# Lewes WWTF Long Range Planning Study

## Conceptual Evaluation Report

Lewes Board of Public Works and Sussex County

November 28, 2022

The Power of Commitment

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**The Power of Commitment**

# Executive Summary

The Lewes Board of Public Works (BPW) owns and operates the Lewes BPW Wastewater Treatment Facility (WWTF). Due to the low elevation of the existing facility, the BPW would like to evaluate options to mitigate impacts of sea level rise and flood/storm events as well as evaluate options to relocate the facility.

Sussex County owns and operates wastewater infrastructure in the areas surrounding Lewes and has an existing agreement in place with the BPW to transfer wastewater flows from the County's collection network to the Lewes WWTF when demand is lower in Lewes during the winter months. Sussex County has committed a significant portion of its ARPA funding and is interested in expanding the current cooperation with the Lewes BPW, as set forth in Agreement for Wastewater Services, via diversification of the County's wastewater treatment and disposal options.

This report sets out the concept development for upgrade options that will provide increased resilience for wastewater treatment within the BPW's service area, including options for further collaboration with Sussex County.

GHD evaluated a total of six (6) options to increase the resilience of BPW's wastewater treatment to storm events and sea level rise. The following options were evaluated:

*Table 1 Summary of Options Evaluated*

| Option Reference | Option Title | Notes |
|---|---|---|
| **1** | Existing WWTF Hardening | Determine existing site improvements necessary to mitigate treatment impacts from sea level rise, subsidence, storm events including flooding, power loss etc., including:<br>– Perimeter Dike around facility with stormwater/dewatering pumping station.<br>– Raising and or flood proofing the biosolids unit processes.<br>– On-site fuel storage for extended storm events/emergencies. |
| **2 – a** | Relocation & Spray Irrigation and/or RIBS | Determine if a suitable site can be found to construct a new WWTF using Rapid Infiltration Beds (RIBS) or spray irrigation for effluent disposal and decommission the existing WWTF. |
| **2 – b** | Relocation & Utilization of Existing WWTP Outfall | Construct a new WWTF but maintain the existing permitted outfall, new force main, and decommission the WWTF. |
| 2 – c | Relocation & New Ocean Outfall | Construct a new WWTF with new ocean outfall and decommission the existing WWTF. |
| 3 – a | Partnership with Sussex County & Utilization of Existing WWTP Outfall | Network upgrades to transfer wastewater from the Lewes collection network to a new WWTP in Sussex County, and transfer treated flows back to the existing permitted, outfall in Lewes. |
| 3 – b | Partnership with Sussex County & Constructed Wetland | Given a suitable site, provide network upgrades required to transfer wastewater from the Lewes collection network to a new WWTF in Sussex County and decommission the existing WWTF. |

A multi-criteria analysis (MCA) was performed to evaluate the concept options based on a series of non-cost criteria, grouped into three categories: Permitting & Schedule, Community & Environmental Impacts and Operation & Maintenance.

The MCA scoring is summarized in Figure 1.

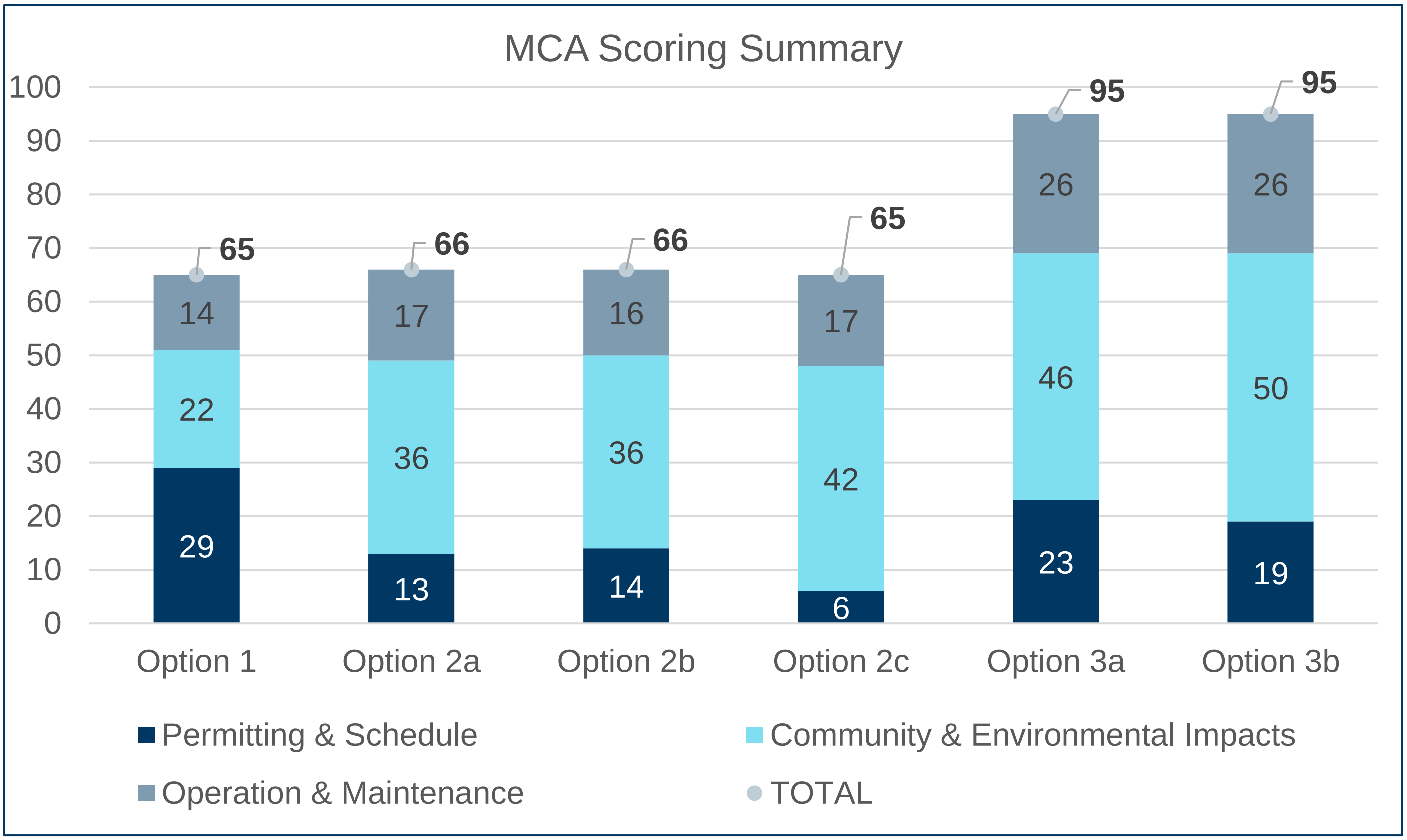


*Figure 1* *MCA Scoring Summary*

Note: a higher MCA score indicates that an Option is more favorable.

The Project Lifecycle Costs incurred by Lewes BPW for the long range planning study concepts are summarized in Table 2.

*Table 2* *Project Lifecycle Cost Estimates*

| | Option 1 | Option 2a | Option 2b | Option 2c | Option 3a | Option 3b |
|---|---|---|---|---|---|---|
| **Preliminary Capital Cost Estimate** | $23,000,000 | $156,000,000 | $114,000,000 | $186,500,000 | $20,000,000 | $20,000,000 |
| **2050 NPV O&M Cost Estimate** | $75,500,000 | $40,000,000 | $40,000,000 | $40,500,000 | $36,000,000 | $36,000,000 |
| **Project Lifecycle Cost** | **$98,500,000** | **$196,000,000** | **$154,000,000** | **$227,000,000** | **$56,000,000** | **$56,000,000** |
| **MCA Score** | 65 | 66 | 66 | 65 | 95 | 95 |
| **Cost per MCA Scoring Point** | $1,520,000.00 | $2,970,000.00 | $2,330,000.00 | $3,490,000.00 | $590,000.00 | $590,000.00 |

All costs are presented in 2022 US Dollars.

Option 3a and Option 3b have the lowest estimated Project Lifecycle Costs for Lewes BPW, as well as the joint-highest MCA scores. Therefore, these options also have the lowest cost per MCA scoring point, which indicates that they provide the best value for Lewes BPW.

Option 3a scores higher for the Permitting & Schedule category, primary due to the relative uncertainty associated with acquiring permitting approvals for the constructed wetland discharge arrangement under Option 3b. Option 3b scores higher for the Community & Environmental Impacts category as there is no requirement to pump treated effluent back to the existing outfall location in Lewes.

Option 2c has the highest estimated Project Lifecyle Costs for Lewes BPW, primarily due to the requirement to purchase land and the complexities associated with a new ocean outfall.

The Option 1 and Option 2 concepts have very similar overall MCA scores; Option 1 scores lower for Community & Environmental Impacts due to the residual risk of flood damage at the coastal location, leading to failure at the treatment plant.  The Option 2 concepts score lower for Permitting & Schedule due to the requirement to acquire land and install significant lengths of transfer force mains in public roads. Option 2c scores particularly low in this category due to the permitting complexities associated with constructing a new ocean outfall. However, Option 2c scores relatively well in the Community & Environmental Impacts category as treated effluent would no longer be discharged to the Canal or surrounding bays.

The next steps to advance the Lewes WWTF Long Range Planning Study and address the underlying issues are as follows:

1. BPW will include the Long Range Planning Study on the agenda for an upcoming Board meeting and at that time the BPW Board will discuss the findings of this report.
2. Sussex County will present the findings of this report to the County Council.
3. BPW will arrange a Special Meeting to present the findings to the public, engage with the community stakeholders and provide an opportunity for stakeholders to comment on the findings before a preferred option is identified by the BPW Board.
4. BPW will include the Long Range Planning Study on the agenda for a further Board meeting and at that time the Board will make its final decision on a preferred option for further design development.
5. The preferred option will advance for further development, including (but not limited to): field investigations, modeling, conceptual design and permitting design stages.

The following specific tasks should be undertaken as part of future design development, as a means of validating the preferred option:

– Hydraulic Modeling and Analysis for the Lewes and Rehoboth Canal.
– Greenhouse Gas Emissions Analysis of the selected option.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1 and the assumptions and qualifications contained throughout the Report.

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# 1. Introduction

## 1.1 Purpose of this report

The Lewes Board of Public Works (BPW) owns and operates the Lewes BPW Wastewater Treatment Facility (WWTF), which is also known as the Howard Seymour Water Reclamation Facility and is located in Lewes, DE. The WWTF was originally constructed in 1950 and major refurbishments were completed in 2008, which included the installation of a membrane filtration process in the secondary treatment train. Due to the low elevation of the existing facility, the BPW would like to evaluate options to mitigate impacts of sea level rise and flood/storm events as well as evaluate options to relocate the facility.

Sussex County owns and operates wastewater infrastructure in the areas surrounding Lewes and has an existing agreement in place with the BPW to transfer a proportion of the wastewater flows from the County's collection network to the Lewes WWTF when demand is lower in Lewes during the winter months. Flow that is not transferred to Lewes is treated at one of the County's four regional wastewater facilities: South Coastal, Inland Bays, Wolfe Neck, and Piney Neck.

The County is experiencing growth and is open to further collaboration with BPW in order to increase their wastewater treatment and disposal capacity.

This report sets out the concept development for upgrade options that will provide increased resilience for wastewater treatment within the BPW's service area, including options for further collaboration with Sussex County.

## 1.2 Scope

The following tasks were completed for the WWTF Long Range Planning Study:

GHD evaluated a total of six (6) options to increase the resilience of BPW's wastewater treatment facilities to storm events and sea level rise. The following options were evaluated:

*Table 3 Summary of Options Evaluated*

| Option Reference | Option Title | Notes |
|---|---|---|
| 1 | Existing WWTF Hardening | Determine existing site improvements necessary to mitigate treatment impacts from sea level rise, subsidence, storm events including flooding, power loss etc., including:<br>– Perimeter Dike around facility with stormwater/dewatering pumping station.<br>– Raising and or flood proofing the biosolids unit processes.<br>– On-site fuel storage for extended storm events/emergencies. |
| 2 – a | Relocation & Spray Irrigation and/or RIBS | Determine if a suitable site can be found to construct a new WWTF using Rapid Infiltration Beds (RIBS) or spray irrigation for effluent disposal and decommission the existing WWTF. |
| 2 – b | Relocation & Utilization of Existing WWTP Outfall | Construct a new WWTF but maintain the existing permitted outfall, new force main, and decommission the WWTF. |
| 2 – c | Relocation & New Ocean Outfall | Construct a new WWTF with new ocean outfall and decommission the existing WWTF. |
| 3 – a | Partnership with Sussex County & Utilization of | Network upgrades to transfer wastewater from the Lewes collection network to a new WWTP in Sussex County currently zoned for wastewater treatment, and transfer treated flows back to the existing permitted, outfall in Lewes. |

| Option Reference | Option Title | Notes |
| --- | --- | --- |
| | Existing WWTP Outfall | |
| 3 – b | Partnership with Sussex County & Constructed Wetland | Given a suitable site, provide network upgrades required to transfer wastewater from the Lewes collection network to a new WWTF in Sussex County currently zoned for wastewater treatment and decommission the existing WWTF. |

The aim is to provide a like-for-like comparison of the total financial implications of each option to BPW. The cost estimates will only account for costs incurred by BPW directly, i.e., will exclude any costs incurred by Sussex County or other stakeholders.

For each of the options outlined above, GHD performed the following analyses:

1. Preliminary hydraulic analysis to size major equipment:
   a. Developed facility treatment capacity and effluent performance goals.
   b. Performed high level calculations, based on agreed average and peak flow rates, sufficient to determine the size of collection and/or transfer pipelines and pumping requirements.
2. Project Lifecycle Cost analysis:
   a. Assuming an overall project lifecycle of 25 years, developed Preliminary Capital Cost Estimates and 25-year Net Present Value (NPV) Operation & Maintenance Cost Estimates for each option.
3. Multi-Criterial Analysis (MCA) was performed to rate and assign overall scores to each option based on the non-cost attributes:
   a. The final MCA criteria included:
      i. Permitting Complexity
      ii. Delivery Schedule
      iii. Property & Easement Acquisition
      iv. Interagency & Regulatory Coordination
      v. Stakeholder Impacts – Construction Stage
      vi. Stakeholder Impacts – Long Term
      vii. Water Quality Impacts for Inland Bays
      viii. Overall Environmental Risk
      ix. Energy & Chemical Use
      x. Land Use within City of Lewes
      xi. Impact to WWTF Operations During Construction
      xii. Operational Complexity
      xiii. Future Flexibility
4. The final MCA scoring and Project Lifecycle Costs were used to assess the Best Value (BV) option for BPW, and will form the basis of GHD’s recommendations.

## 1.3 Limitations

*This report: has been prepared by GHD for Lewes Board of Public Works and Sussex County and may only be used and relied on by Lewes Board of Public Works and Sussex County for the purpose agreed between GHD and Lewes Board of Public Works and Sussex County as set out in section 1.1 of this report.*

*GHD otherwise disclaims responsibility to any person other than Lewes Board of Public Works and Sussex County arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*

*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.*

**Accessibility of documents**

*If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.*

## 1.4 Information

The following background information has been utilized by GHD as part of the concept development work:

- Design Drawings
  - Lewes Board of Public Works (1960); Proposed Improvements to Sanitary Sewerage System
  - GMB, LLC (2021); Howard Seymour Water Reclamation Plant Headworks Rehabilitation
- As-built Drawings
  - GMB, LLC (2007); Pump Station No. 4 Force Main Upgrade
  - GMB, LLC (2009); WWTF Upgrade and Expansion
  - GMB, LLC (2019); Lewes Board of Public Works and Sussex County Flow Diversion Project, Phase 1
- Elevation Certificates
  - Atlantic Surveying & Mapping, LLC (2021); *City of Lewes Wastewater Treatment Plant*
- Reports
  - Inframark, LLC (2021); Monthly Operations Report: January 2021 to September 2021
  - SUEZ Water Technologies & Solutions (2020); Lewes, DE Outage Report
  - GMB, LLC (2021); Lewes BPW Asset Management Report
  - Dolphin Electric, LLC (2021); Lewes BPW Electrical Survey
  - Mumford-Bjorkman Associates, Inc. (2020); Lewes WWTF EQ Tank Condition Assessment
  - National Oceanic and Atmosphere Administration (2022); Global and Regional Sea Level Rise Scenarios for the United States
  - Lewes Board of Public Works (2020); Root Cause Report for WWTF Failure Event
- Operational Data
  - Daily Average Flow Rates at LS-4 and LS-8; 2019, 2020 and 2021
- Permits
  - NPDES Permit for Lewes WWTF; Expiration Date October 31, 2023
- Geographic Information System (GIS) Databases
  - Lewes BPW Sewer Master Plans
  - Lewes BPW Water Master Plans
  - Lewes BPW Electric Master Plans
  - City of Lewes Zoning Map (2020)
  - Sussex County GIS Map Viewer
  - First Map, Delaware

- Delaware Geological Survey
- US Geological Survey
- FEMA Floodplain Mapping

Note: no survey, utility locating, geotechnical investigations, or other field investigations were undertaken as part of the project scope.

# 2. Existing Lewes BPW WWTF

### 2.1.1 Process Overview

A schematic summary of the existing Lewes WWTF collection network and critical lift stations (LS) is provided in Figure 2.

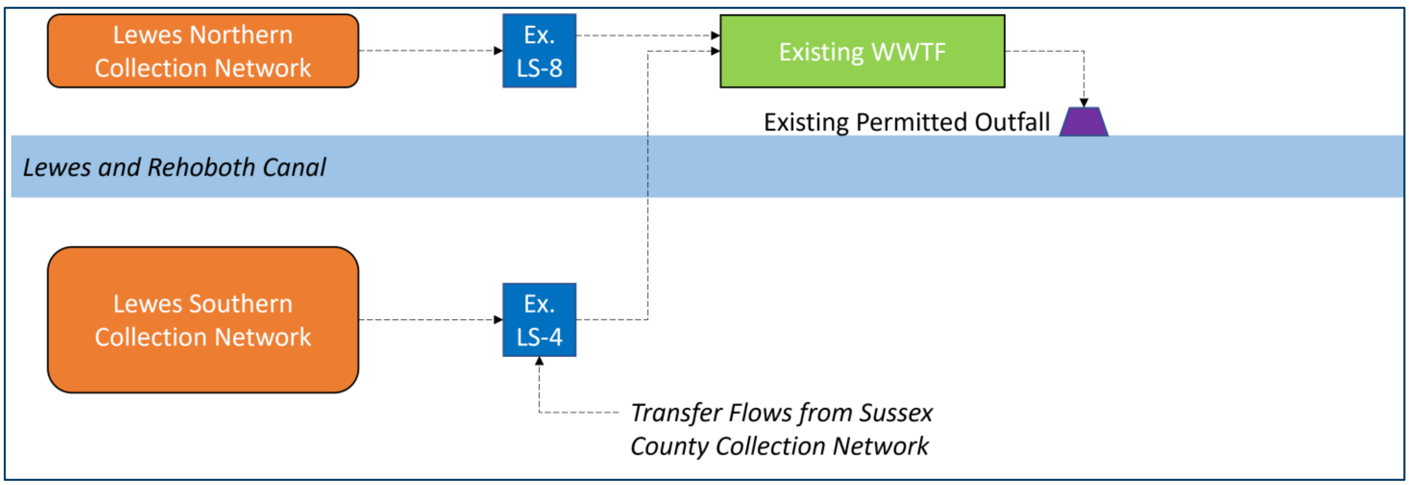



*Figure 2 Existing WWTF Flow Schematic*

The northern collection network includes all connections north of the Lewes and Rehoboth Canal and includes the beachside residential and commercial properties that see significantly higher demand in the summer months. All flows from the northern collection network are conveyed to the WWTF via LS-8.

Flows from the southern collection network are conveyed to the WWTF via LS-4, which also receives transfer flows from the Sussex County wastewater collection network.

The Lewes BPW WWTF was originally constructed in 1950 and major refurbishments were completed in 2008, which included the installation of a membrane bioreactor (MBR) process in the secondary treatment phase.

The key components of the wastewater treatment process are summarized in the annotated schematic diagram in Figure 3.

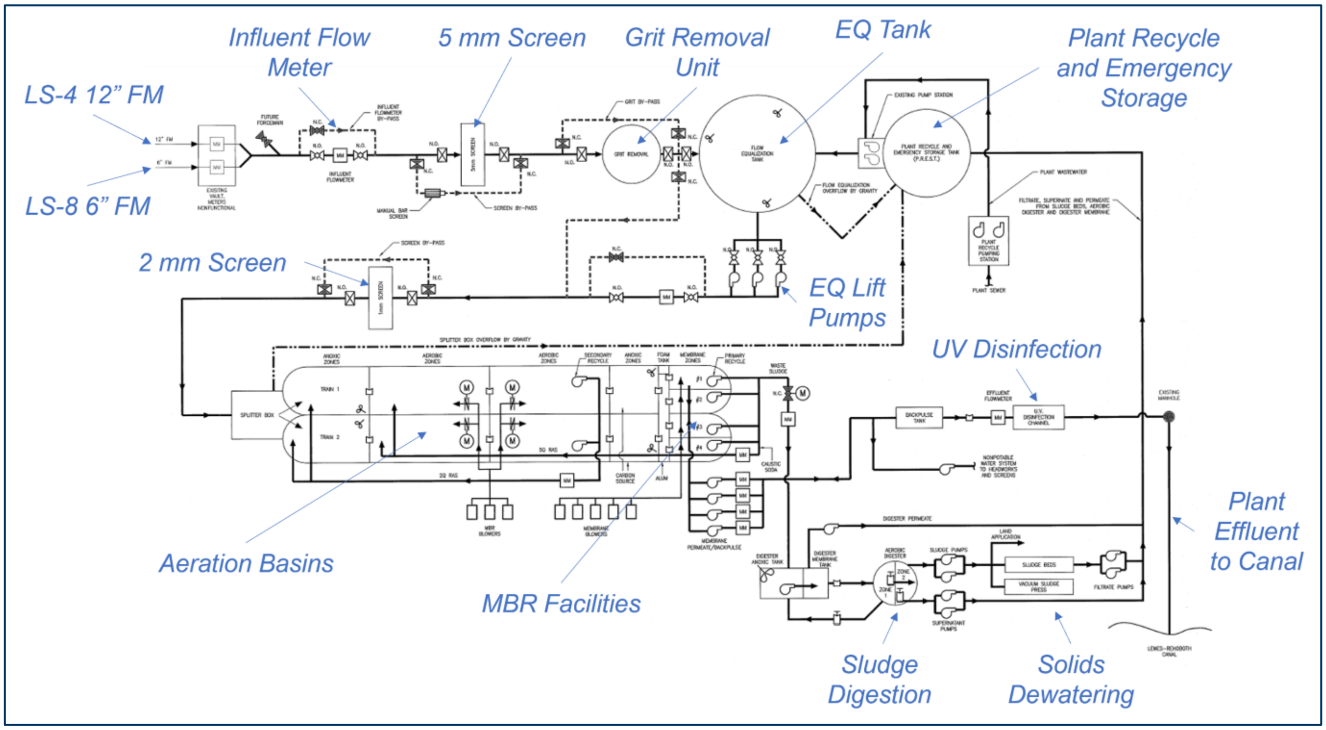



*Figure 3 Existing WWTF Flow Schematic*

The permitted plant outfall discharges to the Lewes and Rehoboth Canal approximately 1,000 feet from the WWTF. According to the current National Pollutant Discharge Elimination System (NPDES) permit (effective November 1, 2018), the facility is rated for 1.5 mgd.

Stabilized, dewatered sludge is disposed of at landfill.

### 2.1.2 Catchment Flows and Loads

The design criteria flow rates that were used for the 2008 facility upgrade are summarized in Table 4.

*Table 4 Lewes WWTF Design Criteria, 2008 Upgrades*

| WWTF Design Criteria[1] | Current Design Flow Rate (mgd) |
|---|---|
| **Design Flow – Average Day** | **1.50** |
| Max Day Flow | 1.80 |
| Max. Week Flow | 1.95 |
| Max. Month Flow | 2.25 |
| Peak Hour Flow | 4.40 |

Note:
1. Design Data per GMB Contract Ref 1998002.D1, "WWTF Upgrade and Expansion", Drawing G-2 – Design Data & Abbreviations.

The "Average Day" flow corresponds to the rated capacity indicated in the NPDES permit. It is not known how the peaking factors used to calculate the other design criteria flow rates were developed.

GHD reviewed daily average influent flow rate data for the WWTF from January 2019 to September 2021. A summary of the daily average flow rates in each calendar year is provided in Table 5.

*Table 5 Daily Average Flow Rate Data, 2019 to 2021, Lewes WWTF*

| WWTF Daily Average Flow[2] | 2019 | 2020 | 2021[1] |
|---|---|---|---|
| Minimum (mgd) | 0.39 | 0.25 | 0.47 |
| **Average (mgd)** | **0.80** | **0.86** | **0.85** |
| Maximum (mgd) | 1.33 | 1.60 | 1.33 |

Notes:
1. January thru September 2021 only.
2. “Daily Average Flow” has been taken as the daily average flow rate recorded at the WWTF effluent flow meter, i.e., the total flow through the treatment facility, including recycles.

On review of the available flow data, the WWTF does not typically treat the “Average Day” design flow that was used to size the facility during the most recent upgrade project. BPW indicated that the projected daily average flow rate from the Lewes collection network, assuming that all feasible lots are developed, is 1.75 mgd.

BPW currently accepts raw wastewater flows from Sussex County during winter months, when flows in the Lewes collection network are consistently lower, under the existing Agreement for Wastewater Service Transfer. As these additional flows are only receiving during off-peak periods, they are not included in the estimated Average Day design flow noted above.

BPW has also been involved in preliminary discussions with Cape Henlopen State Park to transfer additional flows to the Lewes collection network in the order of 49,000 gpd during winter, increasing to 120,000 gpd during summer. These additional flows were not included in the Average Day design flow provided to GHD for concept development.

Furthermore, BPW has advised that the existing gravity sewers that connect the State Park to the Lewes collection network can only accommodate an additional 25,000 gpd, and therefore considerable network upgrades would be required in order to convey additional flows of up to 120,000 gpd from the State Park. Given that the Average Day design flow was estimated based on full build-out of the Lewes BPW service area, assuming all available parcels are fully developed per current zoning (considered a highly conservate approach), no additional allowance will be made in the Average Day design flow for future flows transferred from Cape Henlopen State Park to the Lewes collection network for this study.

An extract from the existing NPDES permit for Lewes WWTF, outlining the effluent limitations, is provided in Figure 4.

| Parameter | Effluent Limitations | | | | | | Monitoring Requirements(2) | |
|---|---|---|---|---|---|---|---|---|
| | Load | | | Concentration | | | | |
| | Daily Average | Daily Maximum | Units | Daily Average | Daily Maximum | Units | Measurement Frequency | Sample Type |
| Flow(3) | | | MGD | --- | --- | --- | Continuous | Record/ Totalize |
| Dissolved Oxygen | Monitoring Only | | | | | mg/L | Continuous | Membrane Probe Immersion/ Record |
| pH | The pH shall be between 6.0 S.U. and 9.0 S.U. at all times. | | | | | S.U. | Once Daily | Grab |
| Enterococcus(4) | --- | --- | --- | 10 | 104 | Col/ 100 mL | Once Weekly | Grab |
| $BOD_5$ | 188 | 288 | lbs/day | 15.0 | 23.0 | mg/L | Once Weekly | Composite |
| $BOD_5$ (Influent)(5) | --- | --- | lbs/day | | | mg/L | Once Monthly | Composite |
| Total Suspended Solids (TSS) | 188 | 288 | lbs/day | 15.0 | 23.0 | mg/L | Once Weekly | Composite |
| TSS (Influent)(5) | --- | --- | lbs/day | | | mg/L | Once Monthly | Composite |
| Total Nitrogen (as N) | 100 | | lbs/day | 8 | | mg/L | Once Monthly | Composite |
| | See Part III. A., Special Condition No. 9 | | | | | | | |
| Total Phosphorus (as P) | 25 | | lbs/day | 2 | | mg/L | Once Monthly | Composite |
| | See Part III. A., Special Condition No. 9 | | | | | | | |
| Biomonitoring | See Part III. A., Special Condition No. 4 of this permit. | | | | | | | Composite |
| The discharge shall be free from floating solids, sludge deposits, debris, oil and scum. | | | | | | | | |

*Figure 4 NPDES Permit Extract, Lewes WWTF*

The Monthly Operation & Maintenance reports produced by BPW's appointed contractor, Inframark, LLC, were summarized to show nutrient trends over the operational period. Treated effluent nutrient data observed between January 2021 and September 2021 is provided in Table 6.

*Table 6 Effluent Nutrient Data, January 2021 to September 2021*

| Parameter | Minimum | Average | Maximum | Permit Limit |
|---|---|---|---|---|
| pH | 7.1 | 7.3 | 7.5 | 6 - 9 |
| Total Nitrogen (mg/L) | 3.5 | 5.6 | 7.7 | 8 (daily av.) |
| Total Phosphorous (mg/L) | 0.05 | 0.59 | 1.66 | 2 (daily av.) |
| Enterococcus (cfu/100 mL) | 0.50 | 0.89 | 2.0 | 10 (daily av.); 104 (daily max) |
| Total Suspended Solids (mg/L) | 0.25 | 0.33 | 0.40 | 15 (daily av.); 23 (daily max) |
| BOD (mg/L) | 1.2 | 1.2 | 1.3 | 15 (daily av.); 23 (daily max) |
| Average Daily Flow (mgd) | 0.39 | 0.89 | 1.69 | - |

The data indicates that the WWTF did not exceed any of the permit limits during the observed period.

The estimated average effluent waste loads for Total Nitrogen (TN) and Total Phosphorus (TP) during this time period are summarized in Figure 5.

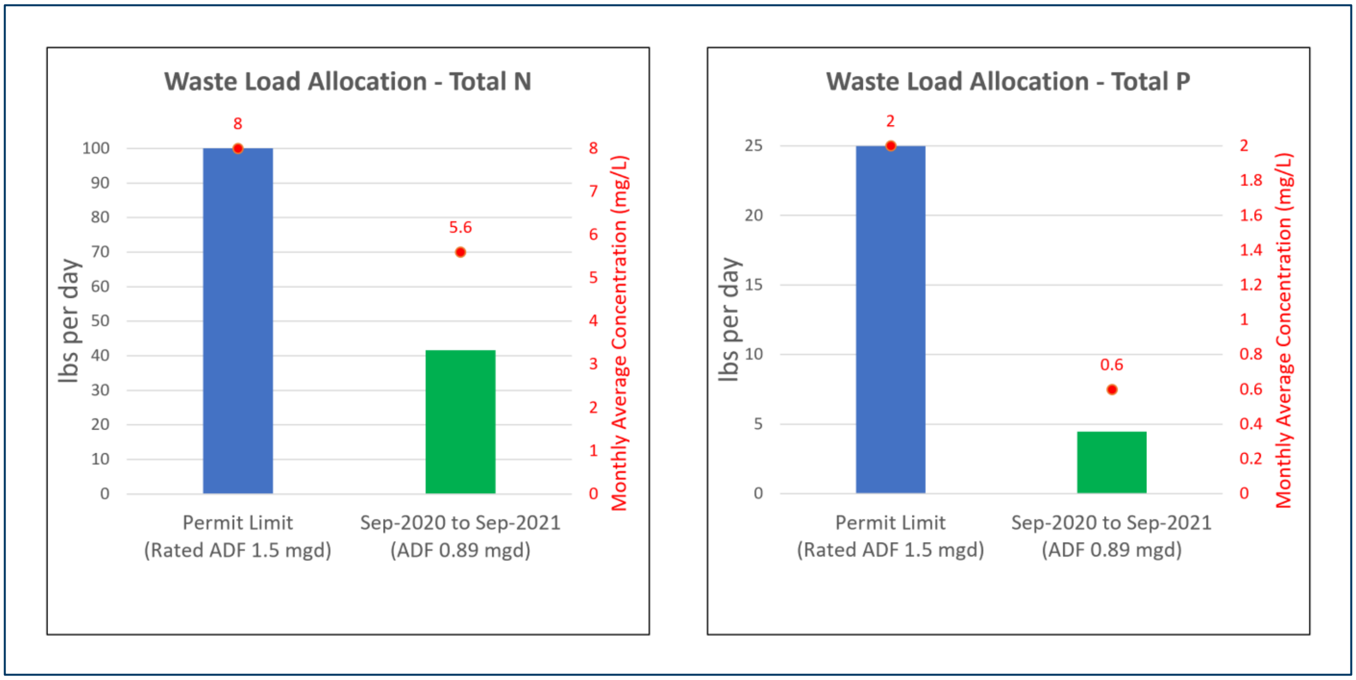



***Figure 5 Estimated Average Effluent Waste Loads, TN and TP***

The average daily flow during this period was 0.89 mgd. The data indicates that the average total pounds per day of TN and TP discharged by the BPW was less than half of the permitted waste load allocated for the observed data period.

