Annual O&M				$ 561,487	
Net Present Worth				$ 8,350,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	36.8	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	19796	lbs/yr	$80	$	1,583,666	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	884	lbs/yr	$6,000	$	5,303,439	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	184	lbs/yr	$25,000	$	4,603,680	
Net Present Worth (Maximum Value)				$	5,303,439	

COA LTCPU
Alternative 2 - 2.0 MG

Date: 16-Nov-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
002 Tank - Alternative 2					
Below Grade Storage Tank	2.0	MG	Equation	$11,970,000	Cost Curve
Pump Station	2.0	MGD	Equation	$800,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$12,770,000	
Facilities					
Odor Control	1	EA	$300,000	$300,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$750,000	$750,000	Allowance
				$1,650,000	
Subtotal				*$14,420,000*	
Construction Contingency	35%			$5,050,000	
Construction Subtotal				*$19,470,000*	
Planning, Design, CM, Administration,	35%			$6,810,000	
Land Acquisition	0	SF	$75	$0	City right-of-way
Total Project				**$26,280,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	37.0	MGY	$ 6.44	$ 238,280	$6.44/1,000 Gallons
Pumping Costs	6,535	kw-hrs	$ 0.08	$ 523	
Annual Volume	37.0	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	800	TG	$ 4.00	$ 3,200	
Labor Costs	574.5	Hrs	$ 50.00	$ 28,725	
Daily Check (365@0.5hrs/each)	182.5	Hrs			
Weekly Inspections (52@2hrs/each)	104	Hrs			
Monthly Inspections (12@8hrs/each)	96	Hrs			
Quarterly Cleaning (4@48hrs/each)	192	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 292,050	DC LTCP Assumption
Annual O&M				$ 562,778	
Net Present Worth				$ 8,370,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	37.0	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	19903	lbs/yr	$80	$	1,592,273	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	889	lbs/yr	$6,000	$	5,332,262	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	185	lbs/yr	$25,000	$	4,628,700	
Net Present Worth (Maximum Value)				$	5,332,262	

COA LTCPU
Alternative 3 - 2.0 MG

Date: 16-Nov-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
002 Tank - Alternative 3					
Below Grade Storage Tank	2.0	MG	Equation	$11,970,000	Cost Curve
Pump Station	2.0	MGD	Equation	$800,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$12,770,000	
Facilities					
Odor Control	1	EA	$300,000	$300,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$750,000	$750,000	Allowance
				$1,650,000	
Embayment					
Hunting Creek Embayment Restoration	1	EA	$500,000	$500,000	Allowance
Temporaty CSO Extension	500	LF	$2,000	$1,000,000	
Port-A-Dam Installation/Removal	1	EA	$250,000	$250,000	LW RWI Project
Port-A-Dam Rental	12	mo	$50,000	$600,000	LW RWI Project
				$2,350,000	
Subtotal				*$16,770,000*	
Construction Contingency	35%			$5,870,000	
Construction Subtotal				*$22,640,000*	
Planning, Design, CM, Admin, Permitting	35%			$7,920,000	
Construction Easement	21,780	SF	$25	$543,956	0.5 acres for laydown
Total Project				**$31,100,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	37.0	MGY	$ 6.44	$ 238,280	$6.44/1,000 Gallons
Pumping Costs	6,535	kw-hrs	$ 0.08	$ 523	
Annual Volume	37.0	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	800	TG	$ 4.00	$ 3,200	
Labor Costs	574.5	Hrs	$ 50.00	$ 28,725	
Daily Check (365@0.5hrs/each)	182.5	Hrs			
Weekly Inspections (52@2hrs/each)	104	Hrs			
Monthly Inspections (12@8hrs/each)	96	Hrs			
Quarterly Cleaning (4@48hrs/each)	192	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 339,600	DC LTCP Assumption
Annual O&M				$ 610,328	
Net Present Worth				$ 9,080,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	37.0	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	19903	lbs/yr	$80	$	1,592,273	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	889	lbs/yr	$6,000	$	5,332,262	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	185	lbs/yr	$25,000	$	4,628,700	
Net Present Worth (Maximum Value)				$	5,332,262	

COA LTCPU
Alternative 4 - 2.0 MG

Date: 15-Oct-15
Prepared By: D. Dvorak
Checked By: J. McGettigan

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
002 Tank - Alternative 4					
Below Grade 10' Boxed Culvert	1,000	LF	Equation	$4,380,000	Cost Curve
Pump Station	2.0	MGD	Equation	$800,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$5,180,000	
Facilities					
Odor Control	1	EA	$300,000	$300,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$750,000	$750,000	Allowance
				$1,650,000	
Subtotal				*$6,830,000*	
Construction Contingency	35%			$2,390,000	
Construction Subtotal				*$9,220,000*	
Planning, Design, CM, Administration,	35%			$3,230,000	
Land Acquisition	63,000	SF	$75	$4,725,000	Jones Point Park
Total Project				**$17,180,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	37.0	MGY	$ 6.44	$ 238,280	$6.44/1,000 Gallons
Pumping Costs	6,535	kw-hrs	$ 0.08	$ 523	
Annual Volume	37.0	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	800	TG	$ 4.00	$ 3,200	
Labor Costs	574.5	Hrs	$ 50.00	$ 28,725	
Daily Check (365@0.5hrs/each)	182.5	Hrs			
Weekly Inspections (52@2hrs/each)	104	Hrs			
Monthly Inspections (12@8hrs/each)	96	Hrs			
Quarterly Cleaning (4@48hrs/each)	192	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 138,300	DC LTCP Assumption
Annual O&M				$ 409,028	
Net Present Worth				$ 6,090,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	37.0	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	19903	lbs/yr	$80	$	1,592,273	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	889	lbs/yr	$6,000	$	5,332,262	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	185	lbs/yr	$25,000	$	4,628,700	
Net Present Worth (Maximum Value)				$	5,332,262	

Attachment G

CSO-002 Tanks Ratings, Weightings, and Weighted Scores

Weighting		40%	5%	5%	10%	10%	15%	10%	5%	100%	
Alternative	Estimated Cost	Cost Rating	Utilities	Right-of-Way	Property Acquisition	Residential and Archaeological Impacts	Geotechnical Conditions	Construction Risk	Permitting	Weighted Score	Rank
Tank 1	$32.9	5	5	2	3	3	3	5	4	4.1	3
Tank 2	$29.3	5	5	5	5	2	3	3	5	4.2	2
Tank 3	$34.9	5	5	4	5	5	3	2	3	4.25	1
Tank 4	$17.9	5	5	2	2	3	3	4	3	3.85	4

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Alexandria, VA 22312
571.581.3000
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GREELEY AND HANSEN