### 2.1.3 Existing Treatment Capacity

The supplier of the MBR arrangement, SUEZ Water Technologies and Solutions (SUEZ), provided GHD with process modeling calculations to estimate the capacity of the WWTF assuming effluent is discharged at the permit limits. This data is provided as Appendix A. Review of that data and other facility data provided by BPW indicated that the limiting factors on the treatment capacity of the existing facilities are:

- Hydraulic
  - The hydraulic capacity of the WWTF is limited by the MBR facilities, which currently have a stated capacity of 1.62 mgd with all three existing cassettes in place (space is allocated for a future fourth unit).
- Maximum Month Biological Treatment Capacity
  - SUEZ estimated that the max. month biological treatment capacity at the permit limits is 1.80 mgd.
- Maintaining Current Effluent Nutrient Performance
  - For comparison purposes, assuming the WWTF continues to discharge treated effluent with an average Total N concentration of 5.4 mg/L (noting that this may not be feasible using the same tanks/ equipment with significantly higher flow), the plant would reach the permitted Waste Load Allocation at an average daily flow of 2.14 mgd.
  - Refer to Figure 6 for a summary of performance comparison data.

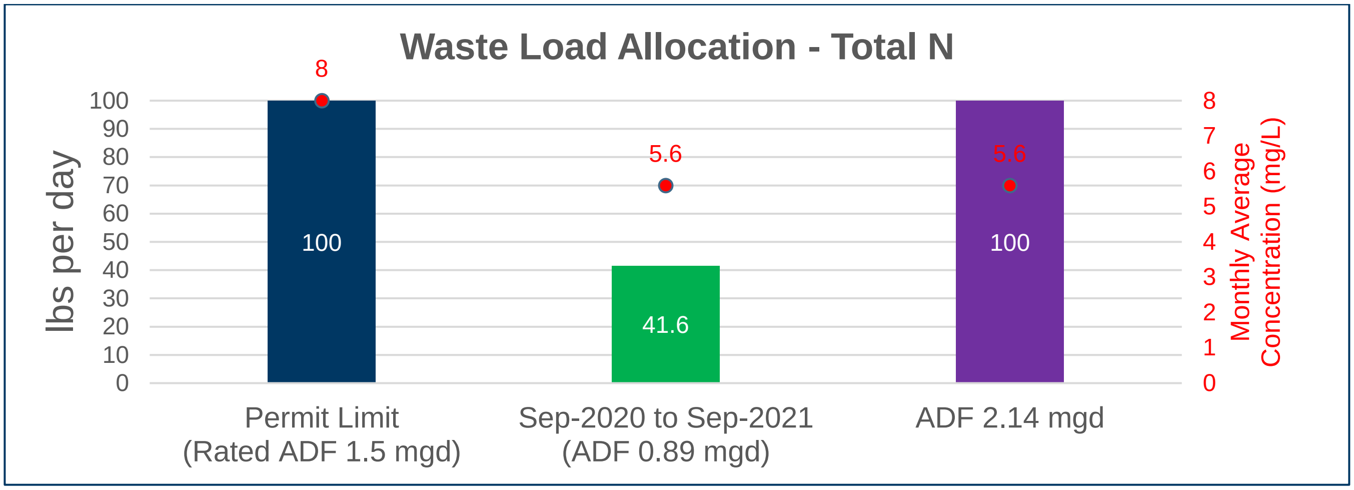



***Figure 6*** ***Comparison of Existing Effluent Waste Load Performance Compared with Permit Limits, Total N***

## 2.1.4 Site Flood Risk

### 2.1.4.1 Definitions

The following terminology has been used to outline the site flood risk for existing and future facilities:

- Base Flood Elevation
  - The elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year (FEMA; March 2020).
  - Also referred to as the "100-yr Flood Elevation".
- Eustatic Sea Level Rise (SLR)
  - An observed increase in the average Global Sea Level Trend and is caused by two primary factors: melting land ice and thermal expansion of the Earth's oceans (Lindsey and Dahlman; 2021).
- Coastal Subsidence
  - The gradual sinking of landmass, which can occur due to Glacial Isostatic Adjustment (the ongoing movement of land once burdened by ice-age glaciers, GIA), sediment compaction (both from natural and anthropogenic processes), and oceanographic changes (Miller et al.; 2013).
- 2050 Basis of Design Flood Elevation
  - The current Base Flood Elevation plus the projected Eustatic Sea Level Rise and Coastal Subsidence estimated to the year 2050.
- Recommended Freeboard
  - The recommended vertical offset from the Flood Elevation to building thresholds, equipment elevations and other critical components for treatment capacity.
  - Freeboard is not added to, or included in, the Flood Elevation; it is used to compare building and equipment elevations with projected water surface elevations.
- Calculated Freeboard
  - The calculated vertical offset from the Flood Elevation to building thresholds, equipment elevations and other critical components for treatment capacity.
  - The Calculated Freeboard is compared with the Recommended Freeboard to assess the flood risk at a particular location.

### 2.1.4.2 Regulatory Guidance Review

According to the Ten State Standards (Wastewater Committee of the Great Lakes – Upper Mississippi River; Recommended Standards for Wastewater Facilities, 2014 Edition), which is widely used in Delaware, wastewater treatment plant structures, electrical, and mechanical equipment shall be protected from physical damage by a one hundred (100) year flood. Treatment plants should remain fully operational and accessible during a twenty-five (25) year flood. This requirement applies to new construction and to existing facilities undergoing major modification.

The American Society of Civil Engineers (ASCE) 24-14 Flood Resistance Design and Construction is a referenced standard in the 2015 International Building Code® (IBC) and the 2015 International Residential Code® (IRC). ASCE 24-14 classifies buildings and structures associated with water and wastewater treatment facilities to be Flood Design Class 3 structures which should be set 2 feet or more above the Base Flood Elevation (BFE, i.e., 100-year flood elevation).

Executive Order 13690 (EO 13690), establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input, signed in 2015, states that federally funded projects are required to provide 3 feet of freeboard above the BFE for critical actions such as wastewater treatment facilities.

Based on the published industry standards and previous precedents, GHD considers the following to be the best design practice for Recommended Freeboard:

- All critical wastewater treatment equipment such as mechanical, electrical, or control systems protected at least 3 feet above the 100-year flood elevation.
- All other infrastructure, such as structural slab elevations for buildings or top of wall for open tanks, set at least 2 feet above the 100-year flood elevation.

It should be noted that the current FEMA flood maps do not account for future climate change. Climate change and sea level rise will also impact future flooding and a greater level of flood protection may be warranted in some cases.

Additional analysis related to projected sea level rise and coastal subsidence is outlined in Section 2.1.5, below.

### 2.1.4.3 Preliminary Flood Risk Assessment

An extract from the FEMA National Flood Hazard Layer FIRMette mapping for the City of Lewes, showing the 100-year flood elevation for different zones, is provided in Figure 7. The flood map data was last refreshed in October 2020.


*Figure 7* *Extract from FEMA Flood Maps, Lewes WWTF*

The FEMA mapping indicates that the 100-year flood elevation is 7 ft for most of the WWTF site, with a small section in the southeast at 6 ft. A sitewide 100-year flood elevation of 7 ft has been assumed for the high-level flood risk assessment outlined below.

GHD reviewed the finished surface elevations of existing facilities relative to the published 100-year flood elevation in order to assess the existing flood risk at each location. The findings are summarized in Table 7.

*Table 7* *Existing Facilities Flood Risk Assessment Summary*

| WWTF Area | 100-yr Flood Elevation (ft)[1] | Existing Grade (ft)[2] | Threshold Elevation (ft)[3] | Calculated Freeboard to 100-yr Flood Elevation (ft)[4] |
|---|---|---|---|---|
| Site Access (American Legion Road) | 7 | 3.78 | 3.78 | -3.22 |
| Headworks Building: Lower Level, Structural Slab | 7 | 5.5 | 9.50 | 2.50 |
| WWTF Office & Administration Building | 7 | 6.31 | 9.55 | 2.55 |
| Aeration Basins, Top of Wall | 7 | 5.5 | 10.32 | 3.32 |
| Process Building: Structural Slab | 7 | 6.0 | 7.50 | 0.50 |
| Process Building: MBR Tanks, Top of Wall | 7 | N/A | 10.13 | 3.13 |
| Digester Blower Building, Structural Slab | 7 | 6 | 7.13 | 0.13 |

| WWTF Area | 100-yr Flood Elevation (ft)[1] | Existing Grade (ft)[2] | Threshold Elevation (ft)[3] | Calculated Freeboard to 100-yr Flood Elevation (ft)[4] |
|---|---|---|---|---|
| Sludge Drying Beds | 7 | 6.60 | 6.60 | -0.40 |

Notes:
1. FEMA National Flood Hazard Layer FIRMette, cell ref: 10005C0194K.
2. Existing grade elevations per GMB Contract Ref 1998002.D1, "WWTF Upgrade and Expansion", Drawing C-4 – Site Plan.
3. Threshold elevation is the lowest elevation at which water ingress may occur for a given building or structure.
4. Freeboard is the difference between the 100-year flood elevation and the threshold elevation.

As noted above, the current FEMA flood maps do not account for future climate change. Additional analysis related to projected sea level rise and coastal subsidence is outlined in Section 2.1.5, below.

The assessment found that all the major process building thresholds are above the current published 100-year flood elevation. The only facilities below flood elevation are the sludge drying beds, which do not contain any critical equipment (although flooding may lead to sludge being dispersed to the surrounding environment, which would be a major issue).

The Aeration Basins and MBR Tanks have threshold elevations that provide in excess of 3 ft of freeboard during a 100-year flood scenario, and therefore are aligned with the guidelines outlined in Section 2.1.4.1.

The lower level slab elevation of the Headworks Building has freeboard greater than 2 ft above the 100-year elevation. Provided that all critical equipment at that level (MCC, Pump Motors etc) are located at least 6 in. above the structural slab elevation, then the building is in line with the guidelines outlined in Section 2.1.4.1.

The WWTF Office & Administration Building is 2.55 ft above the 100-year flood elevation; the building does not contain any critical equipment and therefore meets the guidelines outlined in Section 2.1.4.1.

The structural slab elevation at the Process Building and Digester Blower Building are above the 100-year flood elevation but do not provide the recommended freeboard. In the process building, the following equipment is located in areas that do not meet the guidelines outlined in Section 2.1.4.1:

– Sodium Hypochlorite Feed Systems
– Sodium Hydroxide Feed Systems
– Sodium Acetate Feed Systems
– Citric Acid Feed Systems

The Digester Blowers and associated electrical equipment are located in areas with very little freeboard above the 100-year flood elevation.

Access to the site (via American Legion Road) would be severely restricted during a 100-yr flooding scenario, with surface water approximately 3ft above the existing road elevation. Plant site road elevations are generally 12 to 18 inches higher than the public access road but would still be hazardous for Plant Operations & Maintenance staff during a flooding scenario.

Under the Ten State Standards (Wastewater Committee of the Great Lakes – Upper Mississippi River; Recommended Standards for Wastewater Facilities, 2014 Edition), treatment plants should remain fully operational and accessible during the 25-year flood.

While it is not officially published, the 25-year flood elevation has been estimated based on NOAA tide gauge data (Center for Operational Oceanographic Products and Services – Annual Exceedance Probability Curves 8557380 Lewes, DE). At the Lewes monitoring station as of 2018, the water level with a 4% annual exceedance probability is 3.9 ft above the Mean Higher High Water Level, which is itself 2.3 ft above the base elevation. Therefore, a 25-year flood elevation has been approximated as 6.2 ft.

During a 25-year flooding scenario, access to the site would be significantly impacted as American Legion Road would be approximately 2.4 ft below the surface water elevation.

Site roads would also be potentially hazardous. Unlike the 100-year flood scenario, the surface water elevation would be lower than that of the sludge drying beds, although the resulting 0.4 ft of freeboard would be less than the recommended 2.0 ft.

## 2.1.5 Projected Sea Level Rise and Coastal Subsidence

### 2.1.5.1 Background

Eustatic Sea Level Rise (SLR) refers to an observed increase in the average Global Sea Level Trend and is caused by two primary factors: melting land ice and thermal expansion of the Earth's oceans. As global temperatures rise (Lindsey and Dahlman 2021), terrestrial ice caps begin to melt and runoff into the ocean, contributing to SLR. Thermal expansion is the increase in the volume of water (in this case, sea water) as the temperature of the water increases.

Subsidence, or the gradual sinking of landmass, can occur due to Glacial Isostatic Adjustment (GIA), sediment compaction (both from natural and anthropogenic processes), and oceanographic changes (Miller et al. 2013). GIA is the ongoing movement of land that was once covered by ice-age glaciers (NOAA 2021). During the last ice age, glaciers covered large portions of North America, which caused landmass under the ice sheets to sink, and landmass on the borders of those glaciers to rise. As the glaciers receded and the ice age ended, landmass that was previously under the ice sheets are rising, while landmass that was on the borders of the glaciers is subsiding. The extent to which GIA affects subsidence rates is determined by the location (relative to the historical ice sheet) and whether the local geology is based in a bedrock location (lower effects) or a coastal plain sediment location (higher effects) (Karegar et al. 2016). Beyond GIA, groundwater withdrawal also plays a critical role in local land subsidence (Miller et al. 2013). High rates of groundwater withdrawal result in reduced pore fluid pressure, which leads to compaction of the aquifer and land subsidence (Karegar et al. 2016).

Relative SLR is the combination of eustatic SLR and local subsidence and result in the rise in water elevation relative to land (Rovere et al. 2016). Relative SLR can be measured through the use of satellite altimetry and tidal gauge data, as well as utilizing historical geological data. Local factors affecting SLR also include changes in the ocean's currents (Karegar et al. 2017; Lee et al. 2017) and shoreline retreat (Delaware Department of Natural Resources and Environmental Control [DNREC] 2012). Relative SLR causes compounding effects of storm events (nor'easters, hurricanes, etc.) and an increase in flood damage severity and frequency (Miller et al. 2013).

### 2.1.5.2 Observed Eustatic Sea Level Rise Rates

Over the past 2,000 years, the average eustatic SLR was slow (0 to 0.002 inches per year [in/yr]) until the late 1800s (Miller et al. 2013). Between 1880 and 2006, the average eustatic SLR accelerated slightly to 0.006 in/yr, and satellite altimetry indicated further acceleration of eustatic SLR to 0.010 in/yr between 1993 and 2013 (Miller et al. 2013). As global temperatures are expected to continue to rise and cause the melting of land ice and increase the thermal expansion of the oceans, the rates of SLR will continue to accelerate in the future (Lindsey and Dahlman 2021; Miller et al. 2013).

### 2.1.5.3 Subsidence in Delaware

Subsidence also plays a major role in determining the severity of the effects of SLR. The state of Delaware is a coastal plain that lies within the latitudes (approximately 38.5 to 40° North) most affected by the GIA of the former Laurentide Ice Sheet, which contributes up to half of the relative SLR observed in the state (Karegar et al. 2017; DNREC 2012; Watson 2020). Subsidence rates in the state of Delaware are approximately 0.08 in/yr (Karegar et al. 2016).

As mentioned above, high rates of groundwater withdrawal can cause aquifer compaction and land subsidence (Karegar et al. 2016). This was observed in the southern Chesapeake Bay region where heavy groundwater use between 1970 and 2010 caused the groundwater level to decline, and the subsidence rate increased to double that which was due to GIA (Karegar et al. 2016). When groundwater management practices were implemented from 2010 to 2015, the groundwater levels rose again, and the subsidence rate slowed to the GIA rate. Although Lewes, Delaware's groundwater extraction rates are currently stable (2005-2015), continued groundwater management practices can be effective at reducing aquifer compaction and the associated subsidence (Miller et al. 2013; Karegar et al. 2016).

#### 2.1.5.4 Relative Sea Level Rise in Delaware

Along the Atlantic coast, the mid-Atlantic coastal plains are a hot spot for accelerated relative SLR rates due to the compounding effects of subsidence (Miller et al. 2013; Karegar et al. 2016). Additional contributing factors to relative SLR in the mid-Atlantic region include the weakening of the Gulf Stream and other ocean currents along the Atlantic coast (Lee et al. 2017) and shoreline retreat, which was estimated to recede at 15 to 30 feet per year between 1969 and 2007 in the Bombay Hook area of Delaware Bay (DNREC 2012).

The *SLR Vulnerability Assessment for the State of Delaware* conducted by the DNREC in 2012, noted that the local mean sea level (MSL), as indicated by tide gages in Lewes, Delaware, increased at a rate of 0.13 inches per year between 1919 and 2011 (twice the global rate), due to the additive effects of subsidence in the region. The sea level in Delaware Bay rose a total of 7.9 inches over the twentieth century, and as a result, Hurricane Sandy (2012) flooded approximately 27 square miles more than it would have in 1880 due to the effects of SLR (Miller et al. 2013).

Further, as relative SLR causes coastal erosion and the loss of tidal wetlands – a critical natural flood protection for the state – flood frequency and depths may increase in flood-prone areas, as well as create new flooding areas (DNREC 2012).

#### 2.1.5.5 Forecasting Relative Sea Level Rise

In the *SLR Vulnerability Assessment for the State of Delaware* conducted by DNREC in 2012, the eustatic sea level was projected to rise by up to 1.57 feet (high level projection; range 0.59 to 1.57 feet) by the year 2050. Should SLR rates remain constant, rather than increase as other models suggest, the eustatic sea level is projected to rise by 0.43 feet by the year 2050. NOAA's *Global and Regional Sea Level Rise Scenarios for the United States* (2017) projects the eustatic sea level to rise 2.13 feet (high level projection; range 0.59 to 2.13 feet) by the year 2050.

The mid-Atlantic coastal plains have been identified as a hot spot for accelerated SLR rates due to the compounding effects of subsidence, and projections of eustatic SLR (such as DNREC's 2012 and NOAA's 2017 projections) may be biased low for what the relative SLR may be along the mid-Atlantic coast and the state of Delaware (Miller et al. 2013; Karegar et al. 2016). Miller et al. (2013) projected the relative sea level to rise by up to 2.33 feet (high level projection; range 1.08 to 2.33 feet) on the mid-Atlantic coast by the year 2050.

Factoring in the rate of local subsidence (approximately 0.08 in/yr), relative SLR is projected to rise by up to 2.39 feet (range 0.85 to 2.39 feet) by 2050 based on NOAA's 2017 projections. Forecasting to the year 2100, a eustatic SLR of 2.29 to 4.59 feet (or 2.88 to 5.18 feet of relative SLR, considering local subsidence) is expected with 90-percent probability (Miller et al. 2013). Figure 8 presents the relative SLR projected by 2050 and 2100 and the relative contribution of eustatic sea level rise and subsidence.

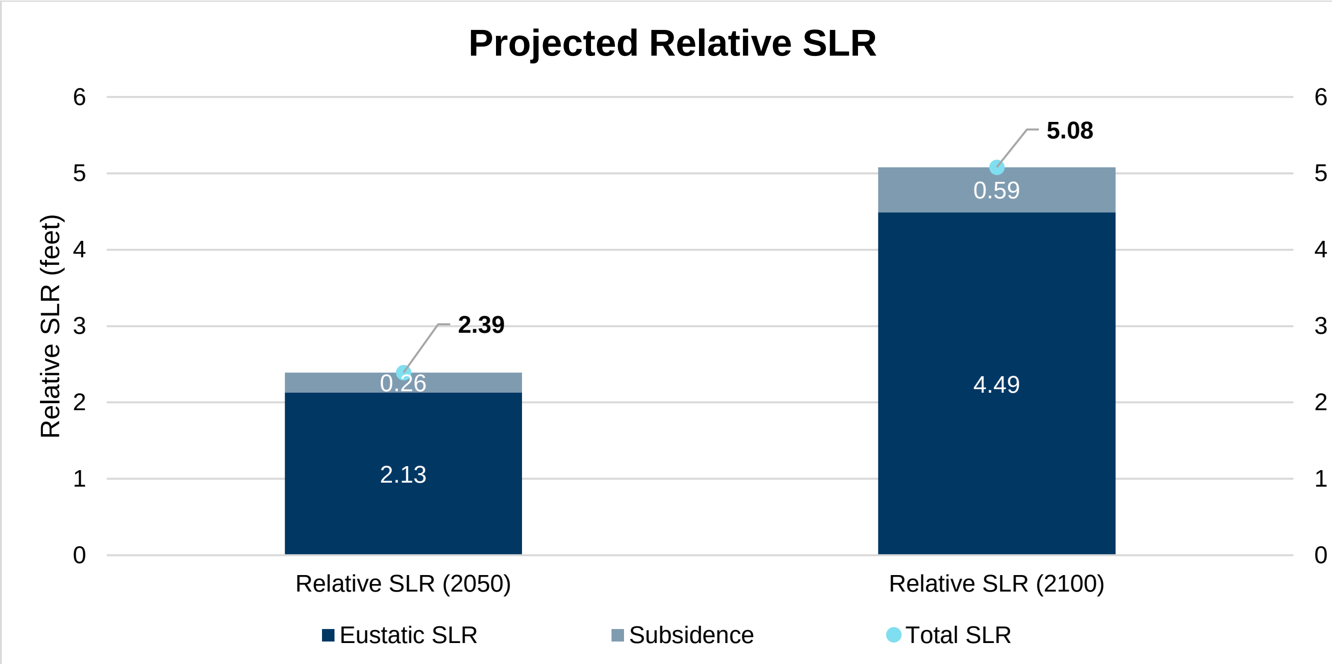



***Figure 8*** ***Relative Sea Level Rise by 2050 and 2100***

### 2.1.5.6 Local Impacts of Relative Sea Level Rise

Utilizing the Delaware Geological Survey's *Coastal Inundation in Delaware* interactive mapping tool, different levels of coastal inundation can be mapped to determine local effects to a specific area. In the area surrounding the Lewes BPW Wastewater Treatment Facility (Site), the mean highest high water (MHHW) has been observed in small channels of the marsh areas to the southwest of the Site. Under a coastal inundation scenario of 1.0 feet (a conservative value of relative SLR by 2050 based on the projections presented in Section 2.0), nearly the entire marsh area to the southwest of the Site will be submerged, with small areas of land to the northwest and southeast of the Site remaining above water. Under a coastal inundation scenario of 2.0 feet, the entire facility will be waterlocked due to water covering large portions of the access road (American Legion Road), as well as portions of East Savannah Road. Under a coastal inundation level of 4.0 feet, as projected by 2100, approximately 60-percent of the Site would be submerged, as well as large portions of American Legion Road and East Savannah Road.

According to the *SLR Vulnerability Assessment for the State of Delaware* (2012), DNREC ranks wastewater facilities as a “moderate concern” for risk to SLR. The initial effects of SLR to wastewater facilities are from intermittent flooding from increasing spring tides (new and full moon tides), resulting in potential flood damage and facility access issues, with effects becoming more chronic as SLR continues to progress (Deyle, Baily & Matheny 2007; Karegar et al. 2017). DNREC (2012) estimates 13 to 37 percent of the wastewater facilities in Sussex County will be exposed to SLR in the future.

The effects of SLR will also exacerbate flooding due to storm events such as hurricanes and nor’easters by increasing storm surge (DNRC 2012; Miller et al. 2013). Studies estimate that a 1.47-foot increase in sea level (intermediate projection of SLR by 2050) would cause a moderate “10-year” storm to have the equivalent flood level of a “100-year” storm event by today’s standards (Miller et al. 2013; Karegar et al. 2017).

### 2.1.5.7 Conclusions

For the purposes of concept development, the projected Relative SLR indicated in Figure 8 (above) will be added to the published FEMA 100-year Site Flood Elevation to estimate a suitable value for the 2050 Design Flood Elevation.

Refer to Section 3.1.1 (below) for further details.

#### 2.1.5.8 References for Project Sea Level Rise and Coast Subsidence Review

The following studies and reports were used to develop the various scenarios described in the previous paragraphs.


Delaware Department of Natural Resources and Environmental Control (DNREC). 2012. *Preparing for Tomorrow's High Tide: Sea Level Rise Vulnerability Assessment for the State of Delaware*. Prepared for the Delaware Sea Level Rise Advisory Committee by the DNREC.

Miller, K.G., R.E. Kopp, B.P. Horton, J.V. Browning, and A.C. Kemp. 2013. A geological perspective on sea-level rise and its impacts along the U.S. mid-Atlantic coast. *Earth's Future, 1*, 3-18, doi:10.1002/2013EF000135.

Karegar, M.A., T.H. Dixon, and S.E. Engelhart. 2016. Subsidence along the Atlantic Coast of North America: Insights from GPS and late Holocene relative sea level data. *Geophys. Res. Lett., 43*, 3126-3133, doi:10.1002/2016GL068015.

Lee, S.B., M. Li, and F. Zhang. 2017. Impact of sea level rise on tidal range in Chesapeake and Delaware Bays. *J. Geophys. Res. Oceans, 122*, 3917-3938, doi:10.1002/2016JC012597.

Lindsey, R., and L. Dahlman. 2021. Climate change: global temperature. NOAA Climate.gov website, https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature, 03/15/21.

Karegar, M.A., T.H. Dixon, R. Malservisi, J. Kusche, and S.E. Engelhart. 2017. Nuisance flooding and relative sea-level rise: the importance of present-day land motion. *Scientific Reports, 7: 11197*, doi:10.1038/s41598-017-11544-y.

Rovere, A., P. Stocchi, and M. Vacchi. 2016. Eustatic and relative sea level changes. *Current Climate Change Report, 2*, 221-231, doi:10.1007/s40641-016-0045-7.

Watson, P.J. 2020. Status of mean sea level rise around the USA. *GeoHazards 2021, 2*, 80-100. https://doi.org/10.3390/geohazards2020005.

National Oceanic and Atmospheric Administration (NOAA). What is glacial isostatic adjustment? National Ocean Service website, https://oceanservice.noaa.gov/facts/glacial-adjustment.html, 08/11/21.

NOAA. 2017. Global and regional sea level rise scenarios for the United States. NOAA Technical Report NOS CO-OPS 083.


# 3. Long Range Upgrade Options: Concept Development

## 3.1 Basis of Design Criteria

The proposed Basis of Design Criteria were used for long-range planning purposes and were developed to provide consistency between the potential upgrade options and to ensure that new facilities meet BPW and Sussex County's performance requirements up to the long-range planning horizon of year 2050.

### 3.1.1 Flood Risk

The Basis of Design Criteria for flood risk are summarized in Table 8.

*Table 8 Basis of Design Criteria, Flood Risk*

| Parameter | Value |
|---|---|
| 2015 FEMA 100-yr Site Flood EL, ft | 7 |
| Projected 2050 Eustatic Sea Level Rise, ft | 2.13 |
| Projected 2050 Coastal Subsidence, ft | 0.26 |
| Estimated 2050 100-yr Design Flood Elevation, ft | 9.39 |
| Freeboard to structural slabs and building thresholds, ft | 2 |
| Freeboard to critical equipment, ft | 3 |

### 3.1.2 Influent Flow Rates

The Basis of Design Criteria for future flow rates have been calculated based on projected increases in average daily flows and using the same catchment peaking factors as the 2008 Lewes WWTF design criteria.

The Basis of Design Criteria for the BPW collection network flow rates are summarized in Table 9.

*Table 9 Basis of Design Criteria, BPW Collection Network Flow Rates*

| Parameter | 2008 | 2050 |
|---|---|---|
| Average Day, mgd | 1.50 | 1.75 |
| Max Day, mgd | 2.25 | 2.63 |
| Max Week, mgd | 1.95 | 2.28 |
| Max Month, mgd | 1.80 | 2.10 |
| Peak Hour, mgd | 4.40 | 5.13 |
| Equalized Flow[1], mgd | 2.60 | 3.03 |

Note:
1. Equalized Flow is the difference between Peak Hour flow and Max Month flow.

For the Option 3 scenarios a combined facility was evaluated to treat flows from both the BPW and Sussex County collection networks. Sussex County has advised that the projected 2050 average day flow for Sussex County should be 1.75 mgd. Combining this with the projected 2050 average day flow for BPW (also 1.75 mgd), and using the same peaking factors as indicated in Table 10, the following Basis of Design Criteria flow rates have been estimated for the combined BPW and Sussex County collection networks:

*Table 10 Basis of Design Criteria, Combined BPW and Sussex County Collection Network*

| Parameter | 2050 |
|---|---|
| Average Day, mgd | 3.50 |
| Max Day, mgd | 5.25 |
| Max Week, mgd | 4.55 |
| Max Month, mgd | 4.20 |
| Peak Hour, mgd | 10.27 |
| Equalized Flow[1], mgd | 6.06 |

Note:
1. Equalized Flow is the difference between Peak Hour flow and Max Month flow.

## 3.1.3 Treated Effluent Water Quality

The Basis of Design Criteria for treated effluent water quality is as follows:

– The future WWTF will meet all of the conditions of the existing NPDES permit

  - Refer to Figure 4 for details.

On that basis, given that the Average Daily Flow is projected to increase for all Options, the critical effluent limitation will be the Waste Load Allocation (WLA) for TN and TP.

In order to maintain the WLAs within the existing permit limits at the 2050 Basis of Design flow rates, the new WWTFs will need to maintain TN and TP concentrations below the stated permit limits. The maximum acceptable average concentrations of TN and TP at 2050 Basis of Design Flows are summarized in Figure 9 (Option 1 and Option 2 concepts) and Figure 10 (Option 3 concepts).

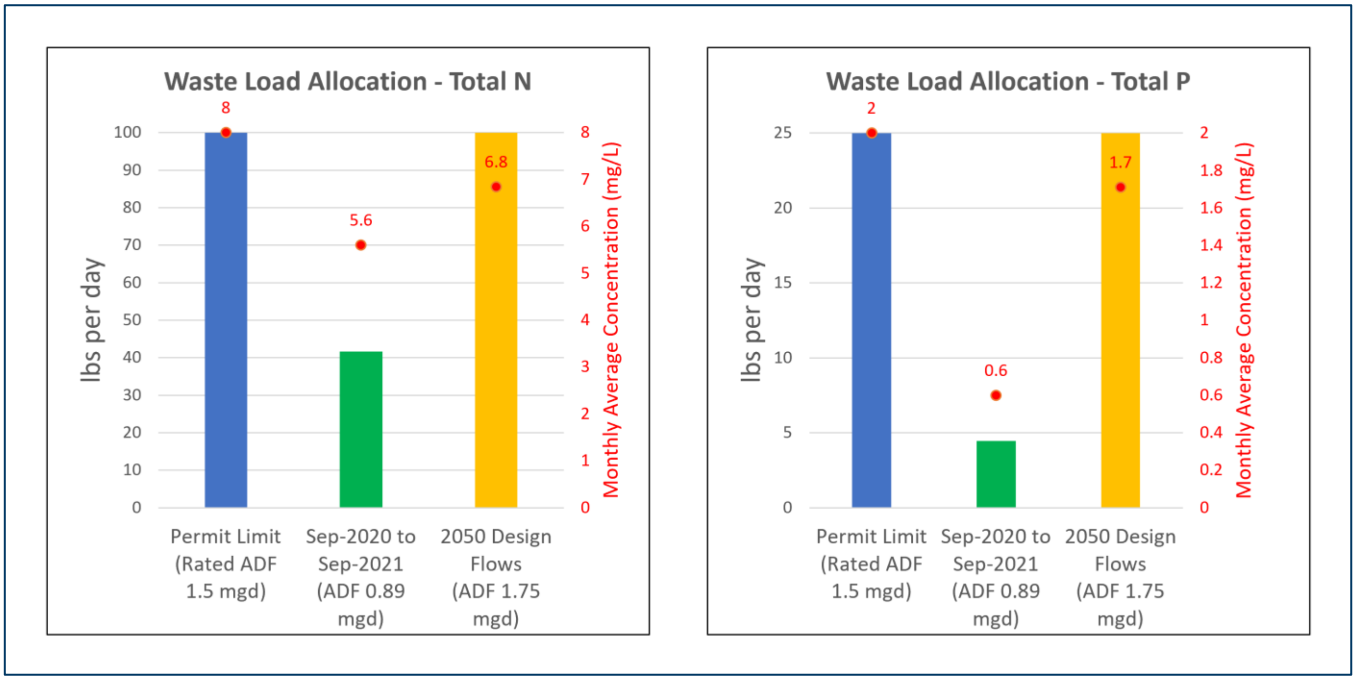



*Figure 9 Waste Load Allocation, 2050 Average Day Flow 1.75 mgd (Option 1 and Option 2)*

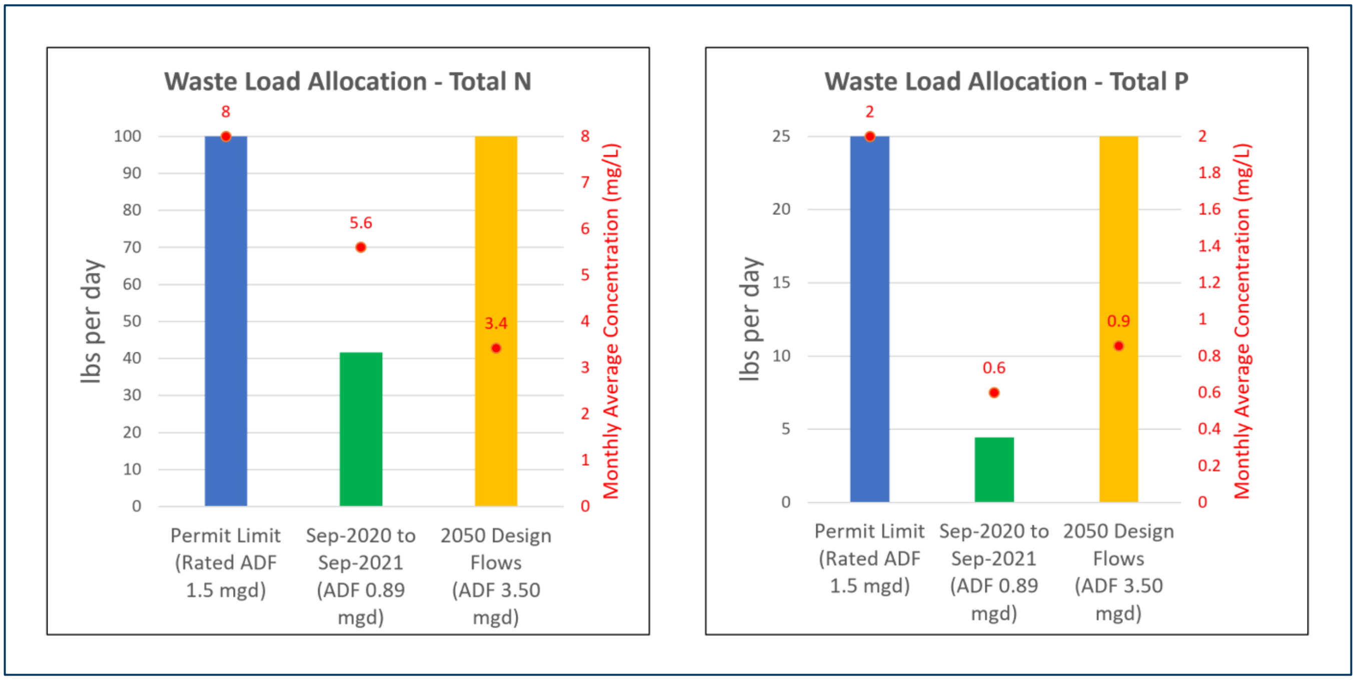



*Figure 10 Waste Load Allocation, 2050 Average Day Flow 3.50 mgd (Option 3)*

The nutrient concentration values indicated in the figures above correspond to the average concentration of TN and TP (mg/L) that would result in the WLA values shown, at a particular ADF.

As noted in Section 2.1.2, the existing Lewes WWTF currently discharges Total N and Total P average waste loads to the Canal that are less than half of the permitted Waste Load Allocation. For Option 1, it is assumed that the existing MBR process will be maintained for the 2050 planning horizon. The maximum allowable TN and TP concentrations for the Option 1 2050 design scenario are higher than the observed average values achieved with the existing MBR facilities. This indicates that the existing MBR arrangement can provide the necessary level of treatment to meet the 2050 Basis of Design Criteria.

Based on a detailed review of treated effluent data from comparable facilities in the Mid-Atlantic region, the maximum acceptable TN and TP concentrations for the 2050 Basis of Design Flows can be achieved by an activated sludge treatment facility with tertiary effluent filtration, similar to existing facilities owned and operated by Sussex County.

Therefore, for concept development purposes, it has been assumed that an activated sludge treatment facility, with tertiary effluent filtration, will be installed for all Option 2 and Option 3 facilities.

Note: Concept development for Option 3 treatment facilities was not included in the scope of the long-range planning study. However, a treatment methodology has been assumed for evaluation purposes (see Section 4.2, below).

A summary of the treated effluent water quality Basis of Design Criteria is provided in Table 11.

*Table 11 Basis of Design Criteria, Treated Effluent Water Quality*

| Design Average Daily Flow (mgd) | Discharge Arrangement | Secondary Treatment Method | Applicable Options | Maximum Treated Effluent Monthly Average Concentration Total N (mg/L) | Maximum Treated Effluent Monthly Average Concentration Total P (mg/L) |
|---|---|---|---|---|---|
| 1.75 | To Existing Canal via Existing Permitted Outfall | MBR | Option 1 | 6.8 | 1.7 |
| | | Activated Sludge Treatment w/ | Option 2b | | |

| Design Average Daily Flow (mgd) | Discharge Arrangement | Secondary Treatment Method | Applicable Options | Maximum Treated Effluent Monthly Average Concentration Total N (mg/L) | Maximum Treated Effluent Monthly Average Concentration Total P (mg/L) |
|---|---|---|---|---|---|
| | | Tertiary Effluent Filtration | | | |
| | Land Application | Activated Sludge Treatment w/ Tertiary Effluent Filtration | Option 2a | | |
| | New Ocean Outfall | Activated Sludge Treatment w/ Tertiary Effluent Filtration | Option 2c | | |
| 3.5 | To Existing Canal via Existing Permitted Outfall | Activated Sludge Treatment w/ Tertiary Effluent Filtration | Option 3a | 3.4 | 0.9 |
| | To Existing Canal via Constructed Wetland | Activated Sludge Treatment w/ Tertiary Effluent Filtration | Option 3b | | |

## 3.2 Option 1: Existing WWTF Hardening

### 3.2.1 Overview

A network schematic for the Option 1 upgrade concept is provided in Figure 11.

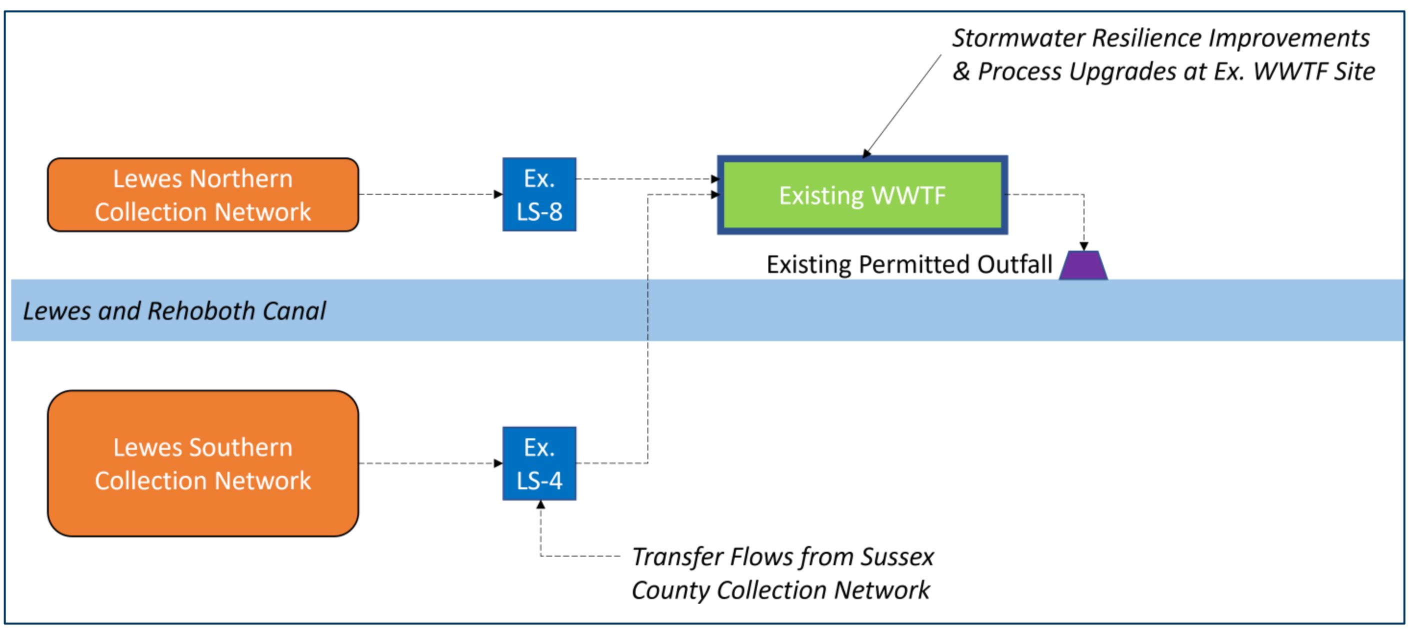



*Figure 11 Option 1, Network Schematic*

Option 1 would involve process upgrades at the existing WWTF to meet the 2050 Basis of Design Criteria, as well as additional flood mitigation measures to protect the low-lying site from future flooding scenarios.

### 3.2.2 Process Upgrades

Table 12 contains a list of the upgrades required to critical treatment facilities to enable the existing Lewes WWTF site to meet the 2050 Basis of Design Criteria for the BPW Collection Network up to 2050:

*Table 12 Option 1, Required Upgrades to Treatment Facilities*

| Treatment Stage | Critical Equipment | Existing Capacity | Required Capacity | Year Installed | Expected Operational Life (Yrs) | Expected Remaining Life (Yrs) | Upgrades Required (Capital Expenditure) |
|---|---|---|---|---|---|---|---|
| Headworks | 5mm Screen (1) and Lipactor (1) | 4.4 mgd | 5.13 mgd [1] | 2006 | 15 | 0 | Install new 5mm screen and compactor unit to treat 2050 Peak Hour Flow. |
| | Grit Removal Unit (1) and Pumps (1) | 4.4 mgd | 5.13 mgd [1] | 2006 | 15 | 0 | Install new grit removal unit and pump to treat 2050 Peak Hour Flow. |
| | 2mm Screen (1) | 2.25 mgd | 2.10 mgd [2] | 2006 | 15 | 0 | Install new 2mm screens (2) and compactor (2) unit to treat 2050 Max. Month Flow.<br>Recommend additional unit to provide additional redundancy to protect MBR facilities. |
| Flow Equalization | Flow EQ Tank (1) | 526,000 gal | 3,030,000 gal [3] | 1987 | 25 | 0 | Demolish existing tank and construct two new tanks to provide required EQ volume. |
| | EQ Lift Pumps (3) | 1250 gpm (each) | 730 gpm (each) [2] | 2005 | 20 | 3 | Replace existing pumps like-for-like. |
| Secondary Treatment | Aeration Basins (2) | 408,000 gal | 875,000 gal [4] | 1986 | 75 | 39 | Construct additional tank volume to provide the required volume. |
| | MBR Facilities (3) | 1.62 mgd (total) | 2.1 mgd [2] | 2009 (Refurb. 2021) | 10 | 9 | Install fourth MBR cassette in space previously allocated (will increase capacity to 2.16 mgd)<br>Ongoing replacement of MBR cassettes (at 10-yr intervals) to be included in O&M cost estimates. |
| Disinfection | UV Reactors (2) | 4.5 mgd (total) | 4.2 mgd [2] | 2009 | 15 | 0 | Replace existing units like-for-like. |

Notes:
1. Treatment facilities sized to treat peak hour flow.
2. Treatment facilities sized to treat max month flow.
3. Flow Equalization facilities sized to provide 24-hrs storage of equalized flow. Equalized flow is the difference between Peak Hour Flow and Max. Month Flow.
4. Treatment facilities sized to provide 12-hrs hydraulic retention time at Average Day Flow.

Sussex County has confirmed that thickened solids could be trucked to the Inland Bays WWTF for drying, avoiding the need to improve existing solids handling facilities at Lewes WWTF to meet 2050 Basis of Design Criteria. However, the increased solids production will result in an increase in ongoing operational costs for BPW – this has been included in the analysis in Section 4.1.2.

A schematic layout showing the process upgrades required for Option 1 is provided in Figure 12.

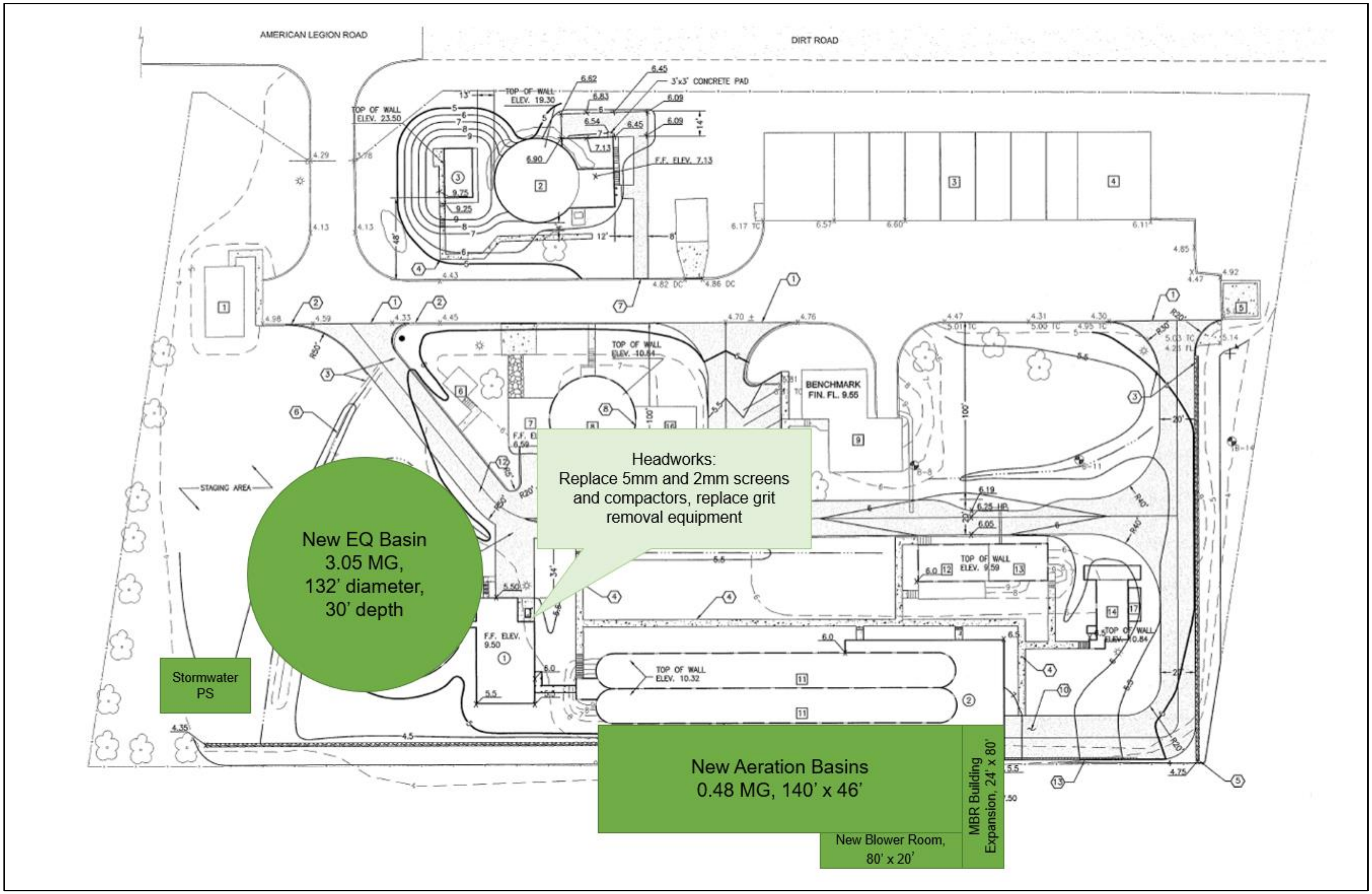



*Figure 12 Option 1, WWTF Site Layout Schematic*

As indicated in Figure 12, the site perimeter fence will need to be moved approximately 60 feet to accommodate the proposed expanded aeration basins.  Due to existing yard piping and electrical conduits, there is not available site space to the north of the existing basins in which to construct the additional volume required.

Lewes BPW owns the land around the existing WWTF site and therefore it is assumed that this alteration to the site area would be feasible.

The new Flow Equalization Basin would be constructed above grade; the existing flow equalization pumps would be upgraded to meet the 2050 Basis of Design Criteria.

The proposed Stormwater Pump Station is outlined in more detail below.

## 3.2.3 Flood Risk Mitigation

The conceptual arrangement for Option 1 was developed on the basis of increasing flood resilience at the existing WWTF site via the following methods:

– A perimeter flood barrier to protect the site from ocean surges and stormwater runoff from surrounding areas.
– A stormwater pump station to discharge stormwater runoff generated from within the site.

The concept development for each component of the flood resilience approach is described below.

### 3.2.3.1 Perimeter Flood Barrier

A schematic layout for the proposed perimeter flood barrier is provided in Figure 13.

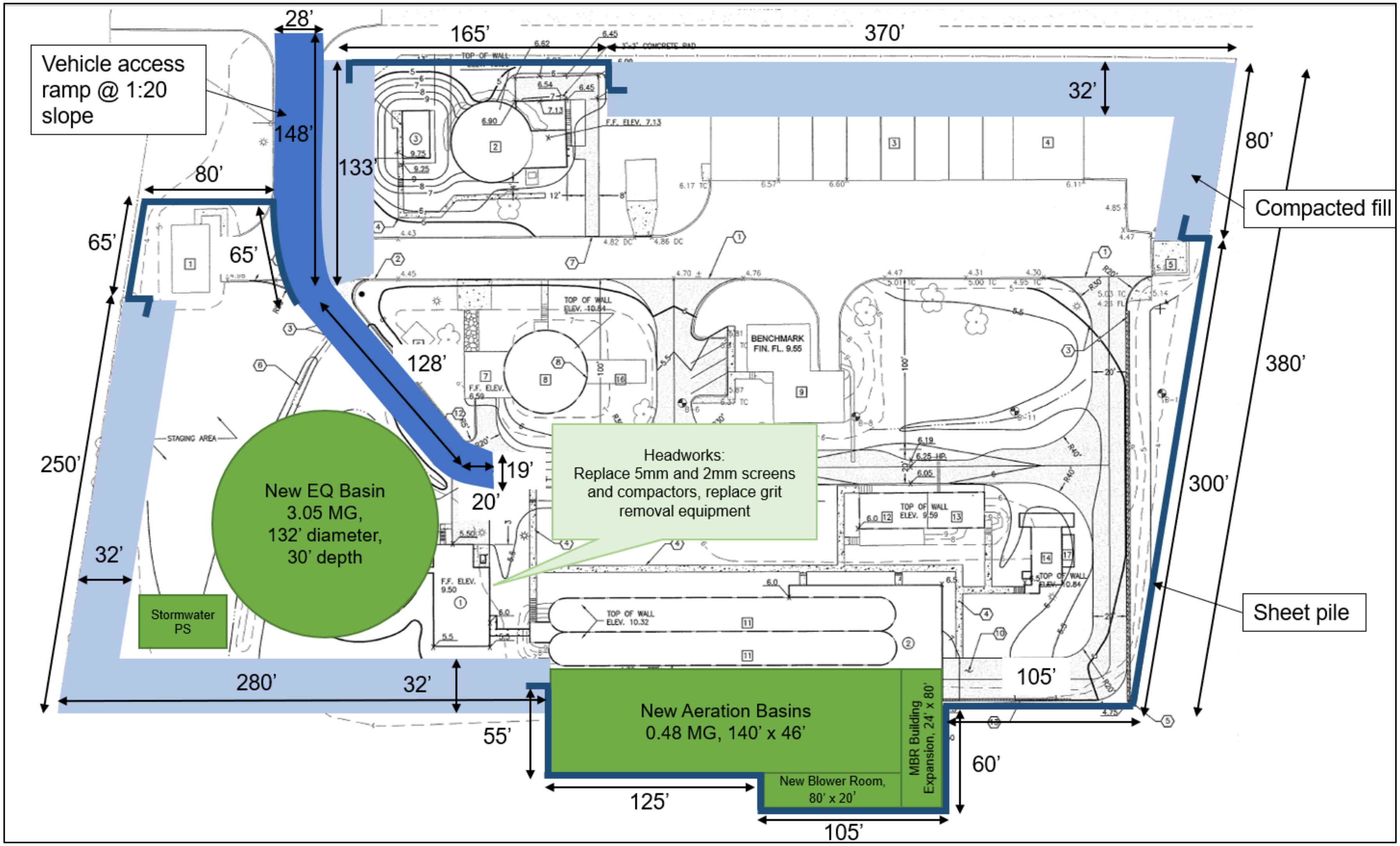



*Figure 13* *Option 1, Perimeter Flood Barrier Concept Arrangement, Plan View*

The sizing of the perimeter flood barriers provides two feet of freeboard above the projected 2050 Flood Elevation of 8.64 feet.

The flood barrier system would be composed primarily of compacted fill; a typical section through the compacted fill barrier is provided in Figure 14.

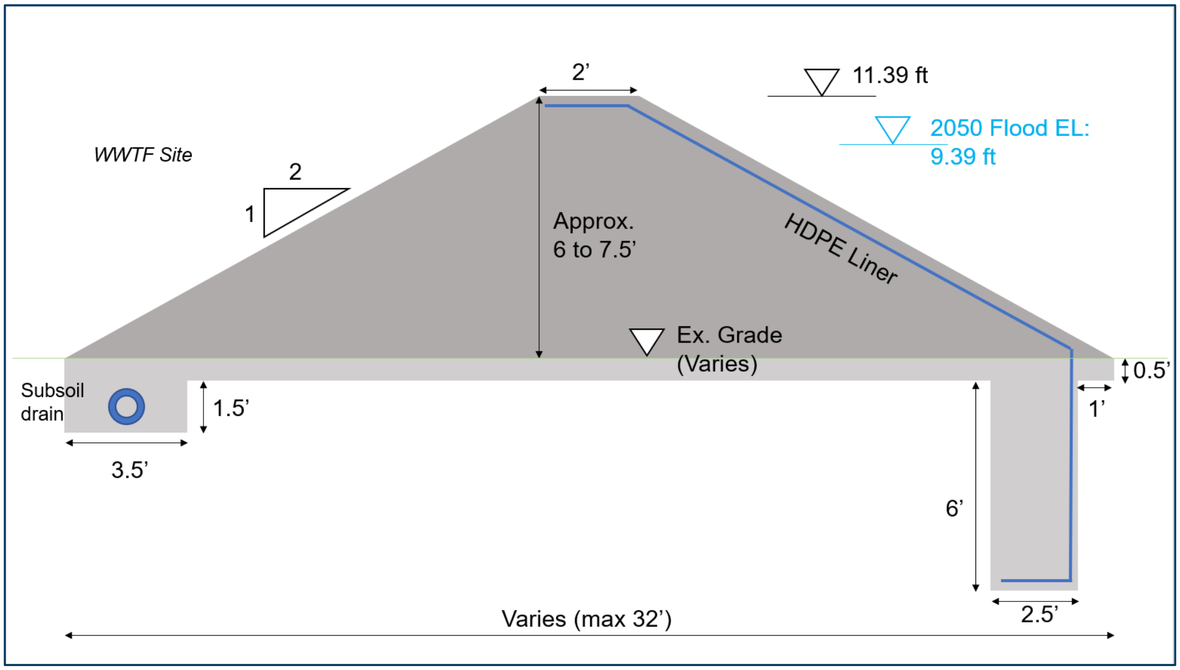



*Figure 14 Option 1, Perimeter Flood Barrier Concept Arrangement, Typical Section*

The height of the barrier will vary between 5 and 6 feet above grade to accommodate the varying site elevations. With a 2-foot crest width and 2:1 side slope, the barrier will have a maximum width of 29 feet. It should be noted that the 2:1 slope of the flood barriers is too steep to be mowed with a conventional lawnmower. However, site geometry does not permit a shallower slope which would further increase the barrier width. A specialized lawnmower will be required to maintain the barrier.

The City of Lewes regulations do not typically allow the addition of new fill on floodplains. Therefore, it has been assumed that a variance would be required in order to construct the proposed perimeter flood barrier.

To prevent the flow of groundwater into the site area, an impermeable HDPE liner will be included on the flood side. The liner will be anchored in a 6-foot trench. A perforated pipe will be included on the facility side of the barrier to provide subsoil drainage within the site.

Existing buried piping will be located below compacted fill barriers in several locations due to site geometry. This includes sludge feed piping to drying beds and portions of the influent and effluent force mains.

The concept layout was created under the assumption that all modifications must take place within the existing site area wherever possible (this is not feasible for the aeration basin expansion, as indicated above). For this reason, the compacted fill arrangement would be supplemented with sheet piling where the site layout does not permit the installation of a wider fill barrier. Sheet pile barriers will be required near the vehicle access ramp, oxidation basins, and sludge handling buildings to maintain access to these facilities and the site roads.

A static perimeter barrier (compacted fill berm and/ or sheet piling) is considered preferable to a flood gate, which would only be effective in the closed position during a major flooding event and could not be opened to allow site access until flood water has dissipated.

A ramp with a 20:1 slope will be used to allow vehicle access from American Legion Rd over the perimeter barrier. Because of the slope requirements, the vehicle access ramp must extend significantly into the site area. Some reconfigurations of site roads will be necessary to accommodate the ramp.

### 3.2.3.2 Stormwater Discharge

To manage stormwater from precipitation falling within the site, a stormwater pump station will be required at the low elevation point of the site. The low elevation point is located near the existing equalization tank as indicated in Figure 15.

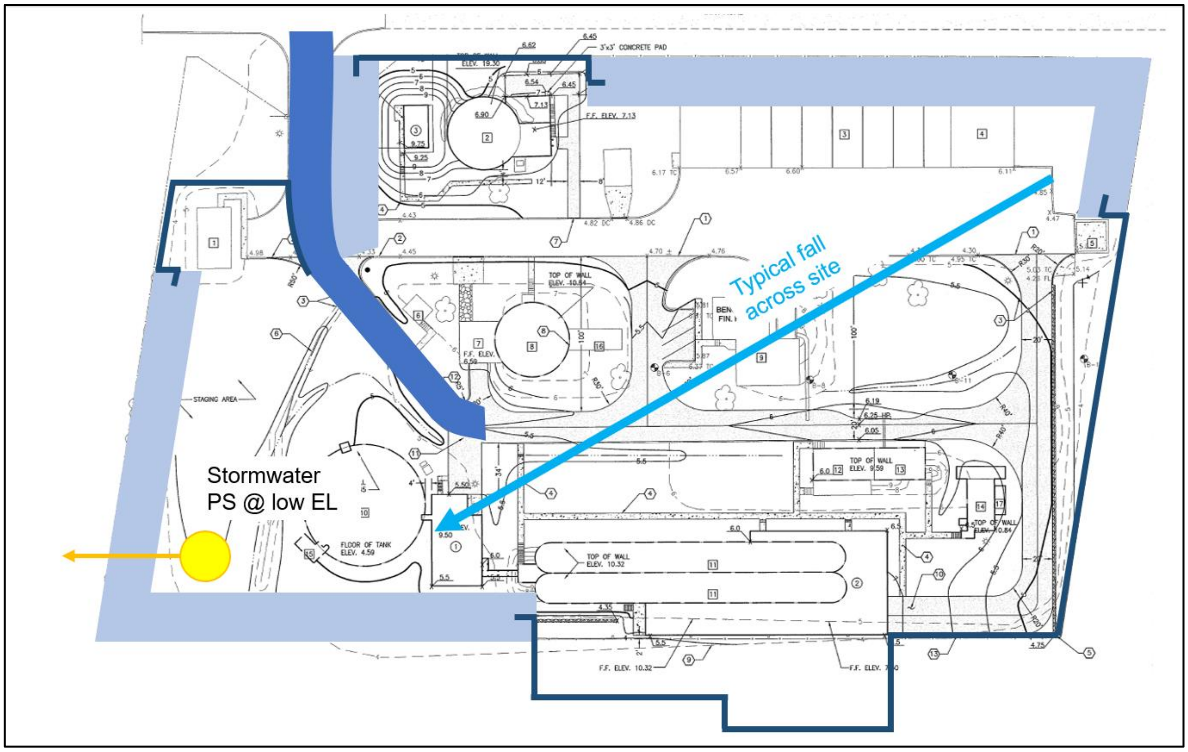



*Figure 15 Option 1, Stormwater Discharge Pump Station Concept Arrangement, Plan View*

A section view of the pump station, showing critical elevations, is provided in Figure 16.

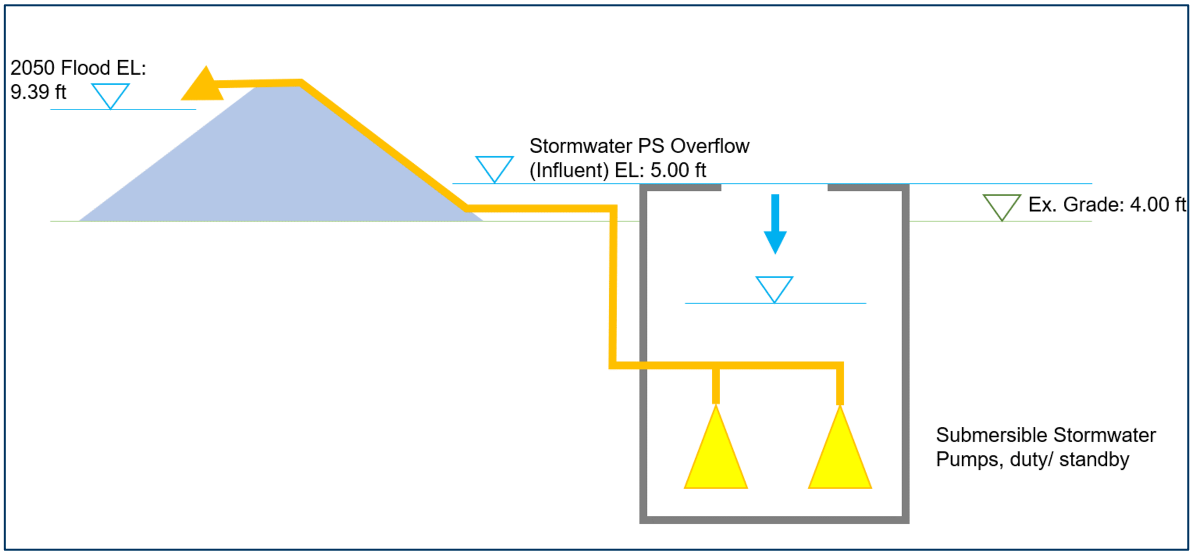



*Figure 16 Option 1, Stormwater Discharge Pump Station Concept Arrangement, Section View*

The overflow elevation for the stormwater pump station is recommended to be set at 5 feet. The elevation of site roads ranges from approximately 4.5 to 5.5 feet. Therefore, there could be a maximum of six inches of water on the site roads during a storm event, which allows safe vehicle access to be maintained across the site. This will also maintain the water level below the sludge beds, which are at approximately 6 feet in elevation.

The stormwater pumps will be in a duty/standby configuration. Pump sizing is based on the 100-year, 6-hour storm for Sussex County, as defined by DelDOT Road Design Manual, 2008. While it is noted that the statistical basis for a100-year storm has been affected by ongoing climate change, the 100-year return period is still recommended for concept development to ensure that Option 1 is consistent with the broader Basis of Design criteria for the long-range planning study.

The stormwater runoff flow for the 100-year, 6-hour storm was calculated to be 1870 gpm; the required pump head is approximately 10 feet, based on the overflow and flood elevations and assuming the discharge pipe is 100 feet in length.

It is possible that stormwater runoff from the WWTF site could contain contamination that would adversely affect the marshland areas on the external side of the proposed perimeter flood barrier. It's possible that additional stormwater treatment would be required prior to discharge from the WWTF site – this would be reviewed during a future design development stage, should Option 1 become the preferred alternative.

### 3.2.3.3 Residual Flood Risk

Following installation of the proposed perimeter flood barrier and stormwater PS, the flood elevation within the WWTF site will be maintained at 5ft, which is the overflow elevation to the stormwater PS. Revising the freeboard calculations on that basis, the residual flood risk is assessed as follows:

*Table 13 Residual Flood Risk Assessment Summary*

| WWTF Area | Site Flood Elevation Post-Mitigation (ft)[1] | Existing Grade (ft)[2] | Threshold Elevation (ft)[3] | Calculated Freeboard to Site Flood Elevation (ft) [4] |
|---|---|---|---|---|
| Site Access (American Legion Road) | 9.39 | 3.78 | 3.78 | -5.61 |
| Headworks Building: Lower Level, Structural Slab | 5 | 5.5 | 9.50 | 4.50 |

| WWTF Area | Site Flood Elevation Post-Mitigation (ft)[1] | Existing Grade (ft)[2] | Threshold Elevation (ft)[3] | Calculated Freeboard to Site Flood Elevation (ft) [4] |
|---|---|---|---|---|
| WWTF Office & Administration Building | 5 | 6.31 | 9.55 | 4.55 |
| Aeration Basins, Top of Wall | 5 | 5.5 | 10.32 | 5.32 |
| Process Building: Structural Slab | 5 | 6.0 | 7.50 | 2.50 |
| Process Building: MBR Tanks, Top of Wall | 5 | N/A | 10.13 | 5.13 |
| Digester Blower Building, Structural Slab | 5 | 6 | 7.13 | 2.13 |
| Sludge Drying Beds | 5 | 6.60 | 6.60 | 1.40 |

Notes:
1. The new stormwater pump station will be configured to maintain the site flood elevation at 5.00 ft. See Figure 16 (above).
2. Existing grade elevations per GMB Contract Ref 1998002.D1, “WWTF Upgrade and Expansion”, Drawing C-4 – Site Plan.
3. Threshold elevation is the lowest elevation at which water ingress may occur for a given building or structure.
4. Freeboard is the difference between the post-mitigation site flood elevation and the threshold elevation.

Following installation of the proposed improvements, all critical WWTF areas will be above the anticipated flood elevation within the WWTF site.

All buildings will have at least 2 ft of freeboard to the site flood elevation, per GHD’s recommendations.

The sludge drying beds will only have 1.40 ft of freeboard; there is no major equipment in this area but flooding of dewatered sludge would constitute a major environmental issue. BPW could transfer dewatered sludge to Sussex County’s Inland Bays facility for drying, rather than utilizing the drying beds onsite. However, this would increase hauling costs and create challenges in maintaining the dewatered sludge within the moisture limits for the County’s facility.

While all WWTF critical areas will be above the flood elevation, vehicle access to the site (via American Legion Road) will be difficult or impossible under flood conditions. Under a coastal inundation scenario of 2.0 feet, water will cover large portions of both American Legion Road and East Savannah Road. This is a wider issue for the coastal area and cannot be mitigated by upgrades to the WWTF site alone, and therefore represents a significant residual risk for Option 1.

### 3.2.4 Summary of Upgrade Requirements

The following capital works are required as part of the Option 1 scope of work:

– Upgrades to the following treatment facilities to enable the existing Lewes WWTF to meet the Basis of Design Criteria up to 2050:
  - New 5mm mechanical screen, compactor installed within the existing Headworks Building.
  - New grit removal unit and pump installed within the existing Headworks Building.
  - New 2mm screens (2) and compactors (2) installed within the existing Headworks Building.
  - Demolish existing Flow EQ tank and install a new 3.03 MG tank.
  - Increase the volume of the Aeration Basins to provide 12-hrs storage at average daily flow.
  - Install a fourth MBR cassette to increase the treatment capacity to 2.16 mgd.
  - Replace the existing UV reactors (2) like-for-like.

– Construction of a new Perimeter Flood Barrier and Vehicle Access Ramp.

– Construction of a Stormwater Discharge Pump Station.

## 3.3 Option 2: Site Relocation within the Greater Lewes Area

### 3.3.1 Overview

Each of the Option 2 concept arrangements would involve relocating the Lewes WWTF to a new site within the Lewes postal area, located above the 2050 flood elevation. The three sub-options vary in the proposed discharge method for treated effluent.

The concept arrangements are outlined in further detail below.

#### 3.3.1.1 Option 2a

A network schematic for the Option 2a upgrade concept is provided in Figure 17.

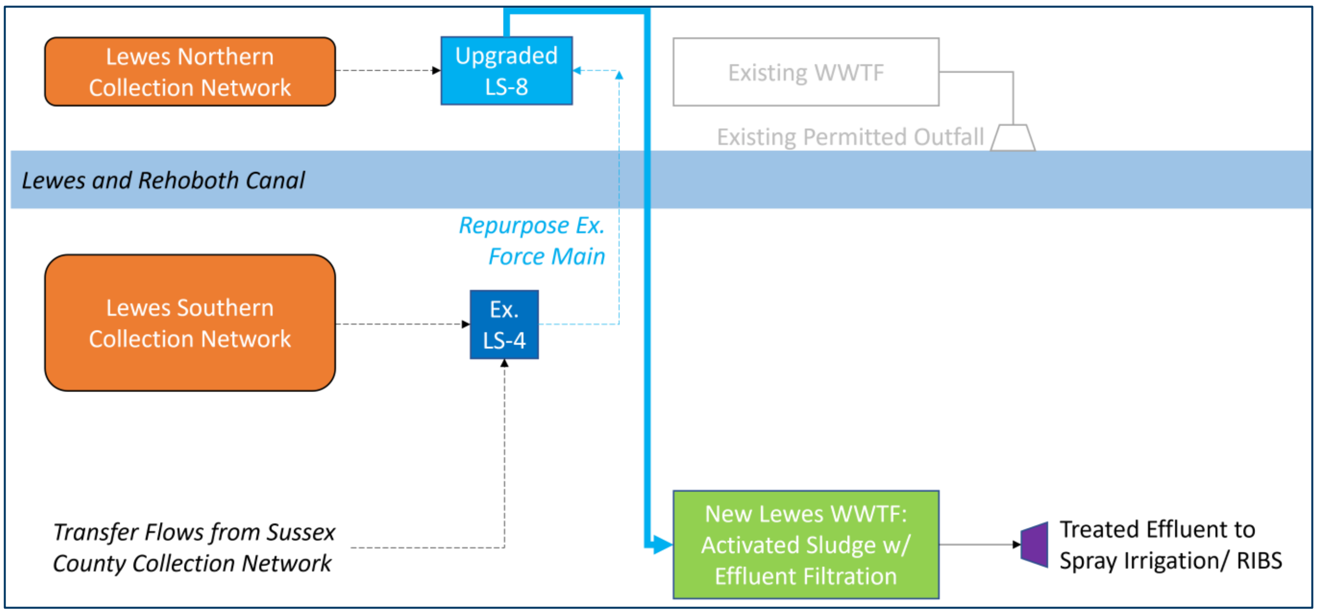



*Figure 17 Option 2a, Network Schematic*

Option 2a would involve consolidating the wastewater flows from the Lewes collection networks and pumping to a new WWTF at a high elevation site, located within the greater Lewes area. An activated sludge treatment process with tertiary effluent filtration would be suitable and the new WWTF would discharge treated effluent to ground, either via spray irrigation or RIBS.

Note: supplemental transfer flows from Sussex County would continue to be conveyed to LS-4 (and therefore to the new WWTF) under this concept arrangement.

#### 3.3.1.2 Option 2b

A network schematic for the Option 2b upgrade concept is provided in Figure 18.

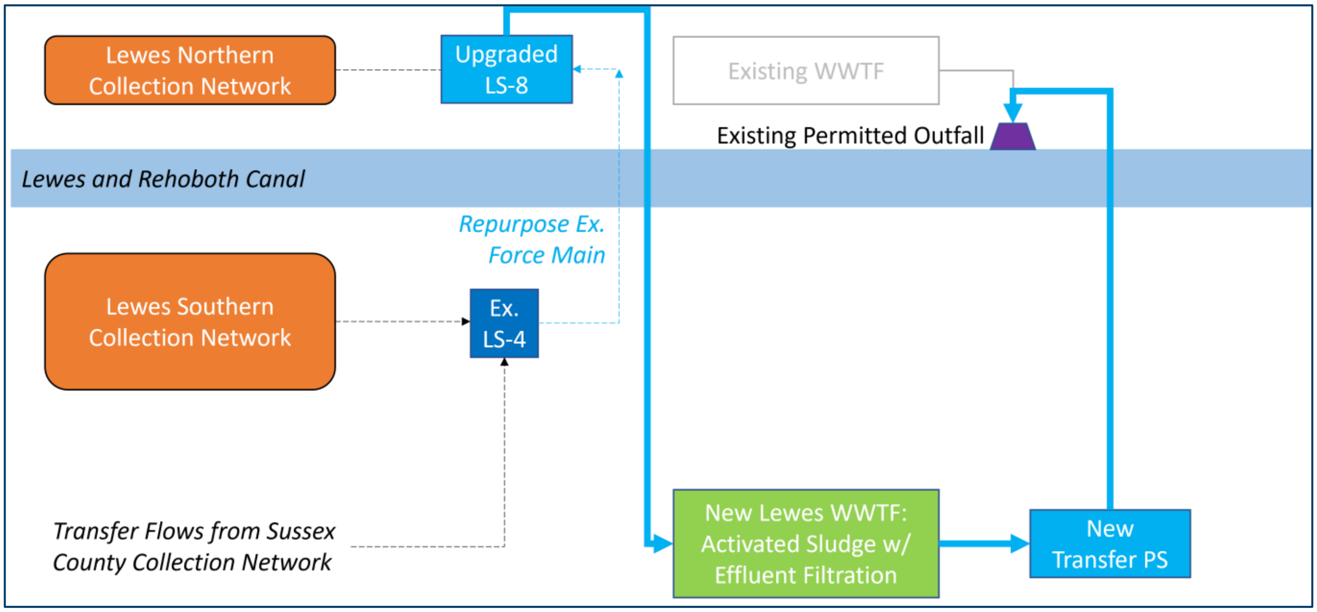



**Figure 18** *Option 2b, Network Schematic*

Option 2b would involve consolidating the wastewater flows from the Lewes collection networks and pumping to a new WWTF at a high elevation site, located within the greater Lewes area. An activated sludge treatment process with tertiary effluent filtration would be suitable and the new WWTF would discharge treated effluent to the existing permitted outfall at the Lewes and Rehoboth Canal, via a new transfer PS.

Note: supplemental transfer flows from Sussex County would continue to be conveyed to LS-4 (and therefore to the new WWTF) under this concept arrangement.

### 3.3.1.3 Option 2c

A network schematic for the Option 2c upgrade concept is provided in Figure 19.

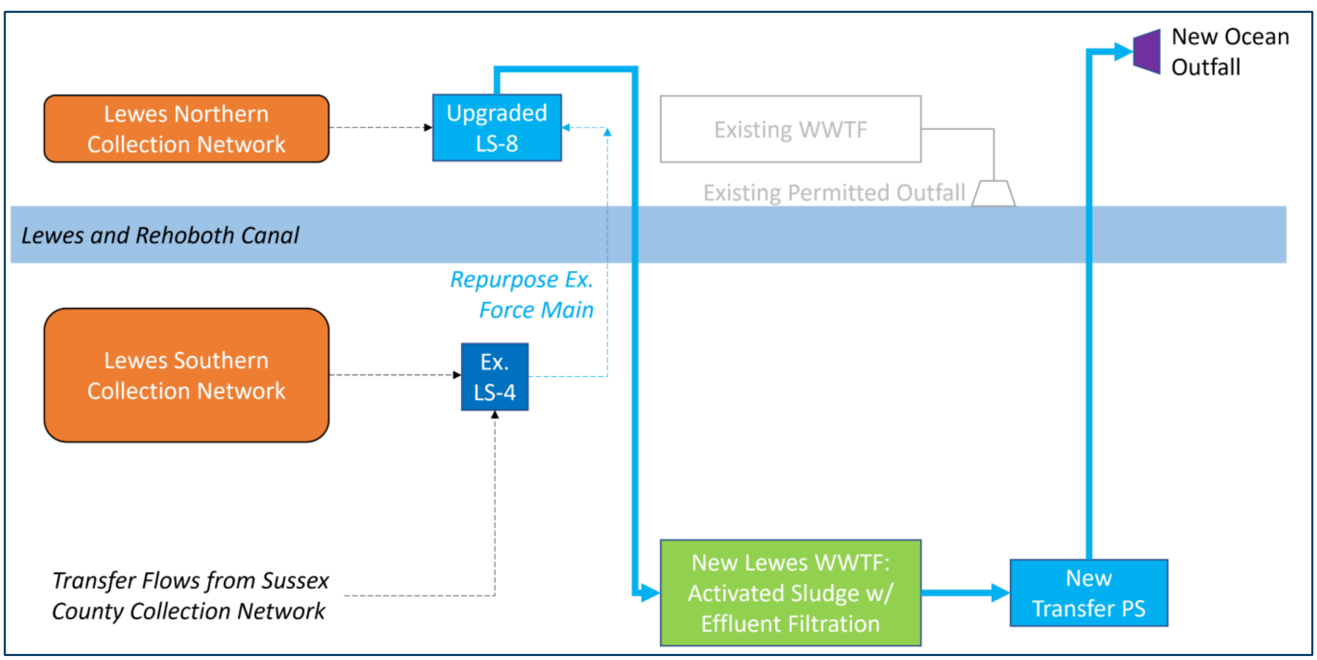



**Figure 19** *Option 2c, Network Schematic*

Option 2c would involve consolidating the wastewater flows from the Lewes collection networks and pumping to a new WWTF at a high elevation site, located within the greater Lewes area. An activated sludge treatment process with tertiary effluent filtration would be suitable and the new WWTF would discharge treated effluent via a new ocean outfall.

Note: supplemental transfer flows from Sussex County would continue to be conveyed to LS-4 (and therefore to the new WWTF) under this concept arrangement.

## 3.3.2 Site Sizing Requirements

### 3.3.2.1 Treatment Facilities

All of the Option 2 concepts have been developed on the basis of constructing a new activated sludge facility with effluent filtration.

A typical layout for the facility was developed with the understanding that it would be adapted to suit the final site selection. The treatment processes and basis for site sizing for the new facility are summarized in Table 14.

*Table 14 Treatment Stage Sizing*

| Item | Treatment Stages | Sizing Approach | WWTF Site, sf |
|---|---|---|---|
| 1 | Headworks | Sized for Peak Hour Flow.<br>Includes grit removal, 5 mm screen and compactor | 2,000 |
| 2 | Aeration Lagoon | Assume 2 units (rectangular).<br>Size so that combined volume gives a 24-hr hydraulic retention time at Average Day flow.<br>Sidewater depth 15 ft. | 15,600 |
| 3 | Secondary Clarifiers | Assume 2 circular units.<br>Sized based on 10 States Standards (surface overflow rate and side depth).<br>Sized using Max Month Flow as peak flow.<br>Assume 12ft side depth. | 2,100 |
| 4 | Effluent Filter and UV Disinfection Building | Assume 2 units each of effluent cloth disc filters and UV disinfection system.<br>Sized for the Max Month flow. | 2,700 |
| 5 | Effluent Storage Lagoons | Required for land application of treated effluent only.<br>Assume 4 units (rectangular).<br>Sized so that combined volume gives a 45 day hydraulic retention time at Average Day flow (per DNREC requirements).<br>Sidewater depth 15 ft.<br>Depth adjusted to balance cut and fill. | 810,000 |
| 6 | Flow EQ Tanks | Sized to store 24-hrs of equalized flow.<br>Equalized flow = Peak Hour flow – Max Month flow. | 27,100 |
| 7 | Sludge Handling Building | Includes sludge dewatering and thickener. | 3,000 |

| Item | Treatment Stages | Sizing Approach | WWTF Site, sf |
|---|---|---|---|
| | | Size adapted from comparable WWTF sites. | |
| **8** | Effluent Pump Station | Sized for:<br>- Peak Hour Flow | 840 |
| | | **Total Surface Area for Key Equipment, sf** | **835,700** |
| | | **Total Surface Area for Key Equipment, acre** | **19.2** |

Allowing for access roads and other site features, for the activated sludge treatment process with tertiary effluent filtration concept, approximately 20 acres would be required for the treatment facility area, not including land required for effluent discharge.

Note: these facilities have been developed for the Option 2 concepts only and may not be suitable for the Option 3 concepts. Schematic site layouts for Option 3 concepts are not included in the scope of this report.

A typical schematic site layout for the new treatment facility is provided in Figure 20.

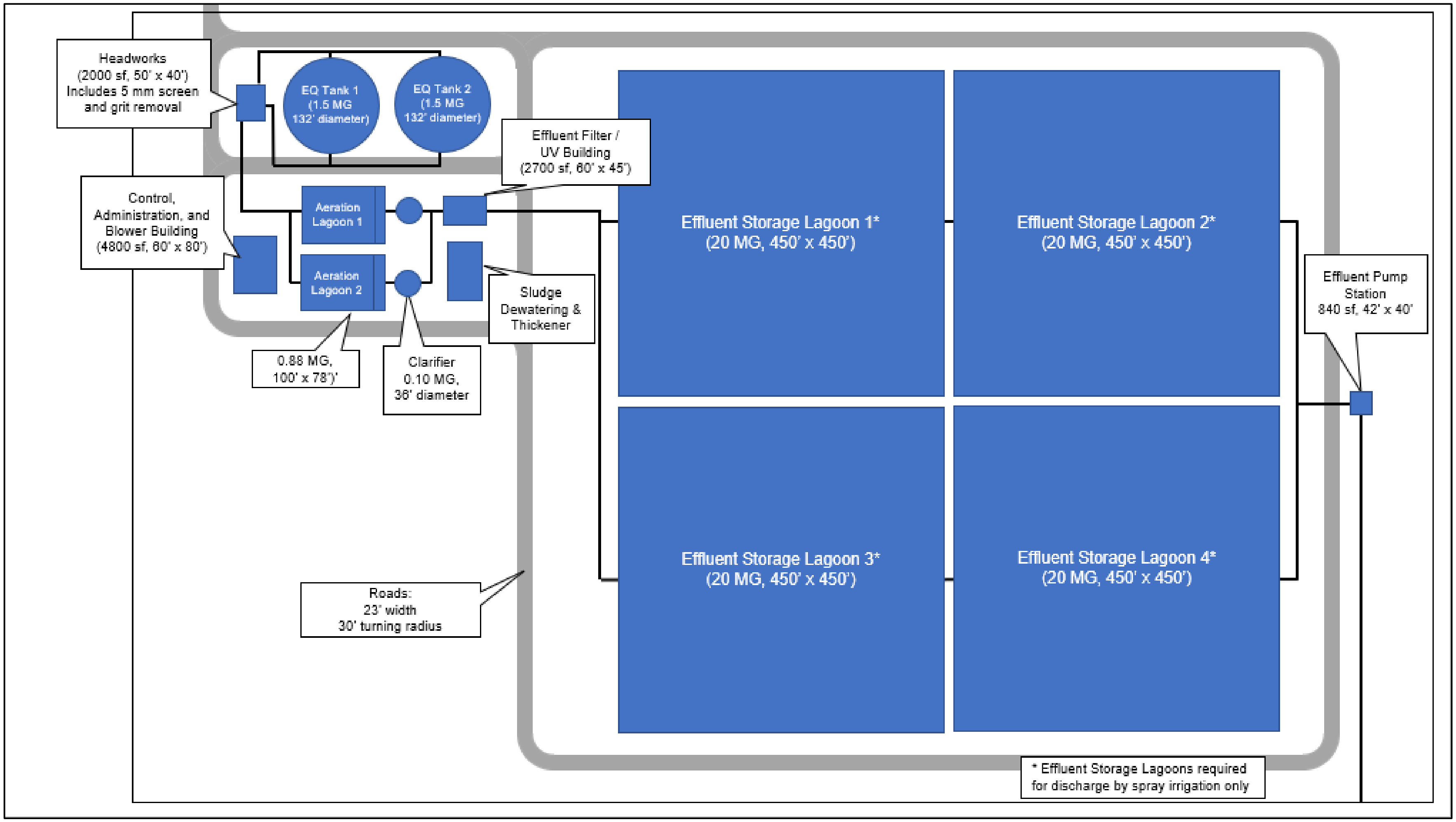



***Figure 20*** ***New WWTF Schematic Layout, Activated Sludge Treatment Process with Effluent Filtration***

### 3.3.2.2 Effluent Discharge: Spray Irrigation & RIBS

#### 3.3.2.2.1 Regional Hydrogeology Desktop Summary

The Lewes WWTF site is located in the Atlantic Coastal Plain Physiographic Province, which is generally characterized by unconsolidated sediments overlying older sedimentary formations composed primarily of interbedded sands. The Lewes WWTF is underlain by the shallow, unconsolidated aquifer, which lies above the Pocomoke – Ocean City Aquifer (~approx. -10ft msl).

The Pocomoke-Ocean City Aquifer is made up of three hydraulically connected aquifers, the Manokin, Ocean City, and Pocomoke aquifers. These units are modelled and investigated as one because of the hydrologic connection which occurs as confining beds become discontinuous. North and West of Lewes the Pocomoke and Ocean City Aquifers become one, as the confining beds are discontinued in this area. Aquifer tests circa 1984 show that the Pocomoke-Manokin-Ocean City aquifer has a transmissivity around 5000 $ft^2$/day [1].

The primary constituent of these aquifers is sand, and the literature points toward rapid hydraulic conductivity (50 ft/d)[1], and low coefficients of storage ($3.57 \times 10^{-4}$). These values point toward a hydrogeologic setting where the surficial aquifer rapidly translates recharge vertically to the underlying aquifer.  These aquifers remain saturated and upon recharging rainfall, begin to saturate the unconsolidated aquifer.

The surface waters of the Pocomoke-Ocean City Aquifer extent derive much of their flow from groundwater. This is evidenced by coupled variation in water level and stream gage height during periods of baseflow[2]. This connection is bridged by the unconsolidated sediments of the surficial unconfined aquifer.

A Delaware Geological Society geologic map of Lewes is provided as Appendix B.

##### *3.3.2.2.1.1 References for Regional Hydrogeology Review*

The following studies and reports were used to develop the Regional Hydrogeology Desktop Summary described in the previous paragraphs.

1. Hodges, Arthur, Hydrology Of The Manokin, Ocean City, And Pocomoke Aquifers of Southeastern Delaware, January 1984, Delaware Geologic Survey, United States Geologic Survey

2. Johnston, Richard, Digital Model of the Unconfined Aquifer in Central and Southeastern Delaware, United States Geological Survey in Cooperation with the Delaware Geologic Survey, Newark Delaware, May 1977

3. Principal Aquifers in Delaware: A. Geographic Distribution; B. Generalized Cross Section.  Sources: Cushing and others, 1973; Sundstrom and Pickett, 1971; Hodges, 1984.  Figure copied from USGS Water Supply Paper 2275 DE

#### 3.3.2.2.2 Spray Irrigation

According to DNREC Division of Water, Groundwater Discharges Section (7 DEL.C. Ch.60 6.3.2), the following restrictions apply for land applicated of treated wastewater:

– Soils with a permeability <0.02 inches/hour are prohibited from irrigation of treated wastewater
– Soils with a depth to water <24 inches are prohibited from irrigation of treated wastewater

Based on the desktop study summarized in Section 3.3.2.2.1 (above), the hydrogeological conditions in the Lewes area are **generally suitable for land application of treated wastewater effluent.**

Limited groundwater monitoring borehole data was available for review and therefore additional field investigation would be required to confirm the suitability of any specific sites, should Option 2a be selected for further design development.

In terms of site sizing requirements, DNREC notes that:

– Wastewater application rates may not exceed a maximum of 2.5 inches/acre/7 day period absent Department written authorization.

However, Sussex County have advised that on previous permit applications a more stringent application rate of 1.5 inches/acre/7day period was required. The required spray-irrigation application area for a range of application rates is summarized in Table 15.

*Table 15 Spray Irrigation Require Application Area*

| Application Rate (in/acre/7 day period) | Required Application Area at 1.75 mgd ADF (acres) |
|---|---|
| 1.5 | 310 |
| **2.0** | **230** |
| 2.5 | 190 |

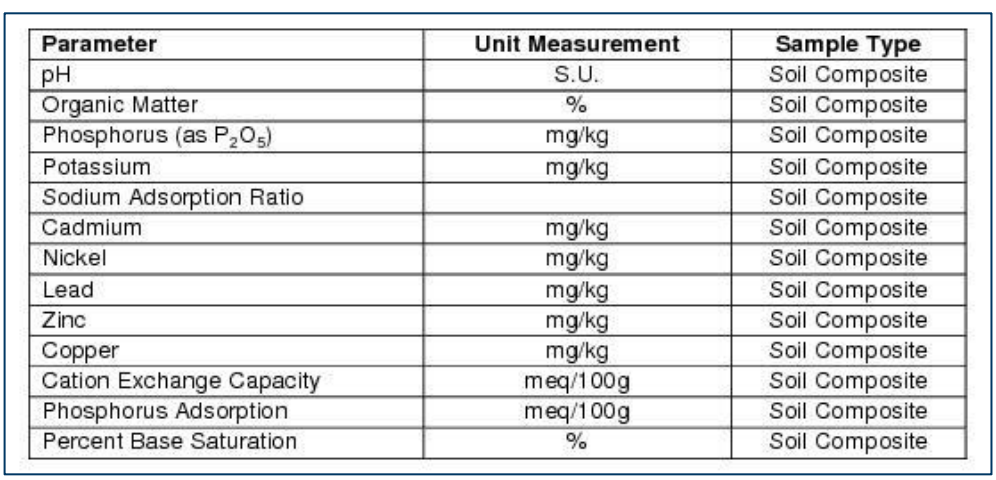
For concept development purposes, GHD has agreed with BPW and Sussex County that an application rate of 2.0 in/ acre/ 7-day period will be assumed for Option 2a. Effluent filtration will be included for options that utilize spray irrigation and therefore no additional buffer zones have been included in the estimates of required application area summarized above.

Therefore, a **total lot size of 230 acres will be required for spray-irrigation purposes.** Spray irrigation fields will need to be planted with cover crops and the cover crops require management and periodic harvesting to maintain optimum growth conditions.

DNREC notes the following additional operations and maintenance requirements for spray irrigation sites:

– Sites with seasonal high groundwater less than 5 feet deep (after consideration of mounding due to wastewater irrigation) must perform depth to water monitoring prior to spray irrigation to ensure the depth to water is greater than two feet during irrigation.
– The Design Engineer Report must contain monthly water balance calculations to determine the design hydraulic loading.
– Annual loading rates and site life limitations must be determined for phosphorus and heavy metals present in the wastewater.
– Average monthly values for potential evapotranspiration generated from vegetative, soil, and climatological data are to be used in the water balance calculations.
– Surface water bodies adjacent to wastewater spray irrigation sites must be monitored by the wastewater treatment facility.

Furthermore, if the treated wastewater is to be reused for irrigation activities, background and decennial soils sampling must be performed for the parameters listed in Figure 21. A minimum of one (1) composite sample must be taken for each 50 acre area, unless otherwise provided in the permit.



| Parameter | Unit Measurement | Sample Type |
|---|---|---|
| pH | S.U. | Soil Composite |
| Organic Matter | % | Soil Composite |
| Phosphorus (as $P_2O_5$) | mg/kg | Soil Composite |
| Potassium | mg/kg | Soil Composite |
| Sodium Adsorption Ratio | | Soil Composite |
| Cadmium | mg/kg | Soil Composite |
| Nickel | mg/kg | Soil Composite |
| Lead | mg/kg | Soil Composite |
| Zinc | mg/kg | Soil Composite |
| Copper | mg/kg | Soil Composite |
| Cation Exchange Capacity | meq/100g | Soil Composite |
| Phosphorus Adsorption | meq/100g | Soil Composite |
| Percent Base Saturation | % | Soil Composite |

*Figure 21 DNREC Soil Composite Sampling Requirements for Reuse of Treated Wastewater for Irrigation Purposes*

#### 3.3.2.2.3 RIBS

As noted above, based on the desktop study summarized in Section 3.3.2.2.1 (above), the hydrogeological conditions in the Lewes area are generally suitable for land application of treated wastewater effluent.

However, Sussex County and BPW have each noted concerns related to algal growth in RIBS facilities, which can lead to blinding of the infiltration beds. This subsequently affects the feasibility of discharging treated wastewater effluent and can lead to increased ongoing maintenance and cleaning requirements for the RIBS facilities

As a result of these concerns, **RIBS has not been considered any further for the purposes of concept development**.

### 3.3.2.3 Summary of Site Sizing Requirements

A summary of the total site area required, both for treatment facilities and discharge areas (if applicable), for each of the Option 2 concepts is provided in Table 16.

*Table 16 Option 2 Concepts, Summary of Total Site Area Required*

| Applicable Options | Plant Design Flow (ADF, mgd) | Effluent Discharge | Secondary Treatment Process | Total Site Area Required (acres) |
|---|---|---|---|---|
| **Option 2a** | 1.75 | Spray Irrigation (with Effluent Storage Lagoons) | Activated Sludge Treatment with Tertiary Effluent Filtration | 250 |
| **Option 2b** | 1.75 | Permitted Outfall (Canal) | Activated Sludge Treatment with Tertiary Effluent Filtration | 20 |
| **Option 2c** | 1.75 | Permitted Outfall (Ocean) | Activated Sludge Treatment with Tertiary Effluent Filtration | 20 |

Following a high-level review of undeveloped plots of land within the Lewes postal area, it has been assumed for concept development purposes that a suitable plot could be identified for each of the Option 2 concepts.

In the event that one of the Option 2 concepts is identified as the preferred option (see Section 5, below) a detailed siting study would be required as part of the future design development.

## 3.3.3 Pumping Requirements

### 3.3.3.1 Overview

The following approach has been used to develop the concept arrangements for the Option 2 wastewater pump stations:

– Raw wastewater pump stations and treated effluent pump stations shall be sized to convey the 2050 Peak Hour Design Flow for the Lewes collection network
  - 5.13 mgd; 3560 gpm

– Each pump station shall have two pumps in duty/ standby configuration.

– All new force mains shall be HDPE
  - Hazen-Williams roughness coefficient, C = 150
  - Force main lengths will be approximated assuming that a suitable site can be identified for a new WWTF within the Lewes postal area.
  - It is assumed that Option 2a would require a longer force main than Option 2b and 2c as the larger required site area is unlikely to be available close to the existing WWTF/ downtown area.

- Maximum force main velocity shall not exceed 8 ft/s
  - Force main nominal diameter of 16 inches has been selected for all force mains.
- Wet wells shall be configured to achieve 4 pump starts per hour at 2050 Peak Hour Design Flow
  - Per pump supplier (Gorman-Rupp) recommendations.
- Wet wells shall have a maximum drawdown depth per pump cycle of 3 ft
  - Per pump supplier (Gorman-Rupp) recommendations.
- Wet wells slabs shall have a minimum slope of 5%.
- Wet well shall be fitted within grinders on incoming pipes due to the known issues with rags and wipes in the Lewes wastewater collection network.
- A minimum of 2ft of freeboard shall be provided between the wet well high-water level and the lowest incoming gravity pipe.
- Raw wastewater force mains discharge at an elevation equal to max. WWTF site elevation + 20 ft.
- In the treated effluent wet wells, the finished grade shall be assumed to 2050 Flood Elevation (9.39 64ft) + 3ft freeboard, i.e., 12.39 ft. The incoming treated effluent pipe shall be assumed to have an invert elevation 6 ft below finished grade, i.e., 6.39 ft.
- Treated effluent force mains discharging to receiving water discharge at an elevation of 0 ft.
- Assume a standard pump efficiency of 70%.

The pumping requirements for specific components of the upgrade options are summarized below.

Hydraulic calculations are provided in Appendix C.

### 3.3.3.2 Raw Wastewater

In order to pump raw wastewater to a proposed new site at high elevation, wastewater flows from the Lewes Collection network first have to be consolidated at a single site for transfer pumping. As indicated previously, the Lewes collection network has two terminal pump stations: LS-4 (south of the Canal) and LS-8 (north of the Canal).

BPW's preference is for a new transfer pump station to be located at the LS-8 site; LS-4 is located in downtown Lewes, immediately adjacent to prominent businesses and busy roads, and therefore significant construction work at this site would be considerably more challenging and disruptive to stakeholders.

Therefore, the existing LS-4 arrangement will be used to transfer flows from the southern collection network to the LS-8 site, which will be modified to transfer raw wastewater flows to the feasible site for each concept arrangement.

Due to the increased flow and significantly higher delivery head, the existing LS-8 pumping arrangement would need to be upgraded to meet the Basis of Design Criteria. The existing wet well would also need to be expanded, which would require the existing LS-8 facilities to be taken offline for a significant period of time.

Furthermore, the existing building threshold at LS-8 (6.94 ft) is below the 2050 Basis of Design Flood Elevation, and the existing flood door is in poor condition.

Therefore, for concept development purposes, it is assumed that a new LS-8 pump station will be constructed offline, adjacent to the existing structure, and utilized to transfer all flow from the Lewes collection network to the new high elevation WWTF.

A schematic arrangement showing the proposed transfer piping from LS-4 to the new LS-8 pump station is shown in Figure 22.

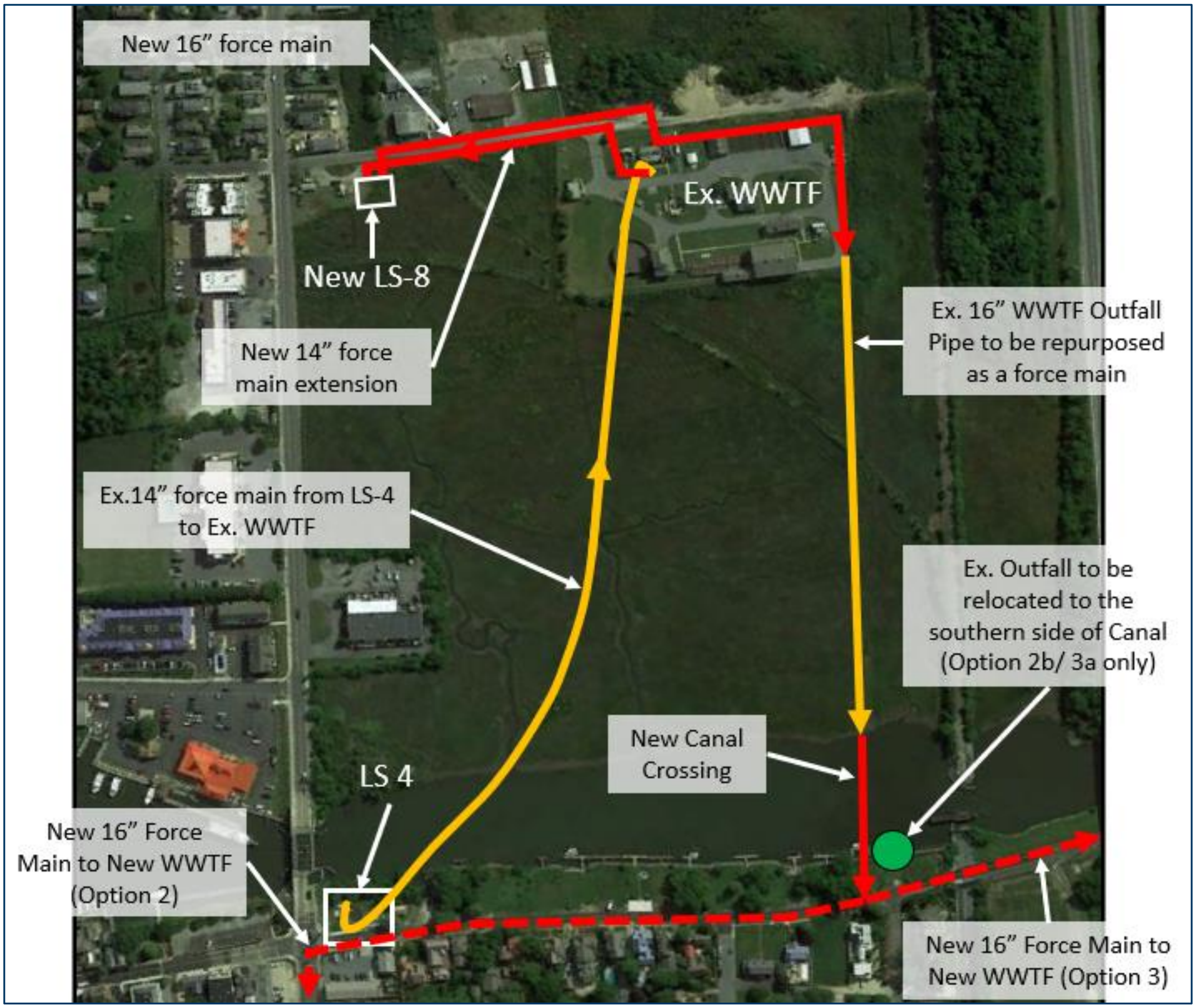



*Figure 22* ***Raw Wastewater Diversion to LS-8***

The existing 14” force main from LS-4 to the existing WWTF would be extended to the new LS-8 and a new 16” force main would be required from LS-8 to the existing WWTF site. The new pipe would then connect into the existing WWTF 16” outfall pipe, which could be relined and repurposed as a force main to convey flows to the canal.

A new canal crossing would be required to transfer flows to the southern side of the Canal, and then new 16” force mains would convey raw wastewater to the new WWTF sites.

As the existing WWTF outfall pipe will be repurposed, the existing permitted outfall will need to be relocated to the southern side of the Canal for the purposes of Option 2b.

Note: this piping configuration would apply for Option 3 concepts as well – see Section 3.4.3, below.

A schematic plan view showing the new LS-8 piping and pump station arrangement is provided in Figure 23.

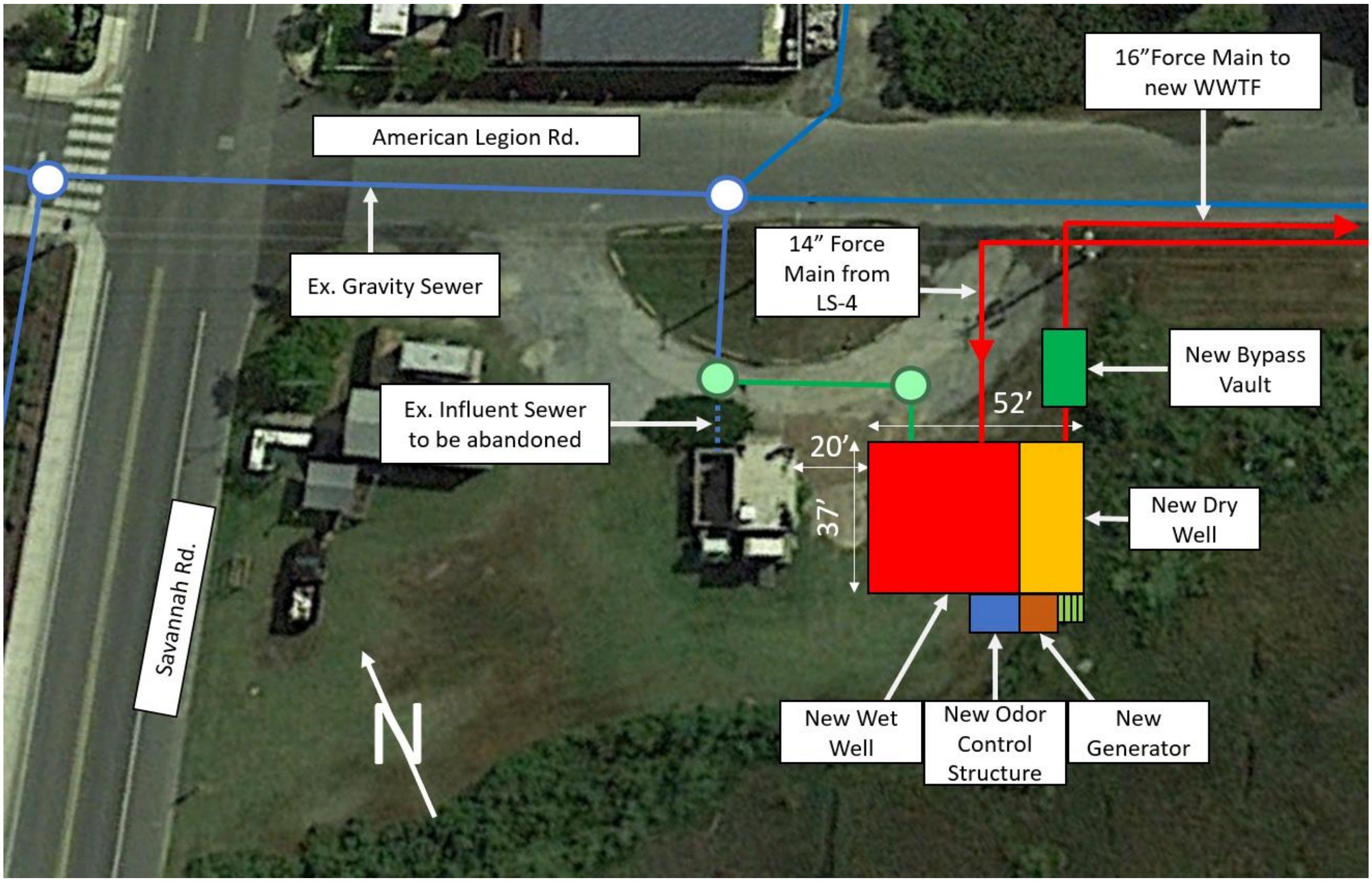



***Figure 23*** ***Options 2a/b/c, Raw Wastewater Pump Station, LS-8 Site Plan***

The reconstructed LS-8 would need to include upsized pumps and a larger wet well in order to meet the requirements set out in Section 3.3.3.1, above. Auxiliary structures and machinery, including an emergency generator with raised concrete pad, bypass vault, and odor control structure would complement the reconstructed station.

A sectional view of the reconstructed LS-8 wet well is provided in Figure 24.

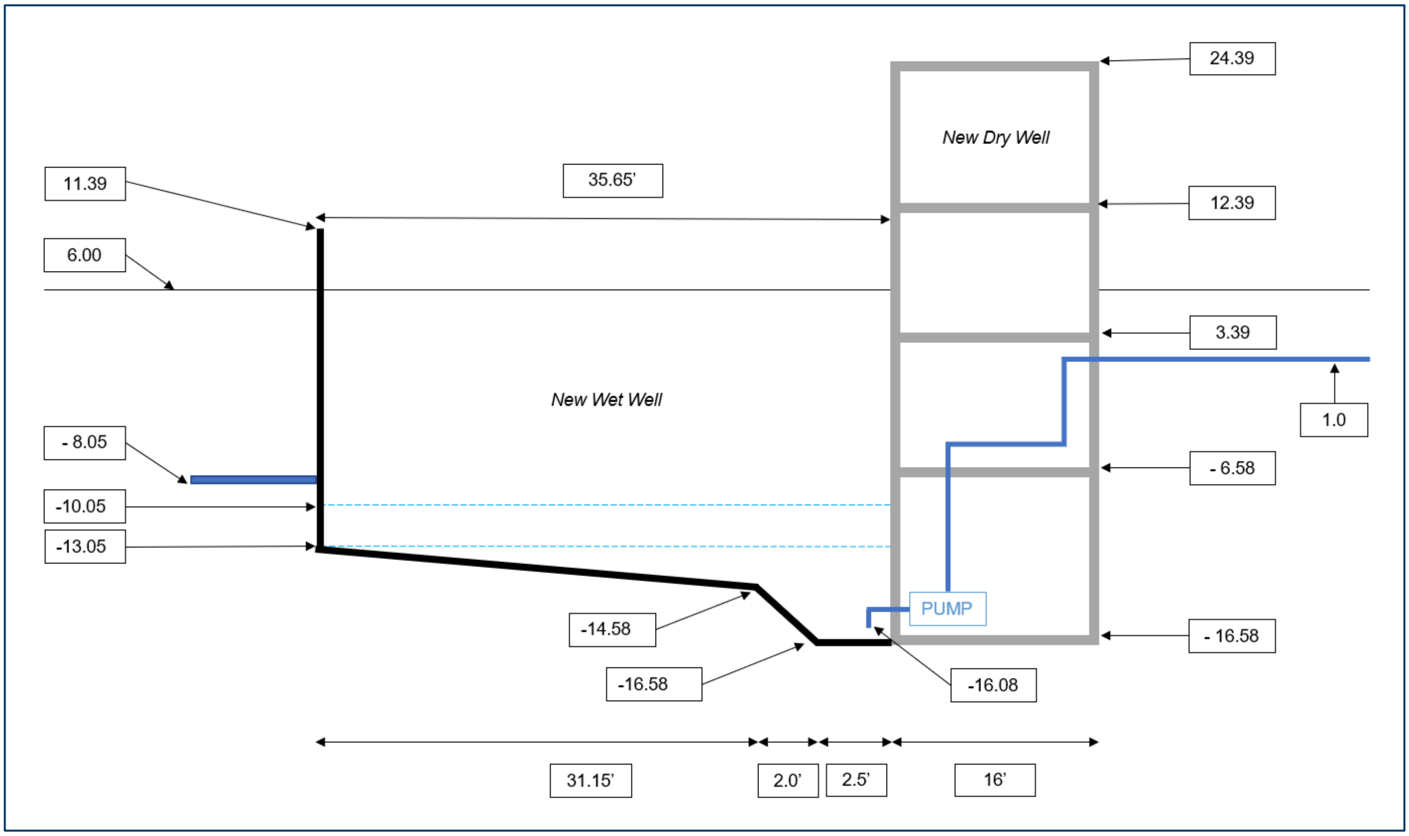



***Figure 24 Options 2a/b/c, Raw Wastewater Pump Station, LS-8 Sectional View***

The new LS-8 threshold elevation will need to be to 12.39 ft to provide 3ft of freeboard to the pumps, which would be located at the lower level. The critical structures exterior to the drywell, generator and odor control, would share a common raised platform with the same 3 feet of freeboard as the LS-8 entry threshold. Access stairs would be required to enter the new dry well operational level as well as to access the generator/odor control platform.

The raw wastewater pumping requirements for the Option 2 concept arrangements are summarized in Table 17.

***Table 17 Option 2, Raw Wastewater Pumping Requirements***

| Ref | Duty Point | Force Main Length (LF) [1] | Wet Well WSE (ft) | Discharge WSE (ft) | Wet Well Operational Volume (CF) | Power Demand (HP) |
|---|---|---|---|---|---|---|
| Option 2a | 3560 gpm, 228 ft | 32,000 | -10.1 | 49.0 | 3,600 | 293 |
| Option 2b/2c | 3560 gpm, 176 ft | 24,000 | --10.1 | 39.0 | 3,600 | 226 |

Note:
1. Force main lengths have been approximated assuming that a suitable site can be identified for a new WWTF within the Lewes postal area. It is assumed that Option 2a would require a longer force main than Option 2b and 2c as the larger required site area is unlikely to be available close to the existing WWTF/ downtown area.

Following consultation with BPW's preferred pump supplier, Gorman-Rupp, the new pumps required to deliver the duty points noted above are suitably sized to allow them to be retro-fitted within the existing dry well, and therefore no structural modifications are required to the dry well arrangement.

### 3.3.3.3 Treated Effluent

A Treated Effluent pump stations will be required for Option 2b and 2c to transfer treated effluent from the new WWTF to the associated outfall locations

Treated effluent pump station wet well sizing schematics for Option 2 are provided in Figure 25 and Figure 26.

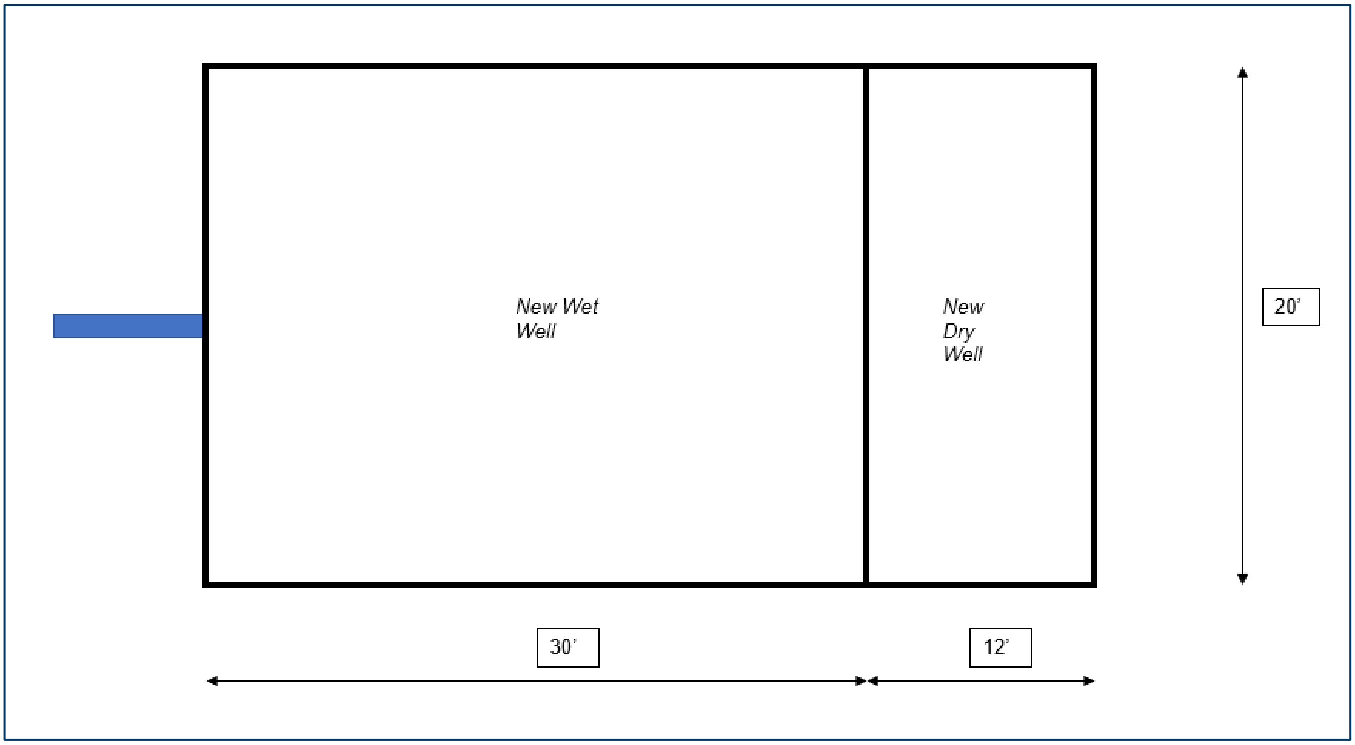



***Figure 25 Options 2b/c, Treated Effluent Pump Station Schematic (Plan)***

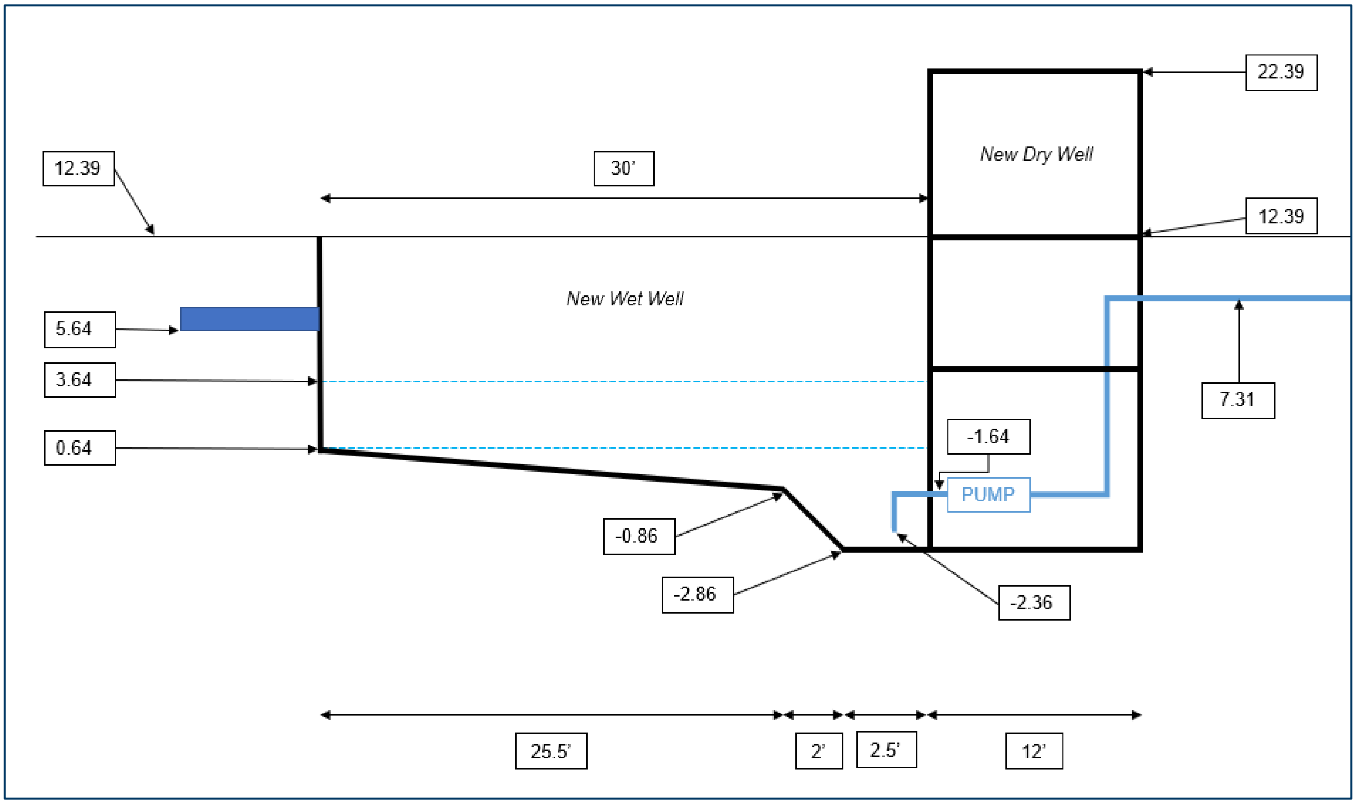



*Figure 26 Options 2b/c, Treated Effluent Pump Station Schematic (Section)*

The treated effluent pumping requirements for the Option 2 concept arrangements are summarized in Table 18.

*Table 18 Option 2, Treated Effluent Pumping Requirements*

| Ref | Duty Point | Force Main Length (LF) | Wet Well WSE (ft) | Discharge WSE (ft) | Wet Well Operational Volume (CF) | Power Demand (HP) |
|---|---|---|---|---|---|---|
| Option 2b | 3560 gpm, 123 ft | 24,000 | 3.64 | 0.00 | 1,800 | 159 |
| Option 2c | 3560 gpm, 221 ft | 42,000 | 3.64 | 0.00 | 1,800 | 284 |

The treated effluent force main length for Option 2b was estimated assuming a suitable site can be identified for a new WWTF within the Lewes postal area.

The Option 2c force main length was estimated assuming that additional sections of pipeline (beyond the location of the existing permitted outfall) would be required to a form a new ocean outfall, as indicated in Figure 27.

The ocean outfall alignment would continue past the existing WWTF and follow E Savannah Rd until it meets Cape Henlopen Drive. The route would then continue east within the paved roadway of Cape Henlopen Drive, following Post Lane through an existing paved parking lot, until reaching the beach.

Following this route would allow the alignment to minimize the impact to Cape Henlopen State Park and avoid the Delaware Bay. To mitigate concerns from stakeholders and the public, the outfall would discharge into the Atlantic Ocean rather than the Delaware Bay and would extend 6000-feet offshore.


*Figure 27* *Options 2c, Treated Effluent Force Main to New Ocean Outfall*

Note: for Option 2a a treated effluent booster pump station has been included in the site arrangements and the capital cost estimates to transfer treated effluent from the effluent storage lagoons to the spray irrigation equipment. Detailed treated effluent booster pump station wet well sizing calculations have not been undertaken as part of the Option 2a concept arrangement.

### 3.3.4 Summary of Upgrade Requirements

The following capital works are required as part of the Option 2a scope of works:

- Reconfiguration of LS-4 and LS-8 piping to consolidate all Lewes wastewater collection network flows at LS-8.
- LS-8 modifications to create new raw wastewater pump station.
- New Activated Sludge WWTF at high elevation, discharging via spray irrigation.

The following capital works are required as part of the Option 2b scope of works:

- Reconfiguration of LS-4 and LS-8 piping to consolidate all Lewes wastewater collection network flows at LS-8.
- LS-8 modifications to create new raw wastewater pump station.
- New Activated Sludge WWTF at high elevation, discharging to existing (relocated) outfall at Lewes and Rehoboth Canal.

The following capital works are required as part of the Option 2c scope of works:

- Reconfiguration of LS-4 and LS-8 piping to consolidate all Lewes wastewater collection network flows at LS-8.
- LS-8 modifications to create new raw wastewater pump station.
- New Activated Sludge WWTF at high elevation, discharging via new ocean outfall.

# 3.4 Option 3: Partnership with Sussex County

## 3.4.1 Overview

Each of the Option 3 concept arrangements would involve transferring raw wastewater from the Lewes collection network to a new combined treatment facility at Sussex County's Wolfe Neck site. The new facility would treat wastewater from both the Lewes and Sussex County collection network.

The two sub-options vary in the proposed discharge method for treated effluent.

The concept arrangements are outlined in further detail below.

Note: concept development for a new combined WWTF at Wolfe Neck is not included in the scope of this report. The Option 3 concept development scope only includes the transfer pumping stations and force mains required to convey raw wastewater to/ from the Lewes collection network.

### 3.4.1.1 Partnership Scope and Responsibilities

For the purposes of concept development, it is assumed that the terms of the existing Lewes BPW/ Sussex County Agreement for Wastewater Service Transfer will apply for the Option 3 facilities.

The key terms of the agreement are as follows:

- The scope boundary between Lewes BPW and Sussex County, is on Gills Neck Road at the intersection with Rodaline Avenue.
  - See Figure 28.
- New wastewater transfer infrastructure constructed to the west of the scope boundary is funded and maintained by Lewes BPW.
- New wastewater transfer infrastructure constructed to the east of the scope boundary is funded and maintained by Sussex County.
- Sussex County will contribute to any costs associated with increasing the treatment capacity of the Lewes WWTF in proportion to the amount of flow that is transferred from Sussex County to BPW's facilities.


*Figure 28 Lewes BPW/ Sussex County Partnership Handshake Point*

Per the agreed scope of the Long Range Planning Study (see Section 1.2, above), estimates will only be produced for costs (capital and operation & maintenance) that Lewes BPW would be responsible for.

Based on the key terms of the BPW/ County partnership outline above, Lewes BPW would be responsible for funding and maintaining the following elements for the Option 3 concept arrangements:

– Raw wastewater pump station.
– Raw wastewater force main from the pumping station to the handshake point.

Conversely, Sussex County would be responsible for funding and maintaining the following elements for the Option 3 concept arrangements:

– Raw wastewater force main from the handshake point to the Wolfe Neck site.
– New combined wastewater treatment facilities at the Wolfe Neck site.
– Treated effluent pump station (Option 3a only).
– Treated effluent force main from Wolfe Neck to Relocated Outfall Location (Option 3a only).
– Relocated Outfall (Option 3a only).

## 3.4.2 Concept Development

### 3.4.2.1 Option 3a

A network schematic for the Option 3a upgrade concept is provided in Figure 29.

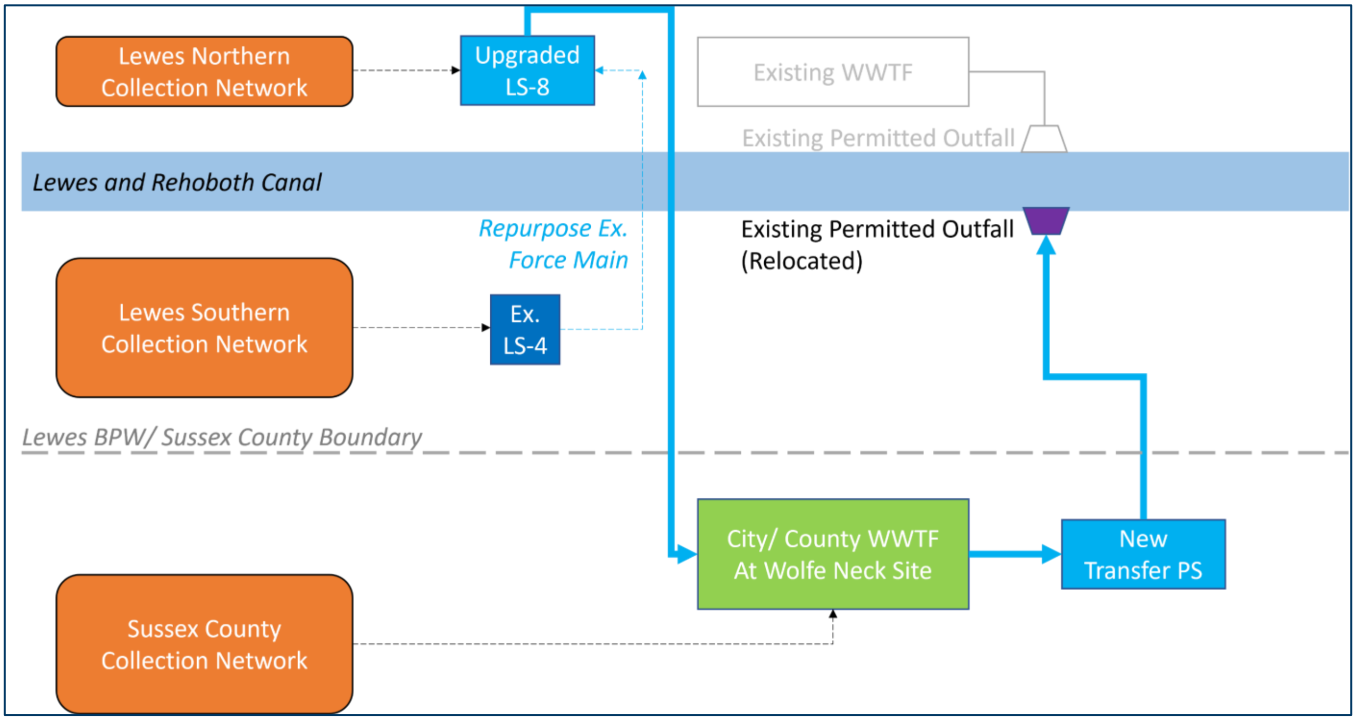



***Figure 29 Option 3a, Network Schematic***

Option 3a would involve consolidating the wastewater flows from the Lewes collection networks and pumping to a new City/ County WWTF located within Sussex County, at the existing Wolfe Neck site. The new WWTF would treat the combined raw wastewater from the Lewes and Sussex County collection networks.

Influent fluctuations would be equalized in the existing lagoon system and treated effluent would only be pumped back to the existing permitted outfall at the Lewes and Rehoboth Canal under outgoing tidal conditions. The benefits of discharging under outgoing tidal conditions would be assessed through additional modeling works, as part of a future design development stage – refer to Section 5 for further details.

### 3.4.2.2 Option 3b

A network schematic for the Option 3b upgrade concept is provided in Figure 30.

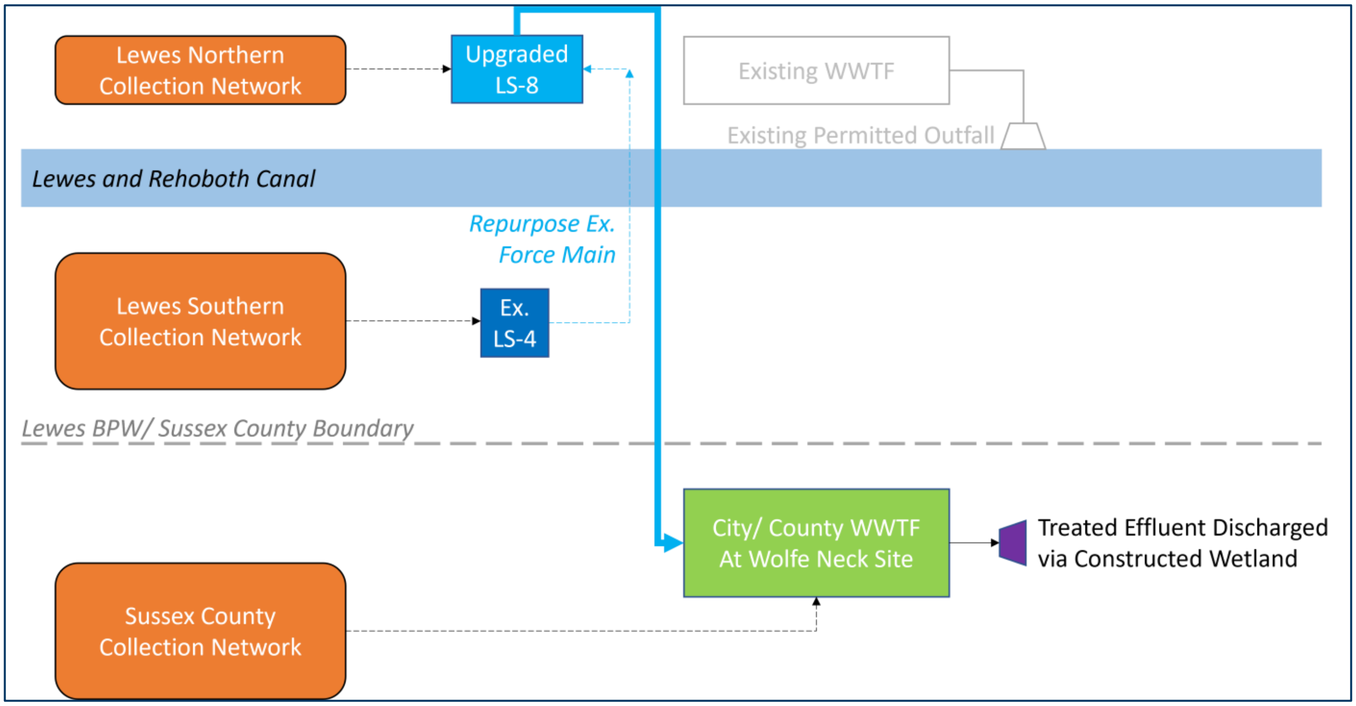



*Figure 30 Option 3b, Network Schematic*

Option 3b would involve consolidating the wastewater flows from the Lewes collection networks and pumping to a new City/ County WWTF located within Sussex County, at the existing Wolfe Neck site. The new WWTF would treat the combined raw wastewater from the Lewes and Sussex County collection networks.

Treated effluent would be discharged via a constructed wetland with vertical discharge, at a site within Sussex County.

Constructed wetlands are defined by the EPA as, "treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality". Note: concept development for the constructed wetland is not included within the scope of this report. It is assumed that the final treated effluent would then be discharged into the Canal.

The County's preferred site for the constructed wetland is on a plot of land which the County currently leases from the State. The existing lease would need to be modified; however, the term of the existing lease extends well beyond the 2050 project planning horizon.

## 3.4.3 Force Mains

### 3.4.3.1 Overview

The following approach has been used to develop the concept arrangements for force main alignments:

- Per the Option 2 concept development, all raw wastewater force mains originate at LS-8 (see Section 3.3.3.2, above, for further details)
  - Likewise, the treated effluent force main (Option 3a only) will discharge via the existing outfall, which will be relocated to the southern side of the Canal.
- Force mains shall follow existing roads and walking paths wherever possible.
- Force mains shall not be installed on private land.

### 3.4.3.2 Raw Wastewater from Lewes Collection Network

For concept development purposes it is assumed that raw wastewater flows from the Lewes collection network will be consolidated at LS-8 (per Option 2 concepts) – refer to Section 3.3.3.2 above, for the required piping configuration.

As indicated in Section 3.3.3.2, the new 16" raw wastewater force main will cross the canal and proceed east along Gills Neck Road.

An extract from the Sussex County GIS database, showing the existing wastewater infrastructure in the area between the BPW/ Sussex County handshake point and the Wolfe Neck site, is provided in Figure 31.

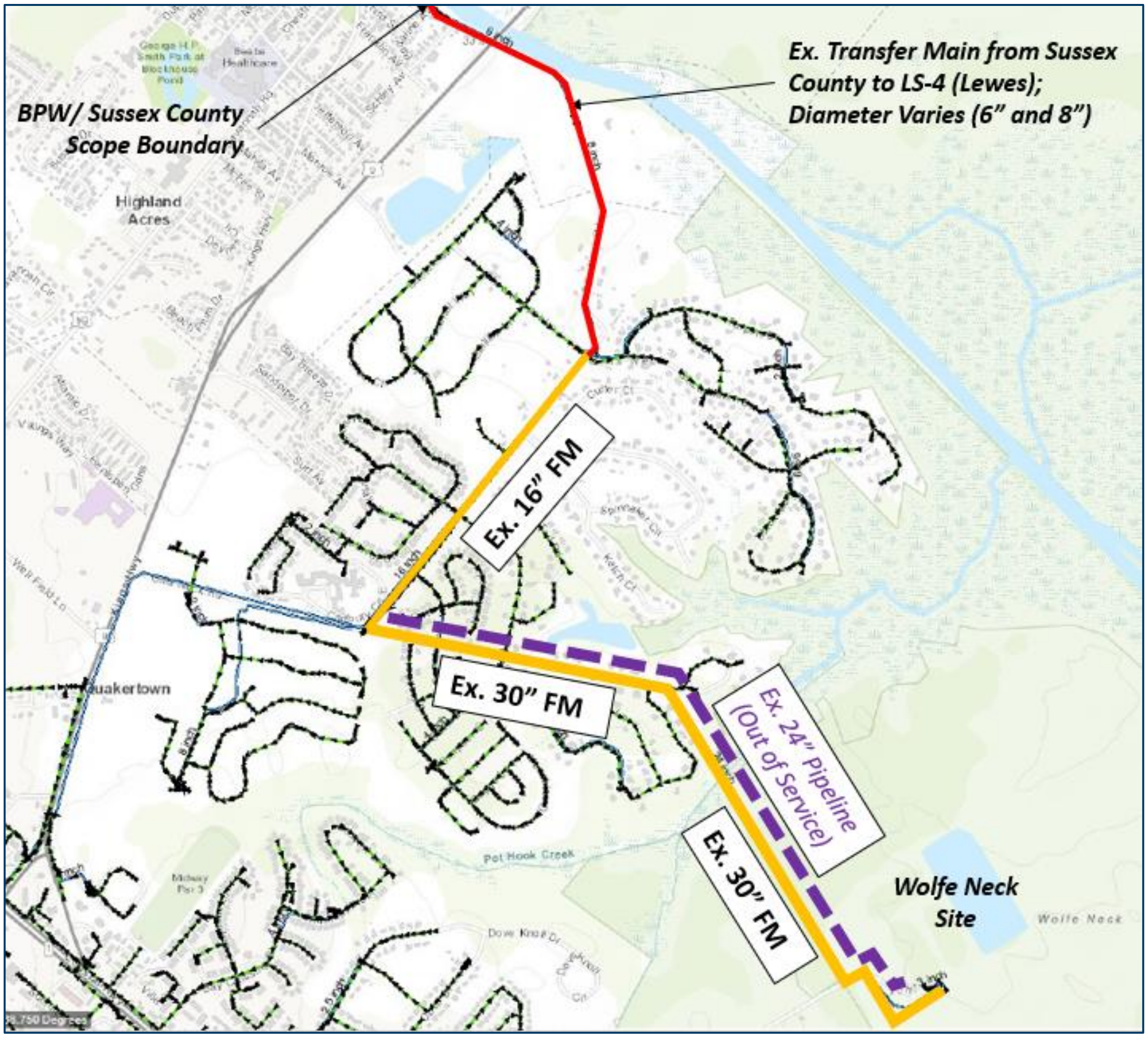



*Figure 31 Existing Sussex County Wastewater Network (GIS Extract)*

The existing 6"/ 8" Sussex County transfer main extends along Gills Neck Road for approximately 5,000 linear feet, up to the intersection of Gills Neck Road and Black Martin Drive.

In the event that an Option 3 concept arrangement is implemented, this transfer main would no longer be required. Therefore, it is assumed that this pipe would be replaced along the same alignment with a new 16" raw wastewater force main.

At the intersection of Gills Neck Road and Black Martin Drive the County has an existing 16" force main, which conveys flows from a small lift pump station located in the adjacent development. The 16" force main connects to a larger 30" force main, which then conveys raw wastewater to the existing Wolfe Neck site.

Sussex County have advised the 16” force main currently conveys very low flows, approximately 0.1 mgd. On that basis, there would be sufficient remaining capacity in the force main to convey the transfer flows from the Lewes collection network to the larger 30” trunk main.

For concept development purposes it is assumed that the existing 16” and 30” force mains can be used to transfer Lewes wastewater flows to Wolfe Neck and that the only new section of force main would be a new 16” main on the same alignment as the existing 6”/ 8” transfer main.

A summary of the Option 3 raw wastewater force mains is provided in Table 19.

*Table 19 Options 3a/3b, Raw Wastewater Force Main Lengths*

| Type | From | To | Details | Force Main Length (mi) |
|---|---|---|---|---|
| Raw Wastewater | LS-8 | BPW/ County Handshake Point | New 16” Force Main, Reuse portion of Ex. WWTF Outfall pipe, New 16” Creek Crossing | 0.55 |
| | BPW/ County Handshake Point | Intersection of Gills Neck Road and Black Martin Drive | New 16” Force Main (replace existing 6”/ 8” transfer main) | 0.97 |
| | Intersection of Gills Neck Road and Black Martin Drive | Gills Neck Road, east of intersection with Cadbury Circle East | Existing 16” Force Main | 0.81 |
| | Gills Neck Road, east of intersection with Cadbury Circle East | Wolfe Neck Site | Existing 30” Force Main | 1.75 |
| | | | **TOTAL** | **4.08** |

### 3.4.3.3 Treated Effluent to Canal Outfall (Option 3a Only)

For Option 3a, a treated effluent force main will be required to transfer combined treated flow from the Wolfe Neck site to the existing (relocated) outfall.

Several potential alignment alternatives have been identified for the force main, and these are presented in Figure 32.


*Figure 32* ***Option 3a, Potential Treated Effluent Force Main Alignment Alternatives***

As indicated in Figure 31 and Figure 32, Sussex County owns an existing, out-of-service 24" pipeline, which runs parallel to the existing 30" force main between Gills Neck Road (east of the intersection with Cadbury Circle East) and the Wolfe Neck site. For concept development purposes, it has been assumed that this sewer can be lined with butt-fusion welded HDPE piping to form the upstream portion of the new treated effluent force main.

Note: the County has advised that the 24" pipeline is constructed from ductile iron and was recently pressure-tested to confirm operability for force main applications. However, for concept development purposes, it has been assumed that the pipeline will need to be relined in order to remain in service up to the 2050 project planning horizon.

Downstream of this location, a new force main will be required to convey treated effluent to the permitted outfall.

Three alignment options have been identified between the end of the ex. 24" pipeline (to be relined) and the permitted outfall. The three alignments have a common section between Cadbury Circle East and the intersection of Gills Neck Road and Spinnaker Drive, which has been labelled as "Alignment 0" in Figure 32.

The three unique alignment options for the new force main have been assessed by assigning a risk rating to reflect the expected difficulty of implementing each option.

Risk rating scores vary as follows:

- 1 = Low Risk
- 2 = Moderate Risk
- 3 = High Risk

Risk ratings were evaluated for the following criteria for each alignment option:

- Utility Congestion
- Traffic Density
- Construction Access
- Permitting
- Operation & Maintenance

The risk ratings for the new force main alignment options 1, 2 and 3 are summarized in Table 20.

*Table 20 Option 3a, Treated Effluent Force Main, New Section Alignment Options*

| Criteria | Alignment Option 1 - Gills Neck Rd (North of Spinnaker Dr.) | | | Alignment Option 2 - Show Jumper Ln & Monroe Ave | | | Alignment Option 3 – Junction & Breakwater Trail | | |
|---|---|---|---|---|---|---|---|---|---|
| | Risk Rating | Comment | Score | Risk Rating | Comment | Score | Risk Rating | Comment | Score |
| Utility Congestion | Low | Ex. Force main (to be upsized for raw wastewater main) located along this alignment. Opportunity to install both pipes in common trench. | 1 | High | Ex. Utilities in place to supply new housing development. Ex. Wastewater pipes in place on Gills Neck Road. | 3 | Low | No know services in this portion of the trail. | 1 |
| Traffic Density | High | Works would lead to prolonged disruption along portion of Gills Neck Road. | 3 | Moderate | Works within housing development would disrupt local traffic. | 2 | Low | Works completed within walking trail, away from roadways. | 1 |
| Construction Access | Low | Works undertaken along roadway. | 1 | Moderate | Works undertaken predominantly in roadway, however access within the housing development would need to be coordinated with residents. | 2 | Moderate | Truck access to section of trail adjacent to Horseshoe crescent may require crossing private land. | 2 |
| Permitting | Low | Assumed existing easements in place along alignment due to existing force mains. | 1 | High | Access required to construct in recently completed private development. Section of alignment require temporary closure of walking trail. | 3 | Moderate | Requires temporary closure of walking trail, no existing easements in this area. | 2 |
| Operation and Maintenance | Low | Publicly accessible roads. | 1 | Moderate | Some publicly accessible trails/ roads but coordination also required with residents within housing development. | 2 | Moderate | Publicly accessible trail, however access for maintenance vehicles/ equipment would be difficult | 2 |
| **TOTAL** | | | **7** | | | **12** | | | **8** |

Option 1 has the lowest total risk rating and therefore is considered the preferred option for concept development purposes.

A summary of preferred force main alignment options is provided in Table 21.

*Table 21 Option 3a, Treated Effluent Force Main Lengths*

| Type | Zone | Alignment Option | Force Main Length (mi) |
|---|---|---|---|
| Treated Effluent | Ex. Pipeline to be relined with HDPE | Existing | 1.30 |
| | New Force Main, Gills Neck Road (South of Spinnaker Dr.) | 0 | 0.50 |
| | New Force Main, Gills Neck Road (North of Spinnaker Dr.) | 1 | 1.50 |
| | | **TOTAL** | **3.30** |

## 3.4.4 Pumping Requirements

### 3.4.4.1 Overview

The approach used to develop the concept arrangements for the Option 3 wastewater pump stations is the same as was used for Option 2 pump station (see Section 3.3.3.1, above), with the exception of the following items:

– The Raw wastewater pump station shall be sized to convey the 2050 Peak Hour Design Flow for the Lewes collection network
  - 5.13 mgd; 3560 gpm
  - 16” nominal diameter HDPE force main assumed
  - Hazen-Williams roughness coefficient, C = 150

– The Treated effluent pump station and shall be sized to convey the 2050 Max. Month Design Flow for the combined Lewes & Sussex County collection networks
  - 4.10 mgd; 2850 gpm
  - 14” nominal diameter HDPE force main assumed
  - Hazen-Williams roughness coefficient, C = 150

Hydraulic calculations are provided in Appendix C.

### 3.4.4.2 Raw Wastewater

The raw wastewater pump station for Option 3 will be located at LS-8 and will have the same arrangement and convey the same flow rate as for the Option 2 concepts – refer to Section 3.3.3.2 for schematic layout details.

The raw wastewater pumping requirements for the Option 3 concept arrangements are summarized in Table 22.

*Table 22 Option 3, Raw Wastewater Pumping Requirements*

| Ref | Duty Point | Force Main Length (LF) | Wet Well WSE (ft) | Discharge WSE (ft) | Wet Well Operational Volume (CF) | Power Demand (HP) |
|---|---|---|---|---|---|---|
| Option 3a/3b | 3560 gpm, 107 ft | 21,600 | -10.05 | 50.00 | 1,800 | 138 |

### 3.4.4.3 Treated Effluent (Option 3a Only)

A Treated Effluent pump station will be required for Option 3a to transfer treated effluent from the new combined WWTF at the Wolfe Neck site to the existing (relocated) outfall at the Canal.

Treated effluent pump station wet well sizing schematics for Option 3a are provided in Figure 33 and Figure 34.

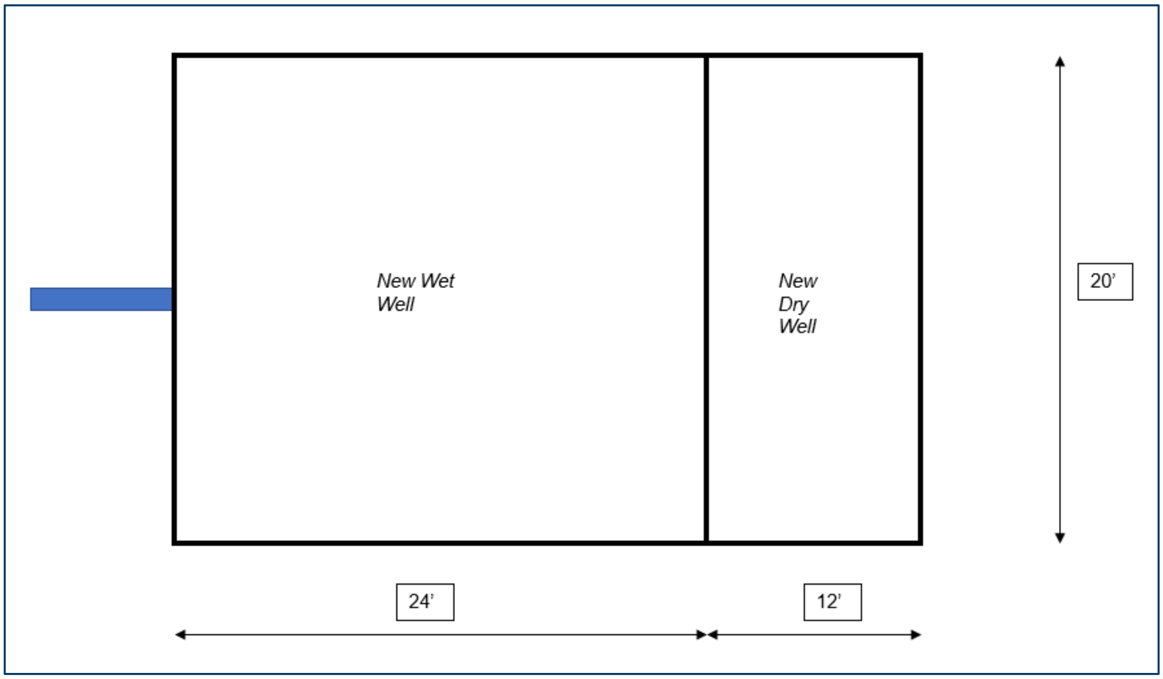



*Figure 33 Option 3a, Treated Effluent Pump Station Schematic (Plan)*

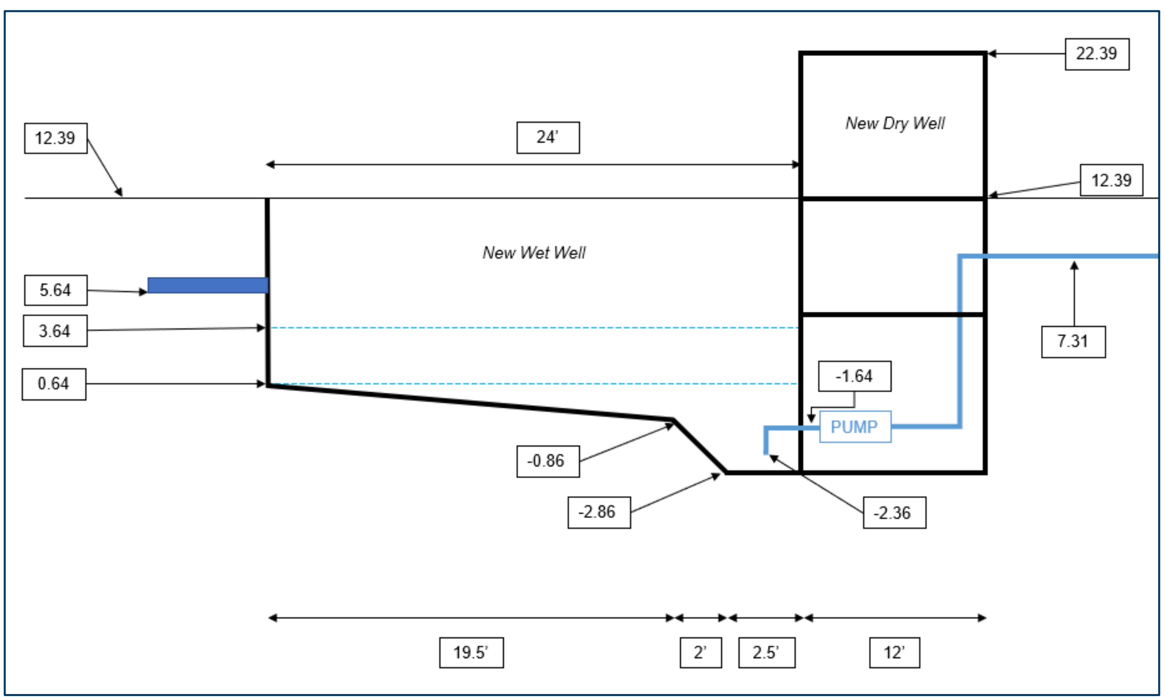



*Figure 34 Option 3a, Treated Effluent Pump Station Schematic (Section)*

The treated effluent pumping requirements for the Option 3a concept arrangement are summarized in Table 23.

*Table 23 Option 3a, Treated Effluent Pumping Requirements*

| Ref | Duty Point | Force Main Length (LF) | Wet Well WSE (ft) | Discharge WSE (ft) | Wet Well Operational Volume (CF) | Power Demand (HP) |
|---|---|---|---|---|---|---|
| Option 3a | 2850 gpm, 115 ft | 17,500 | 3.64 | 0.00 | 1,440 | 118 |

### 3.4.5 Summary of Upgrade Requirements

The following capital works are required as part of the Option 3a scope of work:

– Lewes BPW Responsibility:
  - Raw wastewater pump station.
  - Raw wastewater force main from the pumping station to the scope boundary.

– Sussex County Responsibility:
  - Raw wastewater force main from the scope boundary to the Wolfe Neck site.
  - New combined wastewater treatment facilities at the Wolfe Neck site.
  - Treated effluent pump station.
  - Treated effluent force main from Wolfe Neck to Relocated Outfall Location.
  - Relocated Outfall.

The following capital works are required as part of the Option 3b scope of works:

– Lewes BPW Responsibility:
  - Raw wastewater pump station.
  - Raw wastewater force main from the pumping station to the scope boundary.

– Sussex County Responsibility:
  - Raw wastewater force main from the scope boundary to the Wolfe Neck site.
  - New combined wastewater treatment facilities at the Wolfe Neck site, including a constructed wetland with vertical discharge.

Note: concept development for a new combined WWTF at Wolfe Neck is not included in the scope of this report. The Option 3 concept development scope only includes the transfer pumping stations and force mains required to convey raw wastewater to/ from the Lewes collection network.

# 4. Long Range Upgrade Options: Evaluation

## 4.1 Cost

Preliminary Capital Cost Estimates and 2050 Net Present Value (NPV) Operation & Maintenance (O&M) Cost Estimates for the long range planning study concepts are outlined below.

All costs are presented in 2022 US Dollars.

Note: concept development and capital cost estimation for a new combined WWTF at Wolfe Neck is not included in the scope of this report. The Option 3 concept development scope only includes the transfer pumping stations and force mains required to convey raw wastewater to/ from the Lewes collection network. Capital costs associated with upgrading the treatment facilities at Wolfe Neck will be completed under a separate work order.

However, estimates have been developed for the O&M costs associated with a combined facility (Option 3), using existing budgetary figures from a comparable WWTF owned and operated by Sussex County. Per the terms of the existing BPW/ Sussex County Agreement for Wastewater Service Transfer, it has been assumed that BPW would be responsible for a proportion of the total O&M costs for a combined facility based on the proportion of the total treated flow that is transferred from the Lewes collection network to the new facility. The Basis of Design flow rates for a combined facility (see Section 3.1.2, above) assume a 50% flow contribution from the Lewes collection network, and therefore it has been assumed that BPW will be responsible for 50% of the O&M costs for a combined facility.

Land valuation estimates were provided to GHD by Lewes BPW.

### 4.1.1 Preliminary Capital Cost Estimates

The preliminary capital cost estimates for the long range planning study concepts are summarized in Table 24.

***Table 24 Preliminary Capital Cost Estimates***

| | Option 1 | Option 2a | Option 2b | Option 2c | Option 3a[1] | Option 3b[2] |
|---|---|---|---|---|---|---|
| General Conditions | $2,000,000 | $13,500,000 | $10,000,000 | $16,000,000 | $1,500,000 | $1,500,000 |
| Land Purchase | $0 | $12,500,000 | $1,000,000 | $1,000,000 | $0 | $0 |
| Demolition – Ex. Facility | $0 | $3,500,000 | $3,500,000 | $3,500,000 | $3,500,000 | $3,500,000 |
| Network Upgrades | $0 | $9,500,000 | $13,500,000 | $49,000,000 | $4,000,000 | $4,000,000 |
| Civil – WWTF | $1,500,000 | $14,500,000 | $4,500,000 | $4,500,000 | $0 | $0 |
| Arch/HVAC | $500,000 | $2,000,000 | $2,000,000 | $2,000,000 | $0 | $0 |
| Structural Concrete | $3,000,000 | $7,500,000 | $7,000,000 | $7,000,000 | $0 | $0 |
| Mech/Equipment | $4,000,000 | $13,500,000 | $13,000,000 | $13,500,000 | $0 | $0 |
| Electrical | $2,500,000 | $15,500,000 | $13,000,000 | $14,000,000 | $2,500,000 | $2,500,000 |
| **Construction Subtotal** | **$18,000,000** | **$125,000,000** | **$91,000,000** | **$149,000,000** | **$16,000,000** | **$16,000,000** |
| Contingency (35%) | $4,500,000 | $31,000,000 | $23,000,000 | $37,500,000 | $4,000,000 | $4,000,000 |
| **Construction Total** | **$23,000,000** | **$156,000,000** | **$114,000,000** | **$186,500,000** | **$20,000,000** | **$20,000,000** |
| Legal, Admin., and Eng. (25%) | $4,000,000 | $26,000,000 | $18,500,000 | $33,000,000 | $3,000,000 | $3,000,000 |
| **TOTAL** | **$23,000,000** | **$156,000,000** | **$114,000,000** | **$186,500,000** | **$20,000,000** | **$20,000,000** |

Notes:
1. Cost Estimates presented for Option 3a are for Lewes BPW's component of the total project cost only; The total project costs, excluding the WWTF upgrades, would be $35,000,000; Sussex County's component of the project costs would be $15,000,000.
2. Cost Estimates presented for Option 3b are for Lewes BPW's component of the total project cost only; The total project costs, excluding the WWTF upgrades, would be $22,500,000; Sussex County's component of the project costs would be $2,500,000.

A detailed breakdown for the Preliminary Capital Cost Estimates is provided in Appendix D.

### 4.1.2 Operation & Maintenance Cost Estimates

Operation & Maintenance (O&M) cost estimates are provided below; costs presented in the following sections are the costs that would be incurred by Lewes BPW only.

#### 4.1.2.1 Estimate of Annual O&M costs

The estimated annual O&M costs for the long range planning study concepts are summarized in Table 25.

*Table 25 Estimated Annual O&M Costs for Concept Options*

| Parameter | Option 1 | Option 2a | Option 2b | Option 2c | Option 3a[1] | Option 3b[1] |
|---|---|---|---|---|---|---|
| WWTF Operations & Maintenance | $1,520,000 | $720,000 | $720,000 | $720,000 | $720,000 | $720,000 |
| Periodic Equipment Replacement | $500,000 | $330,000 | $320,000 | $320,000 | $240,000 | $240,000 |
| Transfer Pump Station Energy Use | $0 | $30,000 | $50,000 | $60,000 | $20,000 | $20,000 |
| **TOTAL** | **$2,020,000** | **$1,080,000** | **$1,090,000** | **$1,100,000** | **$980,000** | **$980,000** |

Note:

1. Cost Estimates presented for Option 3a and Option 3b are for Lewes BPW's component of the total project cost only. It has been assumed that BPW would be responsible for 50% of the O&M costs for a combined facility.

#### 4.1.2.2 Estimate of 2050 Net Present Value O&M Costs

The estimated 2050 NPV for O&M costs for the long range planning study concepts are summarized in Table 26 and Figure 35.

*Table 26 Estimated 2050 NPV O&M Costs for Concept Options*

| Parameter | Option 1 | Option 2a | Option 2b | Option 2c | Option 3a[1] | Option 3b[1] |
|---|---|---|---|---|---|---|
| WWTF Operations & Maintenance | $61,500,000 | $29,000,000 | $29,000,000 | $29,000,000 | $29,000,000 | $29,000,000 |
| Periodic Equipment Replacement | $14,000,000 | $9,500,000 | $9,000,000 | $9,000,000 | $6,500,000 | $6,500,000 |
| Transfer Pump Station Energy Use | $0 | $1,500,000 | $2,000,000 | $2,500,000 | $500,000 | $500,000 |
| **NET PRESENT WORTH** | **$75,500,000** | **$40,000,000** | **$40,000,000** | **$40,500,000** | **$36,000,000** | **$36,000,000** |

Note:

1. Cost Estimates presented for Option 3a and Option 3b are for Lewes BPW's component of the total project cost only. Per the terms of the existing BPW/ Sussex County Agreement for Wastewater Service Transfer, it has been assumed that BPW would be responsible for 50% of the O&M costs for a combined facility.

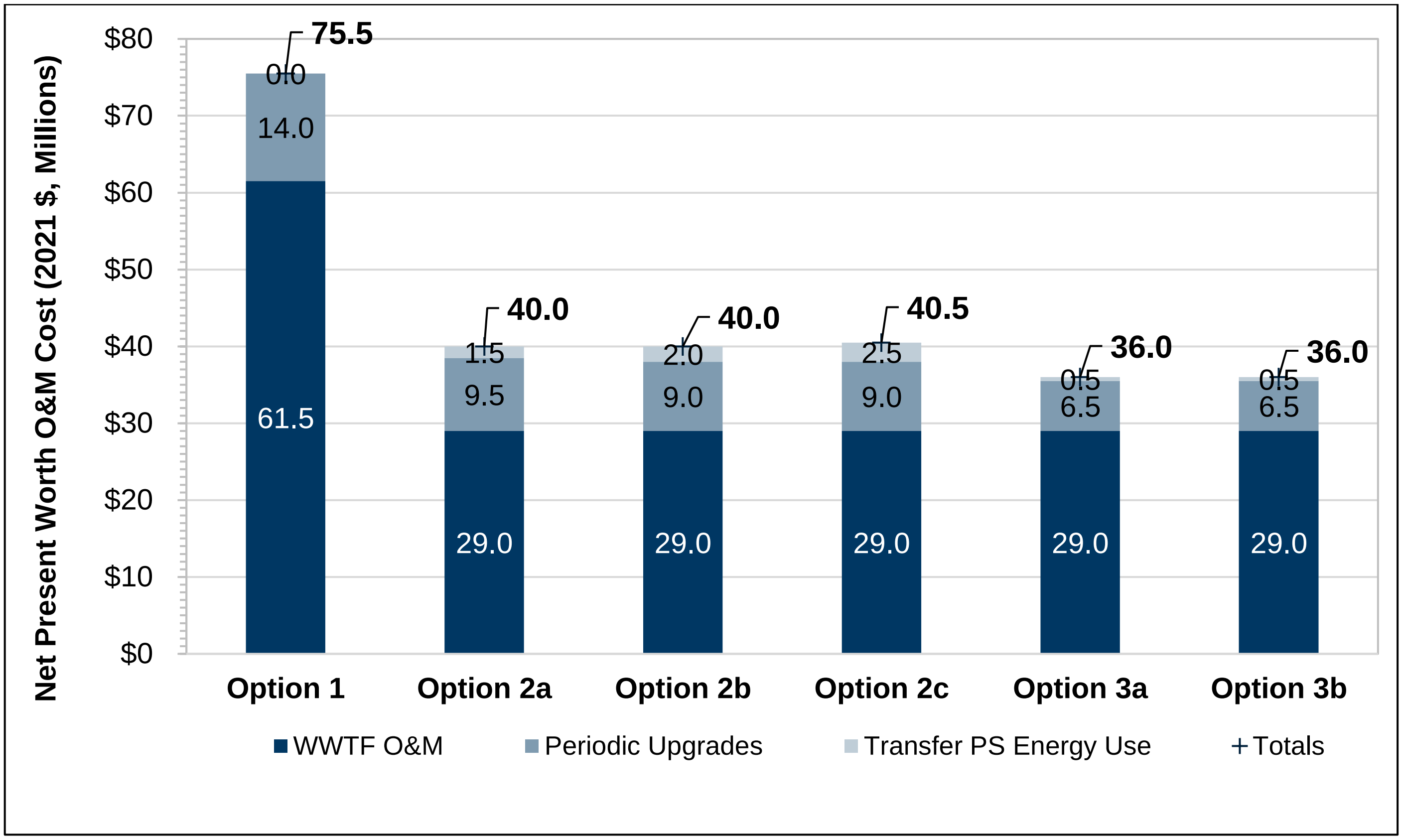



***Figure 35*** ***2050 NPV O&M Cost Summary for Concept Options***

A detailed breakdown for the Operation & Maintenance Cost Estimates is provided in Appendix E.

# 4.2 Multi-Criteria Analysis

A multi-criteria analysis was performed to evaluate the concept options based on a series of non-cost criteria.

Table 27 shows the evaluation criteria, performance measures, rating scale, and weighting factors used for the multi-criteria analysis for the long range planning study concepts.

Each evaluation category has been assigned a weighting to reflect the relatively criticality of each category.

***Table 27*** ***MCA Evaluation Criteria***

| Evaluation Category | Evaluation Criteria | Performance Measure | Weighting | Rating = 1 (Worst) | Rating = 3 (Average) | Rating = 5 (Best) |
|---|---|---|---|---|---|---|
| **Permitting & Schedule** | Permitting Complexity | The expected volume and complexity of permitting procedures | **1** | Greater than other options | Comparable to other options | Less than other options |
| | Delivery Schedule | The length of the overall project implementation schedule including design, permitting and construction stages | **2** | Greater than other options | Comparable to other options | Less than other options |

| Evaluation Category | Evaluation Criteria | Performance Measure | Weighting | Rating = 1 (Worst) | Rating = 3 (Average) | Rating = 5 (Best) |
|---|---|---|---|---|---|---|
| | Property & Easement Acquisition | The complexity of obtaining required additional property and easement acquisition for treatment facilities and conveyance piping | **2** | Greater than other options | Comparable to other options | Less than other options |
| | Interagency & Regulatory Coordination | The schedule risk associated with coordination and approvals from other political bodies (such as Sussex County) or regulatory approvals which are outside of the control of the Lewes Board of Public Works | **1** | Greater than other options | Comparable to other options | Less than other options |
| **Community & Environmental Impacts** | Stakeholder Impacts - Construction Stage | Temporary impacts to the community during the construction stage due to traffic volume, road closures, noise and other factors | **1** | Greater than other options | Comparable to other options | Less than other options |
| | Stakeholder Impacts - Long Term | Long term impacts to the community due to ongoing site traffic, odor, aesthetics and other factors | **2** | Greater than other options | Comparable to other options | Less than other options |
| | Water Quality Impacts for Inland Bays | The likelihood that the proposed treatment process will negatively impact the water quality of the Inland Bays | **3** | More Likely than other options | Comparable to other options | Less Likely than other options |

| Evaluation Category | Evaluation Criteria | Performance Measure | Weighting | Rating = 1 (Worst) | Rating = 3 (Average) | Rating = 5 (Best) |
|---|---|---|---|---|---|---|
| | Overall Environmental Risk | Likelihood of environmental impacts due to failure/ flood damage at treatment facilities, force mains, pumping facilities or other components | 3 | More Likely than other options | Comparable to other options | Less Likely than other options |
| | Sustainability and Energy & Chemical Use | Energy, chemical usage and overall sustainability associated with the proposed treatment and conveyance facilities | 1 | Less Sustainable than other options | Comparable to other options | More Sustainable than other options |
| | Land Use within City of Lewes | Amount of land required within the City of Lewes for wastewater treatment infrastructure | 1 | Greater than other options | Comparable to other options | Less than other options |
| **Operation & Maintenance** | Impact to WWTF Operations During Construction | The extent to which the proposed upgrades will affect the operation and resilience of existing treatment and conveyance facilities | 1 | More Likely than other options | Comparable to other options | Less Likely than other options |
| | Operational Complexity | The level of operational effort required to maintain treatment performance and the difficulty in obtaining qualified staff | 3 | Greater than other options | Comparable to other options | Less than other options |
| | Future Flexibility | The extent to which the proposed treatment and conveyance facilities can be adapted to meet future environmental and compliance conditions | 2 | Less Likely than other options | Comparable to other options | More Likely than other options |

The MCA scoring and evaluation comments for the long range planning study concepts are summarized in Table 28.

*Table 28 MCA Scoring and Evaluation*

| Category/ Criteria | Performance Measures | Criteria Weighting | Option 1 | | | Option 2a | | | Option 2b | | | Option 2c | | | Option 3a | | | Option 3b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments |
| Permitting & Schedule | | | | | | | | | | | | | | | | | | | | |
| Permitting Complexity | The expected volume and complexity of permitting procedures | **1** | 4 | **4** | Adding flood berms around the site will require significant permitting effort within the flood plain, but since site already owned by City and already used for treatment this will mitigate complexity | 2 | **2** | Permitting a new greenfield facility with on-site discharge requires extensive permitting depending on the site and existing environmental features | 3 | **3** | Similar to Option 2 with regards to permitting the greenfield site, but does not require permitting associated with on-site disposal | 1 | **1** | New ocean outfall permitting will be extensive | 5 | **5** | Permitting on existing Wolfe Neck treatment plant site is anticipated to be easier since site is already used for treatment and author believes it to be above 100 year flood plain | 3 | **3** | While treatment permitting should be simplified, permitting for expanded onsite disposal using wetlands will be challenging (Sussex County has already done some advance work, scoring could change if positively received by DNREC and full approval is granted for wetlands concept at Inland Bays)' |

| Category/ Criteria | Performance Measures | Criteria Weighting | Option 1 | | | Option 2a | | | Option 2b | | | Option 2c | | | Option 3a | | | Option 3b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments |
| Delivery Schedule | The length of the overall project implementation schedule including design, permitting and construction stages | **2** | 5 | **10** | All work on existing City treatment plant property, least amount of required new facilities | 2 | **4** | Significant time anticipated to finalize, acquire, permit new treatment plant site and onsite disposal, along with easements for transfer piping | 2 | **4** | Similar to Option 2a | 1 | **2** | Timeline for new ocean outfall permitting is extensive, on top of all else in Option 2 for greenfield plant | 4 | **8** | Work anticipated to be able to proceed relatively fast following design at Wolfe Neck site | 3 | **6** | Longer schedule for delivery than Option 3b due to anticipated longer schedule to obtain wetlands discharge permits |
| Property & Easement Acquisition | The complexity of obtaining required additional property and easement acquisition for treatment facilities and conveyance piping | **2** | 5 | **10** | City already owns all required property | 1 | **2** | City must obtain both treatment plant property and conveyance easements | 1 | **2** | Similar to Option 2a | 1 | **2** | Similar to Option 2b | 4 | **8** | County owns treatment plant property, but some easements needed for transfer piping | 4 | **8** | County owns treatment plant property, but some easements needed for transfer piping |

| Category/ Criteria | Performance Measures | Criteria Weighting | Option 1 | | | Option 2a | | | Option 2b | | | Option 2c | | | Option 3a | | | Option 3b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments |
| Interagency & Regulatory Coordination | The schedule risk associated with coordination and approvals from other political bodies (such as Sussex County) or regulatory approvals which are outside of the control of the Lewes Board of Public Works | **1** | 5 | **5** | N/A | 5 | **5** | N/A | 5 | **5** | N/A | 1 | **1** | Likely additional approvals required for ocean outfall since not on current City property | 2 | **2** | Requires interagency coordination with Sussex Co | 2 | **2** | Requires interagency coordination with Sussex Co |
| Community & Environmental Impacts | | | | | | | | | | | | | | | | | | | | |
| Stakeholder Impacts - Construction Stage | Temporary impacts to the community during the construction stage due to traffic volume, road closures, noise and other factors | **1** | 4 | **4** | Increase truck traffic and construction noise near downtown at existing WWTP site, but already industrial use site | 2 | **2** | Less construction required at existing WWTP site which is near downtown, but will have piping work in community disrupting traffic and work at greenfield site will disrupt local residents | 2 | **2** | Similar to Option 2a | 2 | **2** | Ocean outfall construction may be visible to public | 3 | **3** | Similar to Option 2a | 3 | **3** | Similar to Option 2a |
| Stakeholder Impacts - Long Term | Long term impacts to the community due to ongoing site traffic, odor, aesthetics and other factors | **2** | 1 | **2** | Ongoing industrial site use and truck traffic in central Lewes near downtown | 2 | **4** | Depends on selected site, may be less impactful to broader community if site is further from downtown and more isolated, but could still impact surrounding residents | 2 | **4** | Similar to Option 2a | 2 | **4** | Similar to Option 2a | 5 | **10** | Limited long term impact to Lewes residents | 5 | **10** | Similar to Option3a |
| Water Quality Impacts for Inland Bays | The likelihood that the proposed treatment process will negatively impact the water quality of the Inland Bays | **3** | 3 | **9** | Should be no better or worse than current situation | 5 | **15** | should be improvement from current situation since no more direct discharge into Lewes canal or (indirectly) the inland bays | 3 | **9** | Similar to Option 1 | 5 | **15** | Similar to Option 2a | 3 | **9** | Similar to Option 1 | 5 | **15** | Similar to Option 2a |

| Category/ Criteria | Performance Measures | Criteria Weighting | Option 1 | | | Option 2a | | | Option 2b | | | Option 2c | | | Option 3a | | | Option 3b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments |
| Overall Environmental Risk | Likelihood of environmental impacts due to failure/ flood damage at treatment facilities, force mains, pumping facilities or other components | **3** | 1 | **3** | Existing site is subject to limited access and isolation during flood events | 3 | **9** | Assuming new site is above floodplain, should not be significantly impacted by flooding events. However, may have issues with effluent disposal during excessive precipitation/cold weather periods | 5 | **15** | Assuming new site is above floodplain, least risk of impacts from flood or weather related events | 5 | **15** | Similar to Option 2b | 5 | **15** | Similar to Option 2b | 4 | **12** | Proposed wetlands disposal less impacted by weather than RIBS or spray proposed for Option 2a |
| Sustainability and Energy & Chemical Use | Energy, chemical usage and overall sustainability associated with the proposed treatment and conveyance facilities | **1** | 1 | **1** | Existing MBR process more energy and chemical intense than other alts | 5 | **5** | Aerated lagoon process less energy intense, onsite disposal so limited effluent pumping | 4 | **4** | Similar to Option 2a, but requires pumping back to existing outfall | 4 | **4** | Similar to Option 2b | 4 | **4** | Similar to Option 2b | 5 | **5** | Similar to Option 2a |
| Land Use within City of Lewes | Amount of land required within the City of Lewes for wastewater treatment infrastructure | **1** | 3 | **3** | Same as existing | 1 | **1** | Likely larger property required than existing for treatment and disposal | 2 | **2** | Larger than existing, but not as large as Option 2a since no onsite disposal | 2 | **2** | Similar to Option 2b | 5 | **5** | Only small property needed for PSs | 5 | **5** | Similar to Option 3a |
| Operation & Maintenance | | | | | | | | | | | | | | | | | | | | |
| Impact to WWTF Operations During Construction | The extent to which the proposed upgrades will affect the operation and resilience of existing treatment and conveyance facilities | **1** | 1 | **1** | Process upgrades at existing plant will need to be coordinated to maintain operations and permit compliance | 5 | **5** | Almost all new work is greenfield, just limited to switchover for PS discharge | 4 | **4** | Similar to Option 2a, but also need switchover of outfall connection | 5 | **5** | Similar to Option 2a | 5 | **5** | Similar to Option 2a | 5 | **5** | Similar to Option 2a |
| Operational Complexity | The level of operational effort required to maintain treatment performance and the difficulty in obtaining qualified staff | **3** | 1 | **3** | City will be responsible for operating facility - either with own staff or by retaining a contract operator | 2 | **6** | Similar to Option 1, but conventional process easier to operate and maintain than a MBR | 2 | **6** | Similar to Option 2a | 2 | **6** | Similar to Option 2a | 5 | **15** | City will have no plant operations responsibilities, only the collection system. County is a large organization and has qualified operators | 5 | **15** | Similar to Option 3a |

| Category/ Criteria | Performance Measures | Criteria Weighting | Option 1 | | | Option 2a | | | Option 2b | | | Option 2c | | | Option 3a | | | Option 3b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments | Rating | Score (Weight * Rating) | Comments |
| Future Flexibility | The extent to which the proposed treatment and conveyance facilities can be adapted to meet future environmental and compliance conditions | **2** | 5 | **10** | MBR treatment is state of the art, can potentially meet lower effluent limits | 3 | **6** | Aerated lagoon treatment followed by filtration may need supplemental processes (like membranes) added to meet future lower limits | 3 | **6** | Similar to Option 2a | 3 | **6** | Similar to Option 2a | 3 | **6** | Similar to Option 2a | 3 | **6** | Similar to Option 2a |
| TOTAL | | | | **65** | | | **66** | | | **66** | | | **65** | | | **95** | | | **95** | |

The MCA scoring is summarized in Figure 36.

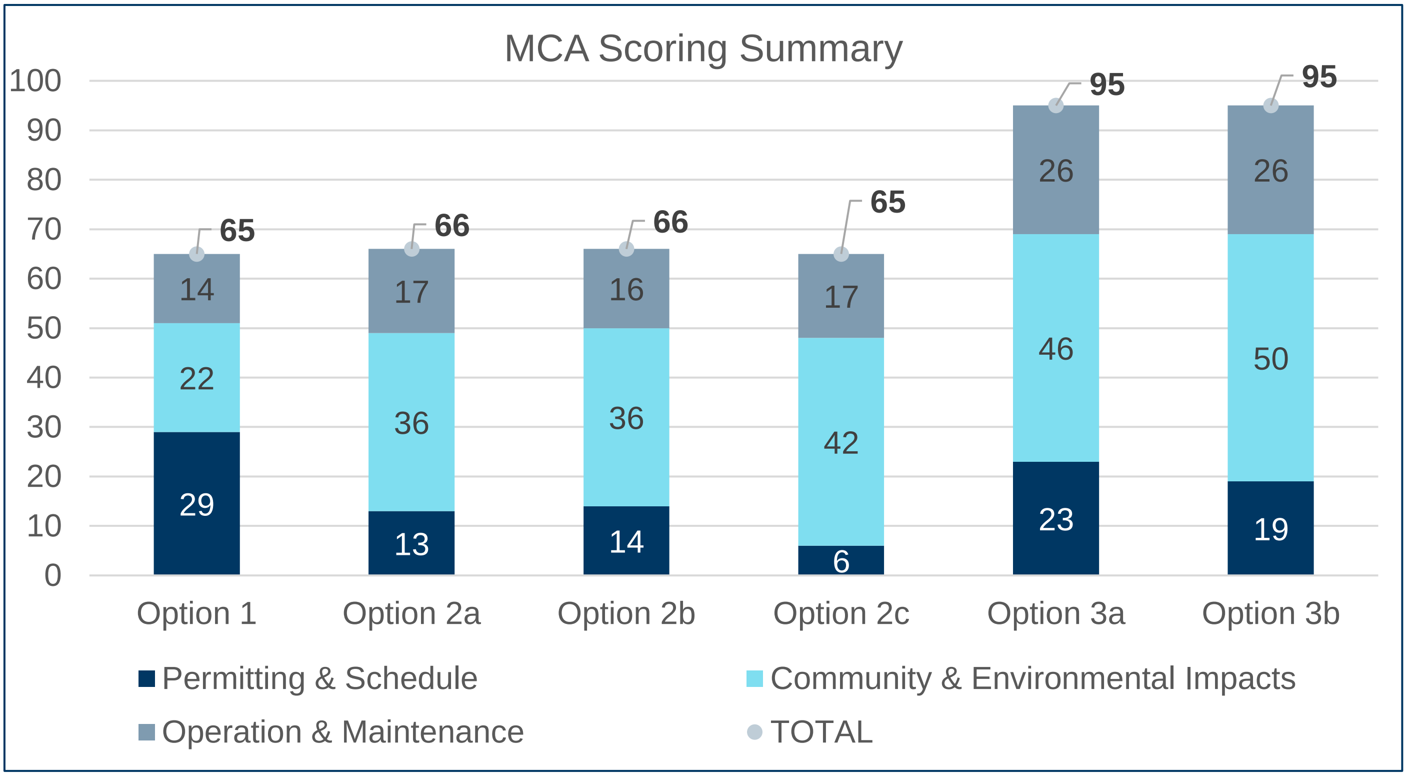



*Figure 36 MCA Scoring Summary*

## 4.3 Project Lifecycle Cost Estimates

The estimated Project Lifecycle Cost is the sum of the Preliminary Capital Cost Estimate and the 2050 NPV O&M Cost Estimate and represents the total cost of each concept option to Lewes BPW over the operational life of the new facilities.

The Project Lifecycle Costs incurred by Lewes BPW for the long range planning study concepts are summarized in Table 29 and Figure 37.

*Table 29 Project Lifecycle Cost Estimates*

| | Option 1 | Option 2a | Option 2b | Option 2c | Option 3a | Option 3b |
|---|---|---|---|---|---|---|
| **Preliminary Capital Cost Estimate** | $23,000,000 | $156,000,000 | $114,000,000 | $186,500,000 | $20,000,000 | $20,000,000 |
| **2050 NPV O&M Cost Estimate** | $75,500,000 | $40,000,000 | $40,000,000 | $40,500,000 | $36,000,000 | $36,000,000 |
| **Project Lifecycle Cost** | **$98,500,000** | **$196,000,000** | **$154,000,000** | **$227,000,000** | **$56,000,000** | **$56,000,000** |
| **MCA Score** | 65 | 66 | 66 | 65 | 95 | 95 |
| **Cost per MCA Scoring Point** | $1,520,000 | $2,970,000 | $2,330,000 | $3,490,000 | $590,000 | $590,000 |

All costs are presented in 2022 US Dollars.

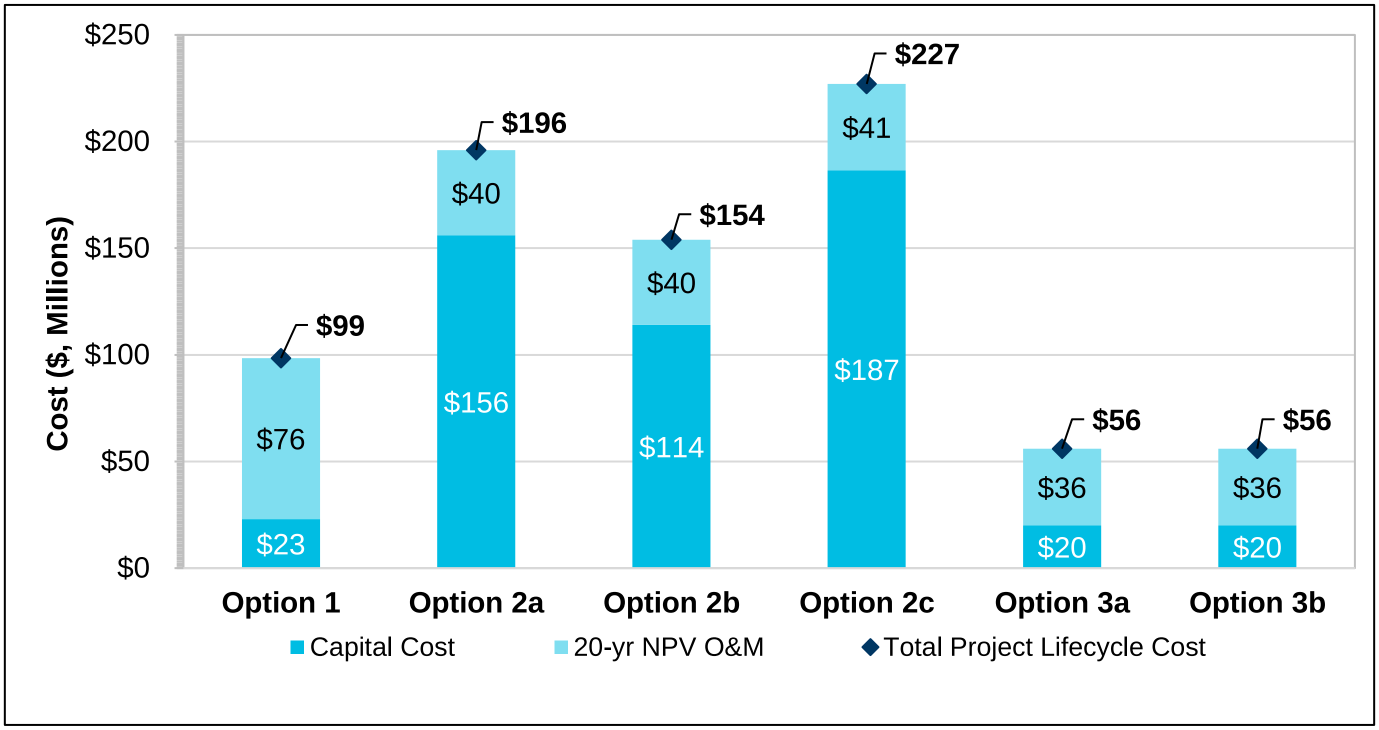



*Figure 37 Project Lifecyle Costs*

## 4.4 Evaluation Summary

Option 3a and Option 3b have the lowest estimated Project Lifecycle Costs for Lewes BPW, as well as the joint-highest MCA scores. Therefore, these options also have the lowest cost per MCA scoring point, which indicates that they provide the best value for Lewes BPW.

Option 3a scores higher for the Permitting & Schedule category, primary due to the relative uncertainty associated with acquiring permitting approvals for the constructed wetland discharge arrangement under Option 3b. Option 3b scores higher for the Community & Environmental Impacts category as there is no requirement to pump treated effluent back to the existing outfall location in Lewes.

Option 2c has the highest estimated Project Lifecyle Costs for Lewes BPW, primarily due to the requirement to purchase land and the complexities associated with a new ocean outfall.

The Option 1 and Option 2 concepts have very similar overall MCA scores; Option 1 scores lower for Community & Environmental Impacts due to the residual risk of flood damage at the coastal location, leading to failure at the treatment plant. The Option 2 concepts score lower for Permitting & Schedule due to the requirement to acquire land and install significant lengths of transfer force mains in public roads. Option 2c scores particularly low in this category due to the permitting complexities associated with constructing a new ocean outfall. However, Option 2c scores relatively well in the Community & Environmental Impacts category as treated effluent would no longer be discharged to the Canal or surrounding bays.

# 5. Next Steps

The next steps to advance the Lewes WWTF Long Range Planning Study and address the underlying issues are as follows:

1. BPW will include the Long Range Planning Study on the agenda for an upcoming Board meeting and at that time the BPW Board will discuss the findings of this report.
2. Sussex County will present the findings of this report to the County Council.
3. BPW will arrange a Special Meeting to present the findings to the public, engage with the community stakeholders and provide an opportunity for stakeholders to comment on the findings before a preferred option is identified by the BPW Board.
4. BPW will include the Long Range Planning Study on the agenda for a further Board meeting and at that time the Board will make its final decision on a preferred option for further design development.
5. The preferred option will advance for further development, including (but not limited to): field investigations, modeling, conceptual design and permitting design stages.

The following specific tasks should be undertaken as part of future design development, as a means of validating the preferred option:

- Hydraulic Modeling and Analysis for the Lewes and Rehoboth Canal
  - A well-calibrated model is required to predict future conditions in the Lewes and Rehoboth Canal, following implementation of the proposed WWTF upgrades.
  - The model will be able to simulate the flows inside the channel, potential net unidirectional flow along the channel and residence time in the canal for masses discharged into it.
  - A canal model will be developed to analyze the impacts for Option 2 and Option 3 concepts, but is not required for Option 1.
  - The model will need to calibrated following a sustained period of data monitoring and sample collection.
- Greenhouse Gas Emissions Analysis
  - The MCA evaluation undertaken as part of the concept development includes consideration of environmental impacts and sustainability; energy use is included in the O&M cost analysis.
  - Additional analyses should be completed to quantitively assess the Greenhouse Gas (GHG) emissions associated with each Option.
  - A GHG Analysis would include:
    - Estimation of tons of GHG emissions for each Option.
    - Consideration of construction and operational stages (lifecycle analysis).
    - Identification of opportunities to reduce GHG emissions, including cost estimates to implement.
  - GHG Analysis will further inform public discussions on sustainability associated with the proposed WWTF upgrades

# Appendices

# Appendix A

## SUEZ Design Review for Lewes WWTF

Water Technologies & Solutions

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June 10, 2022

At the request of GHD, SUEZ has completed a preliminary biological and UF capacity review for the Lewes Wastewater Treatment Plant. Based on our analysis of the as-built drawings, the flow condition maximums are set out below:

**Biological** – Maximum Month Flow (MMF) = 1,800,000 GPD

**UF** – The following ZeeWeed configuration table details the UF flow condition maximums based on two scenarios. See notes below the table for scenario details.

| configuration data | units | scenario 1<br>fill all existing membrane & cassette spaces with RX12 430ft2 modules | scenario 2<br>full plant population with RX12 430ft[2] modules in 52M cassettes[3] |
|---|---|---|---|
| number of trains, plant | | 4 | 4 |
| type of ZeeWeed membrane | | 500D | 500D |
| module surface area | ft² | 370 & 430[2] | 430 |
| total number of cassette spaces per train | | 4 | 4 |
| maximum number of modules per cassette | | 48 & 52[1] | 52 |
| fully populated cassettes installed per train | | 4 | 4 |
| flex cassettes installed per train | | --- | --- |
| installed number of modules per flex cassette | | --- | --- |
| total module count, train | | 196 | 208 |
| total surface area in operation, train | ft² | 77,080 | 89,440 |
| total module count, plant | | 784 | 832 |
| total surface area in operation, plant | ft² | 308,320 | 357,760 |
| % surface area change from existing, plant | % | 73.6% | 101.4% |
| minimum temperature | °C | 11 | 11 |
| flow capacity, average daily flow ADF | GPD | 4,347,300 | 5,044,400 |
| design net flux at ADF at min. temp. | GFD | 14.1 | 14.1 |
| flow capacity, maximum month flow MMF | GPD | 4,809,800 | 5,581,000 |
| design net flux at MMF at min. temp. | GFD | 15.6 | 15.6 |
| flow capacity, maximum week flow MWF | GPD | 5,796,400 | 6,725,900 |
| design net flux at MWF at min. temp. | GFD | 18.8 | 18.8 |
| flow capacity, maximum day flow MDF | GPD | 6,875,500 | 7,978,000 |
| design net flux at MDF at min. temp. | GFD | 22.3 | 22.3 |
| flow capacity, peak hour flow PHF | GPD | 7,677,168 | 8,908,200 |
| design net flux at PHF at min. temp. | GFD | 24.9 | 24.9 |

**notes:**

1 - scenario 1: Existing cassettes are 48M LEAP - cassettes being added to empty cassette spaces (1 per train) will be 52M LEAP cassettes.

2 - scenario 1: Existing cassettes are 40/48M 370ft$^2$. Modules added to empty membrane spaces (8 in each of 12 existing cassettes) will be RX12 430ft$^2$.

3 - scenario 2: Plant will be fully populated with 52/52M cassettes and RX12 430ft$^2$ membranes (4 trains, 4 cassettes per train).

We would be pleased to further discuss any aspect of this review.

Sincerely,

Matt Stapleford, P.Eng.
Regional Lifecycle Manager, northeast USA
SUEZ Water Technologies & Solutions
matthew.stapleford@suez.com

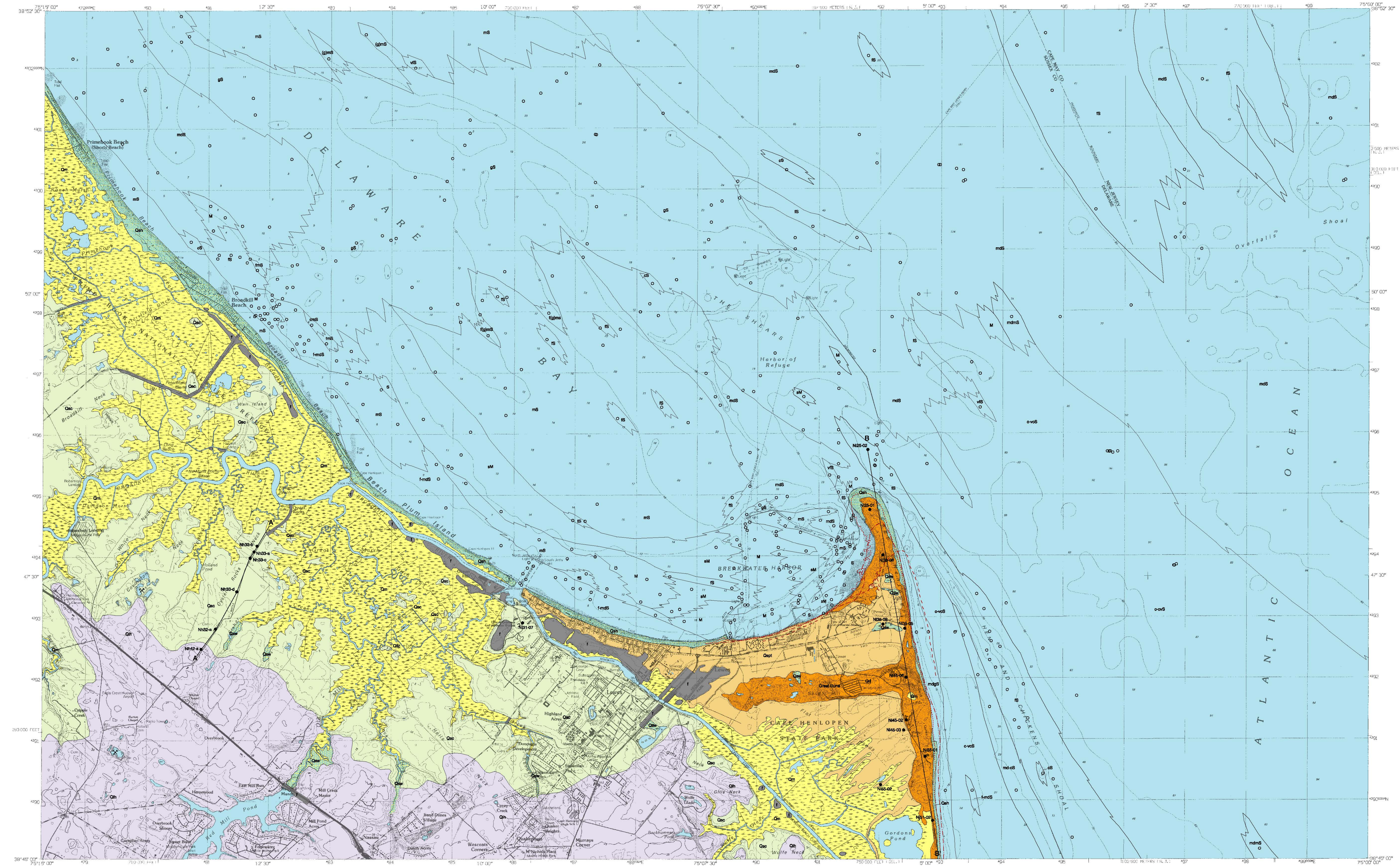
doc. control: author: JE
last modified: 6/10/2022 2:08 PM
filename: Lewes 508864 design review for GHD Jun-10 2022
technical review: JW commercial review: MS

# Appendix B

## Lewes Geological Map

DELAWARE GEOLOGICAL SURVEY
University of Delaware, Newark
John H. Talley, State Geologist






# GEOLOGIC MAP OF THE LEWES AND CAPE HENLOPEN QUADRANGLES, DELAWARE

by

Kelvin W. Ramsey

2003

Base maps from the United States Geological Survey Lewes and Cape Henlopen Quadrangles, 7.5-minute series, 1997.

North American Datum of 1983 (NAD83).
Projection of 100-meter grid: Universal Transverse Mercator, zone 18
10,000-foot grid ticks: Delaware Coordinate System
2,500-meter grid ticks: New Jersey Coordinate System of 1983

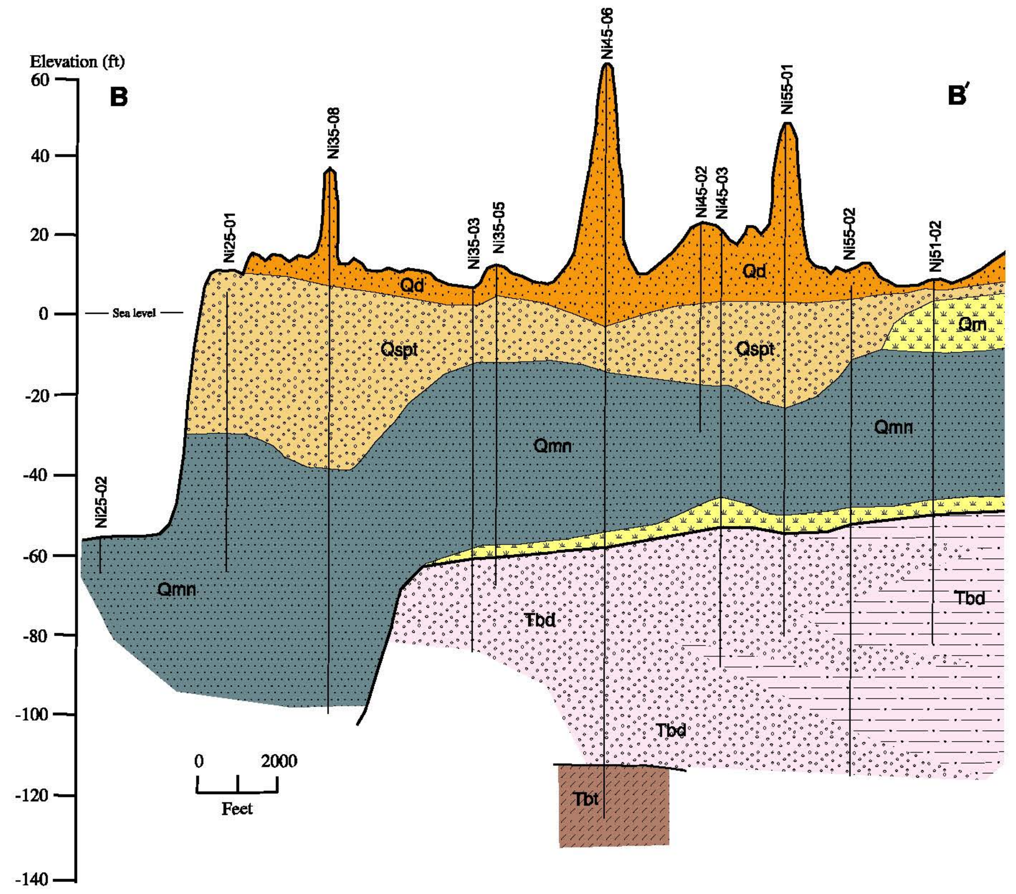
QUADRANGLE LOCATION

SCALE 1:24 000

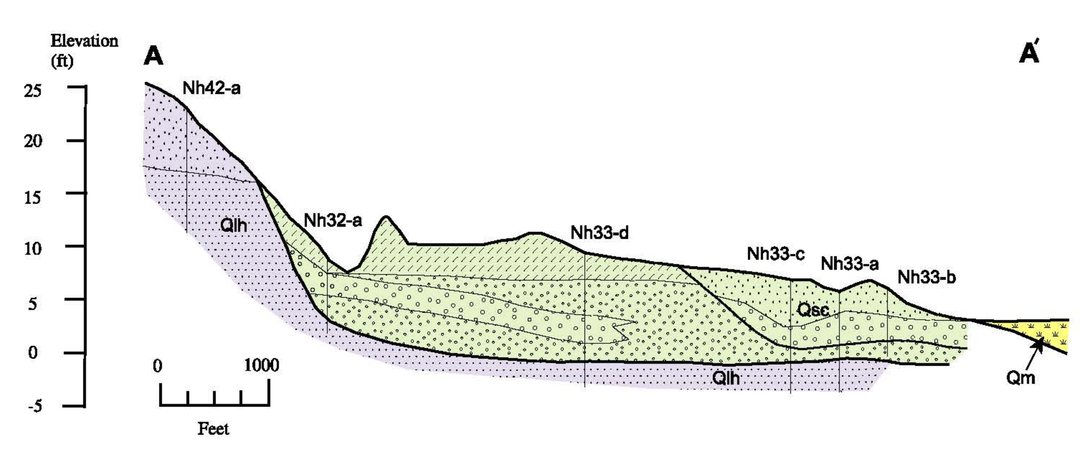
CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

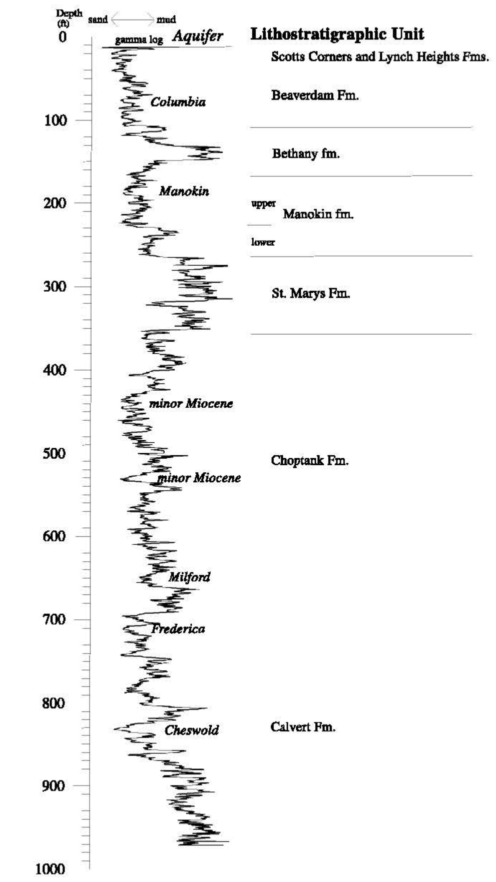
SYMBOLS

- Ni 45-02 Well or borehole
- Nh42-a Outcrop or soil auger boring
- Borrow pit
- Offshore core or grab sample
- 1884 shoreline
- 1944 shoreline
- 1977 shoreline
- formation contact (on cross-sections)




- Organic-rich mud
- Silt with very fine sand
- Interbedded coarse sand and clayey fine sand
- Very fine to fine sand
- Medium to fine sand
- Coarse to very coarse sand
- Gravelly sand to gravel




| | | | |
|---|---|---|---|
| QUATERNARY | HOLOCENE | Qsh | Shoreline deposits |
| | | Qd | Dune deposits |
| | | Qspt | Spit deposits |
| | | Qm | Marsh deposits |
| | | Qsw | Swamp deposits |
| | | Qmn | Marine deposits (subsurface only) |
| | PLEISTOCENE | Qsc | Scotts Corners Formation |
| | | Qlh | Lynch Heights Formation |
| TERTIARY | PLIOCENE | Tbd | Beaverdam Formation (subsurface only) |
| | | Tbt | Bethany formation (subsurface only) |
| | MIOCENE | Tm | Manokin formation (subsurface only) |
| | | Tsm | St. Marys Formation (subsurface only) |
| | | Tch | Choptank Formation (subsurface only) |
| | | Tc | Calvert Formation (subsurface only) |

## EXPLANATION

### FILL (f)

Fill consists of man-made deposits of natural earth material used to extend shore land and/or to fill a low-lying area such as where a road crosses a valley or marsh. Most of the fill in the map area is dredged marsh deposits from channel construction and deepening through the marshes. Some construction debris (concrete, bricks, etc.) may be incorporated in the unit. Holocene.

### SHORELINE DEPOSITS (Qsh)

Shoreline deposits consist of beach and dune deposits found along the shorelines of Delaware Bay and the Atlantic Ocean. Beach deposits consist of medium to coarse quartz sand with pebbles and cobbles. Laminae of opaque heavy minerals and very coarse sand to pebbles are common. Pebble and cobble lithologies are dominated by quartz and chert (commonly containing Paleozoic fossils) with lesser amounts of quartzite, sandstone, and siltstone. Along the margin of Delaware Bay, the unit includes small dunes consisting of fine to medium, well-sorted sand with discontinuous opaque heavy mineral laminae. Shoreline deposits interfinger with, or unconformably overlie, organic-rich mud of the marsh and swamp deposits, dune deposits, or sands of the Scotts Corners Formation. Thickness of the unit is generally less than 20 feet. Holocene.

### DUNE DEPOSITS (Qd)

Dune deposits consist of fine to coarse, cross-bedded quartz sand. Laminae of opaque heavy minerals are common, and laminae of pebbles are rare to common. The unit forms a large dune field that is parallel to the Atlantic Coast and joins with another dune field perpendicular to the coast (the Great Dune). The unit lies conformably to unconformably on the spit deposits of Cape Henlopen. Thickness ranges from 3 to 75 feet. Holocene.

### SPIT DEPOSITS (Qspt)

Spit deposits consist of interbedded fine to coarse sand, gravelly sand, silty sand, and sandy silt. Scattered shelly beds are also present. The unit represents the spit complex of Cape Henlopen that has prograded into the mouth of Delaware Bay and overlies marine deposits. Thickness of the unit ranges from 3 to 80 feet. Holocene.

### MARSH AND SWAMP DEPOSITS (Qm, Qsw)

Marsh deposits consist of structureless to finely laminated, black to dark gray, organic-rich silty clay to clayey silt with discontinuous beds of peat and with rare shells. In-place or transported fragments of marsh grasses such as *Spartina* are common. Includes some clayey silts of estuarine channel origin. It interfingers with swamp deposits and spit deposits and unconformably overlies sands of the Scotts Corners, Lynch Heights, and Beaverdam Formations. Map area delineated on the basis of distribution of salt-tolerant marsh grasses. The unit can be up to 40 feet thick. Holocene.

Swamp deposits consist of structureless, black to brown, organic-rich, silty and clayey, fine to coarse quartz sand with thin interbeds of medium to coarse quartz sand. Organic particles consist of leaves, twigs, and larger fragments of deciduous plants. The swamp deposits fine upwards and grade laterally with marsh deposits. Overlies the Scotts Corners and Lynch Heights Formations. Swamp deposits are defined primarily on the presence of deciduous vegetation in stream valleys. In the upper reaches of streams, they contain alluvial deposits consisting of fine to coarse quartz sand with pebbles. These alluvial deposits are too geographically restricted to show as individual map units. The unit can be up to 20 feet thick. Holocene.

### MARINE DEPOSITS (Subsurface only) (Qmn)

Marine deposits consist of fine to very fine sand to sandy silt with laminae to thin beds of clayey silt to silty clay. Scattered shells are common. These deposits represent marine to estuarine sediments deposited at the mouth of Delaware Bay upon which the spit of Cape Henlopen accreted. This unit can be up to 60 feet thick. Holocene.

### SCOTTS CORNERS FORMATION (Qsc)

The Scotts Corners Formation is a heterogeneous unit of light gray to brown to light yellowish brown coarse to fine sand, gravelly sand, and pebble gravel with rare discontinuous beds of organic-rich clayey silt and clayey silt. Sands are quartzose with some feldspar and muscovite. It is commonly capped by one to two feet of silt to fine sandy silt. Laminae of opaque heavy minerals are common. The unit unconformably overlies the Lynch Heights Formation. The basal contact is marked by a coarse sand to gravelly sand bed overlying an oxidized, compact horizon (paleosol) at the top of the Lynch Heights. Overall thickness of the unit rarely exceeds 15 feet. The Scotts Corners is interpreted to be a transgressive unit consisting of swamp, marsh, estuarine channel, beach, and bay deposits. Climate during the time of deposition was temperate to warm temperate as interpreted from fossil pollen assemblages. Late Pleistocene.

### LYNCH HEIGHTS FORMATION (Qlh)

The Lynch Heights Formation is a heterogeneous unit of light gray to brown to light yellowish brown medium to fine sand with discontinuous beds of coarse sand, gravel, silt, fine to very fine sand, and organic-rich clayey silt to silty sand. The upper part of the unit commonly consists of fine well-sorted sand. Small-scale cross-bedding within the sands is common. Some of the interbedded clayey silts and silty sands are burrowed. Beds of shell are rarely encountered. Sands are quartzose and slightly feldspathic, and typically micaceous where very fine to fine grained. The Lynch Heights is distinguished from the Scotts Corners by its greater thickness, characteristic interbedded sands and silts (primarily in areas where it is the surficial unit), its unique pollen assemblage, and a general lack of a well-defined silt cap that characterizes the Scotts Corners.

The Lynch Heights is interpreted to be a fluvial to estuarine unit of fluvial channel, tidal flat, tidal channel, beach, and bay deposits. In the Lewes and Cape Henlopen quadrangles it is interpreted to represent spit and dune deposits much like those found on the adjacent modern counterpart, Cape Henlopen. It unconformably overlies the Beaverdam Formation. Climate during deposition was cool-temperate, slightly cooler than that indicated for the Scotts Corners. The unit is up to 50 feet thick to the east and thins to the west. Late Pleistocene.

### BEAVERDAM FORMATION (subsurface only) (Tbd)

The Beaverdam Formation consists of yellow-orange, light brown, and light gray, silty, fine to medium quartzose to moderately feldspathic sand, sandy silt, clayey sandy silt, and clayey silt with a white to light yellow silt or clay matrix, with beds of dark gray to brown organic-rich clayey silt. Also common within the Beaverdam are light yellow-orange, medium to coarse sand, gravelly sand, and sandy gravel with rare beds of dark gray or blue- to green-gray, silty clay to clayey silt. The basal beds of the unit are commonly gravelly. Rare cobbles and boulders are also found. Pebbles and cobbles are dominantly quartz and quartzite, with lesser amounts of sandstone, chert, and a variety of lithic clasts. The base of the Beaverdam is a highly irregular surface with as much as 40 feet of relief. The weathered Beaverdam is brightly colored white, red, and orange and contains highly weathered grains of feldspar and degraded kaolinitic clays. The unit unconformably overlies the Manokin or St. Marys Formations. The Beaverdam is interpreted to be a fluvial to estuarine deposit. The unit ranges up to 100 feet thick in the map area. Pliocene.

### BETHANY FORMATION (subsurface only) (Tbt)

Informal unit. The Bethany formation consists of gray, olive gray, and bluish-gray clay to clayey silt interbedded with fine to very coarse sand. Lignitic and gravelly beds are common. The unit is distinguished from the adjacent Beaverdam and Manokin Formations by its overall fine-grained nature. The unit possibly is a more marine facies of the Beaverdam Formation and interfingers with that unit updip. It unconformably overlies the Manokin formation and is 50 to 75 feet thick in the map area. Late Miocene to Pliocene.

### MANOKIN FORMATION (subsurface only) (Tm)

Informal unit. The Manokin formation is subdivided into two units, an upper unit (Manokin B) and a lower unit (Manokin A). The upper unit consists of well-sorted, clean, white to reddish brown, fine to medium sand. Some beds of medium to coarse sand and gray to white clayey silt are also present. The lower unit consists of gray, very fine silty sand to silty clay with rare to common pieces of lignite. The upper and lower units have conformable to unconformable relationships. The lower Manokin rests conformably to unconformably on the St. Marys Formation. The Manokin is interpreted to be an estuarine to marine deposit within a deltaic setting. It ranges from 50 to 100 feet thick in the map area. Late Miocene.

### ST. MARYS FORMATION (subsurface only) (Tsm)

The St. Marys Formation consists of light gray to gray to brown clayey silt and fine to medium quartz sand and clayey silt. Discontinuous beds of fine to medium quartz sand and shelly quartz sand are common. It unconformably overlies the Choptank Formation. The St. Marys is interpreted to be a marginal marine deposit. The thickness of the unit ranges from 90 to 160 feet in the map area. Late Miocene.

### CHOPTANK FORMATION (subsurface only) (Tch)

The Choptank Formation is composed of light gray to blue gray, fine to medium, silty quartz sand and clayey silt. Discontinuous beds of fine sand and medium to coarse sand with shell beds are common. It unconformably overlies the Calvert Formation. Its basal contact is marked by a granular to very coarse sand overlying distinctive brown silty clays of the Calvert. The Choptank is interpreted to be a marine deposit. It is approximately 300 feet thick in the map area. Late Miocene.

### CALVERT FORMATION (subsurface only) (Tc)

The Calvert Formation consists of light gray to brown clayey silt and fine to medium silty quartz sand. Discontinuous beds of shelly sand and shelly clayey silt are common. It is rarely penetrated by water wells in the map area and is over 300 feet thick. The Calvert is interpreted to be a marine deposit. Middle to late Miocene.

### Discussion

The surficial geology of the Lewes and Cape Henlopen quadrangles reflects the geologic history of the Delaware Bay estuary and successive high and low stands of sea levels during the Quaternary. The subsurface Beaverdam Formation was deposited as part of a fluvial-estuarine system during the Pliocene, the sediments of which now form the core of the Delmarva Peninsula. Following a period of glacial outwash during the early Pleistocene represented by the Columbia Formation found to the northwest of the map area (Ramsey, 1997), the Delaware River and Estuary developed their current positions. The Lynch Heights and Scotts Corners Formations (Ramsey, 1993, 1997, 2001) represent shoreline and estuarine deposits associated with high stands of sea level during the middle to late Pleistocene on the margins of the Delaware Estuary. In the map area, the Lynch Heights Formation includes relict spit and dune deposits at the ancestral intersection of the Atlantic Coast and Delaware Bay systems, similar in geomorphic position to the modern Cape Henlopen.

The relationship between the Lynch Heights and Scotts Corners is shown in cross-section A-A'. The Lynch Heights is composed of a fine, well-sorted sand. The break in topography (scarp) between the surface of the Lynch Heights (at approx. 25 ft and higher) and that of the Scotts Corners (at approx. 6 to 15 feet) represents ancestral shorelines of Delaware Bay during a high sea level contemporaneous with the deposition of the Scotts Corners. The cross section also shows two depositional units within the Scotts Corners. A younger shoreline sequence with sand at the land surface has cut into an older unit (marked by silt at the land surface). Gravel beds within both units represent shoreline deposits like those found along the modern Delaware Bay in the area. Two depositional units within the Scotts Corners is consistent with observations of the Scotts Corners by Ramsey (1997) just to the north of the map area. Both of these units were deposited during the last interglacial period. The older unit may be attributed to the high sea stand at 120,000 years B.P. and the younger unit to one at 80,000 years B.P. (Ramsey, 1997).

Quaternary deposits were transgressed by Holocene swamp, marsh, shoreline, estuarine and spit deposits. The spit deposits form the modern Cape Henlopen (Ramsey, et al., 2000, Ramsey, 1999). Cross section B-B' depicts sediment distribution within the Cape Henlopen complex and stratigraphic relationships with units underlying the Holocene spit deposits.

Offshore surficial sediment distribution is a compilation of historical offshore core and grab sample textural descriptions and data (Hoyt, 1982; Maley, 1981; Marx, 1981; Oostdam, 1971; Sheridan et al., 1974; Strom, 1972, 1976; Terchunian, 1985; Weil, 1976; Wethe et al., 1982, 1982a, 1983 and unpublished data in DGS files). From core descriptions, the top six inches was used as the surficial sediment type. Sediment textures shown on the map show a general distribution of sediment size over a large area. Site-specific information about bottom sediment textures may require additional sampling. Refer to the adjacent triangular diagram for sediment texture abbreviations. Historical shoreline positions are from historical U.S. Coast & Geodetic Survey T-sheets (1884) and topographic maps (1944, 1977).

Stratigraphic units found at depth within the map area are shown with the geophysical log of Ni31-07, a 1,035-foot deep geothermal test hole drilled in 1978 for the U.S. Department of Energy. Major aquifer units are also shown (Andres, 1986).

### Acknowledgments

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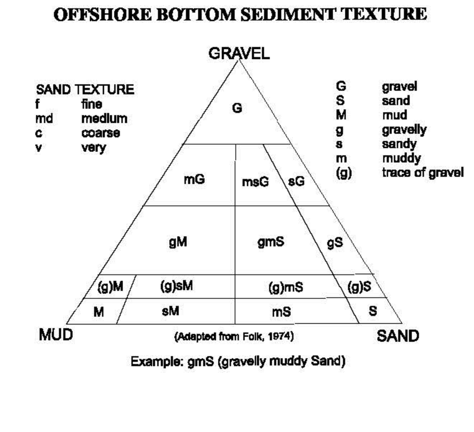
### OFFSHORE BOTTOM SEDIMENT TEXTURE



# Appendix C

## Hydraulic Calculations

**Project Name:** Lewes WWTF Long Range Planning Study
**Project Number:** 12582813
**Client:** Lewes BPW and Sussex County
**Calculation Title:** Option 2a Raw Wastewater Pump Station - Force Main Hydraulics

Author: VC 10/21/2022
Checked: TB 10/24/2022

Pipeline Start LS-8 Wet Well WSE: -10.05 ft
Pipeline Finish Option 2a Site Wet Well WSE: 49 ft site elevation + 20 ft

**Output Summary:**
Design Flow 5.13 mgd Lewes collection network Peak Hour Flow
3563 gpm
TDH 228 ft
Pump Power 293 HP

| DESCRIPTION | Flow (mgd) | Flow (cfs) | Width/Diameter (in) | Width/Diameter (ft.) | Length (ft.) | Invert (ft.) | Depth (ft.) | X-Sect ($ft^2$) | Perim (ft.) | Vel (fps) | $V^2/2g$ | n or C Coef | Fitting Loss | No. Fittings | Headloss (ft.) | HGL (ft.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | 49 |
| Discharge orifice | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | | 1 | 1 | 0.50 | 49.50 |
| HDPE pipe section | 5.13 | 7.94 | 16 | 1.33 | 32016 | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | | | 162.22 | 211.72 |
| 90 L | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.3 | 9 | 1.36 | 213.08 |
| 45 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | | 0.00 | 213.08 |
| 22.5 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | 4 | 0.40 | 213.48 |
| 11.25 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.05 | 7 | 0.18 | 213.65 |
| DIP pipe to HDPE coupler | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 213.74 |
| Butterfly valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 213.89 |
| Bypass Tee (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.05 |
| Butterfly Valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.20 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 214.29 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.44 |
| DIP pipe section though PS wall | 5.13 | 7.94 | 16 | 1.33 | 20 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.18 | 214.62 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.77 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 214.86 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 215.01 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 215.10 |
| flow meter (assume wrap around) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0 | 1 | 0.00 | 215.10 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 215.17 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 215.32 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 215.39 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 215.54 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 215.59 |
| Pump 1 Wye (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 215.74 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 215.78 |
| check valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 2.5 | 1 | 1.26 | 217.04 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 217.19 |
| PUMP | | | | | | | | | | | | | | | | |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.81 |
| 90 EL | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.66 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 12 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.11 | -10.51 |
| 90 EL | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.40 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 3 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.03 | -10.25 |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.23 |
| bellmouth in wet well | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.05 | 1 | 0.03 | -10.08 |
| Upstream Wet Well TWL | | | | | | | | | | | | | | | | -10.05 |

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Lewes WWTF Long Range Planning Study | | Author: | VC | 10/21/2022 |
| **Project Number:** | 12582813 | | Checked: | TB | 10/24/2022 |
| **Client:** | Lewes BPW and Sussex County | | | | |
| **Calculation Title:** | Option 2b/c Raw Wastewater Pump Station - Force Main Hydraulics | | | | |

| | | | | |
|---|---|---|---|---|
| Pipeline Start | LS-8 | Wet Well WSE: | -10.05 ft | |
| Pipeline Finish | Option 2b/c Site | Wet Well WSE: | 39 ft | site elevation + 20 ft |

**Output Summary:**

| | | |
|---|---|---|
| Design Flow | 5.13 mgd | Lewes collection network Peak Hour Flow |
| | 3563 gpm | |
| TDH | 176 ft | |
| Pump Power | 226 HP | |

| DESCRIPTION | Flow (mgd) | (cfs) | Width/Diameter (in) | (ft.) | Length (ft.) | Invert (ft.) | Depth (ft.) | X-Sect ($ft^2$) | Perim (ft.) | Vel (fps) | $V^2/2g$ | n or C Coef | Fitting Loss | No. Fittings | Headloss (ft.) | HGL (ft.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | 39 |
| Discharge orifice | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | | 1 | 1 | 0.50 | 39.50 |
| HDPE pipe section | 5.13 | 7.94 | 16 | 1.33 | 23936 | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | | | 121.28 | 160.78 |
| 90 L | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.3 | 4 | 0.60 | 161.38 |
| 45 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | | 0.00 | 161.38 |
| 22.5 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | 2 | 0.20 | 161.58 |
| 11.25 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.05 | | 0.00 | 161.58 |
| DIP pipe to HDPE coupler | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 161.67 |
| Butterfly valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 161.82 |
| Bypass Tee (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 161.98 |
| Butterfly Valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 162.13 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 162.22 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 162.37 |
| DIP pipe section though PS wall | 5.13 | 7.94 | 16 | 1.33 | 20 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.18 | 162.55 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 162.70 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 162.79 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 162.94 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 163.03 |
| flow meter (assume wrap around) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0 | 1 | 0.00 | 163.03 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 163.10 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 163.25 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 163.32 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 163.47 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 163.52 |
| Pump 1 Wye (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 163.67 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 163.71 |
| check valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 2.5 | 1 | 1.26 | 164.97 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 165.12 |
| gate valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.07 | 1 | 0.04 | 165.16 |
| PUMP 2 | | | | | | | | | | | | | | | | |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.81 |
| 90 EL | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.66 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 12 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.11 | -10.51 |
| 90 EL | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.40 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 3 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.03 | -10.25 |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.23 |
| bellmouth in wet well | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.05 | 1 | 0.03 | -10.08 |
| Upstream Wet Well TWL | | | | | | | | | | | | | | | | -10.05 |

| | | | |
|---|---|---|---|
| **Project Name:** | Lewes WWTF Long Range Planning Study | Author: VC | 10/21/2022 |
| **Project Number:** | 12582813 | Checked: TB | 10/24/2022 |
| **Client:** | Lewes BPW and Sussex County | | |
| **Calculation Title:** | Option 2b Treated Effluent Pump Station - Force Main Hydraulics | | |

| | | | |
|---|---|---|---|
| Pipeline Start | Treated Effluent PS | Wet Well WSE: | 3.64 ft |
| Pipeline Finish | Canal Outfall | Wet Well WSE: | 0 ft |

**Output Summary:**

| | | |
|---|---|---|
| Design Flow | 5.13 mgd | Lewes collection network Peak Hour Flow |
| | 3563 gpm | |
| TDH | 123 ft | |
| Pump Power | 159 HP | |

| DESCRIPTION | Flow | | Width/Diameter | | Length | Invert | Depth | X-Sect | Perim | Vel | $V^2/2g$ | n or C | Fitting | No. | Headloss | HGL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (mgd) | (cfs) | (in) | (ft.) | (ft.) | (ft.) | (ft.) | ($ft^2$) | (ft.) | (fps) | | Coef | Loss | Fittings | (ft.) | (ft.) |
| | | | | | | | | | | | | | | | | 0 |
| Discharge orifice | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | | 1 | 1 | 0.50 | 0.50 |
| HDPE pipe section | 5.13 | 7.94 | 16 | 1.33 | 23936 | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | | | 121.28 | 121.78 |
| 90 L | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.3 | 8 | 1.21 | 122.99 |
| 45 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | | 0.00 | 122.99 |
| 22.5 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | 2 | 0.20 | 123.19 |
| 11.25 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.05 | | 0.00 | 123.19 |
| DIP pipe to HDPE coupler | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 123.28 |
| Butterfly valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 123.43 |
| Bypass Tee (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 123.58 |
| Butterfly Valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 123.73 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 123.82 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 123.97 |
| DIP pipe section though PS wall | 5.13 | 7.94 | 16 | 1.33 | 20 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.18 | 124.15 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 124.30 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 124.39 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 124.54 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 124.63 |
| flow meter (assume wrap around) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0 | 1 | 0.00 | 124.63 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 124.70 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 124.85 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 124.93 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 125.08 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 125.12 |
| Pump 1 Wye (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 125.27 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 125.32 |
| check valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 2.5 | 1 | 1.26 | 126.57 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 126.72 |
| gate valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.07 | 1 | 0.04 | 126.76 |
| PUMP | | | | | | | | | | | | | | | | |
| gate valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 3.27 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 3 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.03 | 3.42 |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 3.45 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 2 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.02 | 3.60 |
| bellmouth in wet well | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.05 | 1 | 0.03 | 3.61 |
| Upstream Wet Well TWL | | | | | | | | | | | | | | | | 3.64 |

**Project Name:** Lewes WWTF Long Range Planning Study
**Project Number:** 12582813
**Client:** Lewes BPW and Sussex County
**Calculation Title:** Option 2c Treated Effluent Pump Station - Force Main Hydraulics

Author: VC 10/21/2022
Checked: TB 10/24/2022

Pipeline Start — Treated Effluent PS — Wet Well WSE: 3.64 ft
Pipeline Finish — Ocean Outfall — Wet Well WSE: 0 ft

**Output Summary:**

Design Flow 5.13 mgd — Lewes collection network Peak Hour Flow
3563 gpm
TDH 221 ft
Pump Power 284 HP

| DESCRIPTION | Flow (mgd) | (cfs) | Width/Diameter (in) | (ft.) | Length (ft.) | Invert (ft.) | Depth (ft.) | X-Sect $(ft^2)$ | Perim (ft.) | Vel (fps) | $V^2/2g$ | n or C Coef | Fitting Loss | No. Fittings | Headloss (ft.) | HGL (ft.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | 0 |
| Discharge orifice | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | | 1 | 1 | 0.50 | 0.50 |
| HDPE pipe section | 5.13 | 7.94 | 16 | 1.33 | 41579 | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | | | 210.67 | 211.17 |
| 90 L | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.3 | 9 | 1.36 | 212.53 |
| 45 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | | 0.00 | 212.53 |
| 22.5 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | 5 | 0.50 | 213.03 |
| 11.25 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.05 | 2 | 0.05 | 213.08 |
| DIP pipe to HDPE coupler | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 213.17 |
| Butterfly valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 213.32 |
| Bypass Tee (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 213.47 |
| Butterfly Valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 213.62 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 213.71 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 213.86 |
| DIP pipe section though PS wall | 5.13 | 7.94 | 16 | 1.33 | 20 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.18 | 214.04 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.20 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 214.29 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.44 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 214.53 |
| flow meter (assume wrap around) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0 | 1 | 0.00 | 214.53 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 214.60 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.75 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 214.82 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 214.97 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 215.02 |
| Pump 1 Wye (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 215.17 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 215.21 |
| check valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 2.5 | 1 | 1.26 | 216.47 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 216.62 |
| gate valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.07 | 1 | 0.04 | 216.65 |
| PUMP | | | | | | | | | | | | | | | | |
| gate valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -4.01 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 3 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.03 | -3.86 |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -3.83 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 2 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.02 | -3.68 |
| bellmouth in wet well | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.05 | 1 | 0.03 | -3.67 |
| Upstream Wet Well TWL | | | | | | | | | | | | | | | | -3.64 |

| | | | |
|---|---|---|---|
| **Project Name:** | Lewes WWTF Long Range Planning Study | Author: VC | 10/21/2022 |
| **Project Number:** | 12582813 | Checked: TB | 10/24/2022 |
| **Client:** | Lewes BPW and Sussex County | | |
| **Calculation Title:** | Option 3a/b Raw Wastewater Pump Station - Force Main Hydraulics | | |

| | | | | |
|---|---|---|---|---|
| Pipeline Start | LS-8 | Wet Well WSE: | -10.05 ft | |
| Pipeline Finish | Wolfe Neck Site | Wet Well WSE: | 50 ft | site elevation + 20 ft |

**Output Summary:**

| | | |
|---|---|---|
| Design Flow | 5.13 mgd | Lewes collection network Peak Hour Flow |
| | 3563 gpm | |
| TDH | 107 ft | |
| Pump Power | 138 HP | |

| | Flow | | Width/Diameter | | Length | Invert | Depth | X-Sect | Perim | Vel | $V^2/2g$ | n or C | Fitting | No. | Headloss | HGL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DESCRIPTION** | (mgd) | (cfs) | (in) | (ft.) | (ft.) | (ft.) | (ft.) | ($ft^2$) | (ft.) | (fps) | | Coef | Loss | Fittings | (ft.) | (ft.) |
| Invert of discharge pipe into screens | | | | | | | | | | | | | | | | 50 |
| Discharge orifice | 10.26 | 15.88 | 24 | 2.00 | | | | 3.14 | 6.28 | 5.05 | 0.40 | | 1 | 1 | 0.40 | 50.40 |
| HDPE pipe section - ex. 24" main | 10.26 | 15.88 | 24 | 2.00 | 9244 | | | 3.14 | 6.28 | 5.05 | 0.40 | 150 | | | 23.48 | 23.48 |
| HDPE pipe section - ex. 16" main | 5.13 | 7.94 | 16 | 1.33 | 4276 | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | | | 21.67 | 71.67 |
| HDPE pipe section | 5.13 | 7.94 | 16 | 1.33 | 8040 | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | | | 40.74 | 91.13 |
| 90 L | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.3 | 9 | 1.36 | 92.49 |
| 45 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | | 0.00 | 92.49 |
| 22.5 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.2 | 4 | 0.40 | 92.89 |
| 11.25 degree bend | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 150 | 0.05 | 7 | 0.18 | 93.07 |
| DIP pipe to HDPE coupler | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 93.16 |
| Butterfly valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 93.31 |
| Bypass Tee (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 93.46 |
| Butterfly Valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 93.61 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | | 0.09 | 93.70 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 93.85 |
| DIP pipe section though PS wall | 5.13 | 7.94 | 16 | 1.33 | 20 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.18 | 94.03 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 94.18 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 94.27 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 94.42 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 10 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.09 | 94.51 |
| flow meter (assume wrap around) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0 | 1 | 0.00 | 94.51 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 94.58 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 94.73 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 8 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.07 | 94.81 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 94.96 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 95.00 |
| Pump 1 Wye (through) | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 95.15 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 5 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.04 | 95.20 |
| check valve | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 2.5 | 1 | 1.26 | 96.45 |
| 90 elbow | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | 96.60 |
| PUMP | | | | | | | | | | | | | | | | |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.81 |
| 90 EL | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.66 |
| DIP pipe section | 5.13 | 7.94 | 16 | 1.33 | 12 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.11 | -10.51 |
| 90 EL | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.40 |
| DIP pipe | 5.13 | 7.94 | 16 | 1.33 | 3 | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | | 1 | 0.03 | -10.25 |
| 90 El | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.3 | 1 | 0.15 | -10.23 |
| bellmouth in wet well | 5.13 | 7.94 | 16 | 1.33 | | | | 1.40 | 4.19 | 5.69 | 0.50 | 110 | 0.05 | 1 | 0.03 | -10.08 |
| Upstream Wet Well TWL | | | | | | | | | | | | | | | | -10.05 |

| | | | |
|---|---|---|---|
| **Project Name:** | Lewes WWTF Long Range Planning Study | Author: VC | 10/21/2022 |
| **Project Number:** | 12582813 | Checked: TB | 10/24/2022 |
| **Client:** | Lewes BPW and Sussex County | | |
| **Calculation Title:** | Option 3a Treated Effluent Pump Station - Force Main Hydraulics | | |

| | | | |
|---|---|---|---|
| Pipeline Start | Treated Effluent PS | Wet Well WSE: | 3.64 ft |
| Pipeline Finish | Canal Outfall | Wet Well WSE: | 0 ft |

**Output Summary:**

| | | |
|---|---|---|
| Design Flow | 4.1 mgd | Combined Lewes and Sussex County collection network Max Month Flow |
| | 2847 gpm | |
| TDH | 115 ft | |
| Pump Power | 118 HP | |

| DESCRIPTION | Flow (mgd) | (cfs) | Width/Diameter (in) | (ft.) | Length (ft.) | Invert (ft.) | Depth (ft.) | X-Sect ($ft^2$) | Perim (ft.) | Vel (fps) | $V^2/2g$ | n or C Coef | Fitting Loss | No. Fittings | Headloss (ft.) | HGL (ft.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | 0 |
| Discharge orifice | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | | 1 | 1 | 0.55 | 0.55 |
| HDPE pipe section | 4.1 | 6.34 | 14 | 1.17 | 17500 | | | 1.07 | 3.67 | 5.93 | 0.55 | 150 | | | 112.17 | 112.71 |
| 90 L | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 150 | 0.3 | 8 | 1.31 | 114.03 |
| 45 degree bend | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 150 | 0.2 | | 0.00 | 114.03 |
| 22.5 degree bend | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 150 | 0.2 | 2 | 0.22 | 114.25 |
| 11.25 degree bend | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 150 | 0.05 | | 0.00 | 114.25 |
| DIP pipe to HDPE coupler | 4.1 | 6.34 | 14 | 1.17 | 10 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | | 0.11 | 114.36 |
| Butterfly valve | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 114.52 |
| Bypass Tee (through) | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 114.69 |
| Butterfly Valve | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 114.85 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 10 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | | 0.11 | 114.97 |
| 90 elbow | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 115.13 |
| DIP pipe section though PS wall | 4.1 | 6.34 | 14 | 1.17 | 20 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.23 | 115.36 |
| 90 elbow | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 115.52 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 10 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.11 | 115.64 |
| 90 elbow | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 115.80 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 10 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.11 | 115.91 |
| flow meter (assume wrap around) | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0 | 1 | 0.00 | 115.91 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 8 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.09 | 116.00 |
| 90 elbow | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 116.17 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 8 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.09 | 116.26 |
| 90 elbow | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 116.42 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 5 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.06 | 116.48 |
| Pump 1 Wye (through) | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 116.65 |
| DIP pipe section | 4.1 | 6.34 | 14 | 1.17 | 5 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.06 | 116.70 |
| check valve | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 2.5 | 1 | 1.37 | 118.07 |
| 90 elbow | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 118.23 |
| gate valve | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.07 | 1 | 0.04 | 118.27 |
| PUMP | | | | | | | | | | | | | | | | |
| gate valve | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 3.23 |
| DIP pipe | 4.1 | 6.34 | 14 | 1.17 | 3 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.03 | 3.39 |
| 90 El | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.3 | 1 | 0.16 | 3.43 |
| DIP pipe | 4.1 | 6.34 | 14 | 1.17 | 2 | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | | 1 | 0.02 | 3.59 |
| bellmouth in wet well | 4.1 | 6.34 | 14 | 1.17 | | | | 1.07 | 3.67 | 5.93 | 0.55 | 110 | 0.05 | 1 | 0.03 | 3.61 |
| Upstream Wet Well TWL | | | | | | | | | | | | | | | | 3.64 |

# Appendix D

## Preliminary Capital Cost Estimates

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 1: Existing WWTF Hardening
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| General Contract Conditions | | | | |
| General Conditions (12% of Total) | 1 | LS | $1,380,647.29 | $ 1,380,647.29 |
| Mobilization/Demobilization (5% of Total) | 1 | LS | $575,269.71 | $ 575,269.71 |
| | | | | |
| Civil | | | | |
| Demolition | | | | |
| Demolish Ex. EQ basin | 530 | CY | $ 500.00 | $ 265,000.00 |
| Concrete disposal - existing EQ basin | 530 | CY | $ 35.00 | $ 18,550.00 |
| Flood Barrier | | | | |
| Excavation | 1,650 | CY | $ 30.00 | $ 49,500.00 |
| Fill - onsite material | 40 | CY | $ 30.00 | $ 1,200.00 |
| Fill - offsite material | 6,160 | CY | $ 40.00 | $ 246,400.00 |
| HDPE liner, 60 mm thick | 34,000 | SF | $ 3.13 | $ 106,420.00 |
| Drainage pipe, 4" perforated PVC | 1,200 | LF | $ 13.07 | $ 15,684.00 |
| Sheet Piling, steel | 15,480 | SF | $ 36.13 | $ 559,292.40 |
| 12" HDPE Pipe for stormwater discharge | 400 | LF | $ 78.22 | $ 31,287.36 |
| Excavation | | | | |
| Stormwater PS | 40 | CY | $ 30.00 | $ 1,200.00 |
| Sheeting for temporary excavation support (salvageable) | | | | |
| Stormwater PS | 570 | SF | $ 90.00 | $ 51,300.00 |
| Dewatering | | | | |
| Stormwater PS | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| WWTF Site Roads | | | | |
| Asphalt Pavement (7.5 inches) | 8,000 | SF | $ 10.00 | $ 80,000.00 |
| Aggregate Base for Asphalt Paving | 8,000 | SF | $ 5.00 | $ 40,000.00 |
| | | | | |
| Structural | | | | |
| New EQ Basin | | | | |
| Base Slab | 1,020 | CY | $ 1,200.00 | $ 1,224,000.00 |
| Side Walls | 470 | CY | $ 1,200.00 | $ 564,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Headworks | | | | |
| 6" core drill existing structure to install grit suction influent line | 1 | EA | $ 2,500.00 | $ 2,500.00 |
| Footings for extended walkway | 1 | LS | $ 5,000.00 | $ 5,000.00 |
| New Metal Walkway | | | | |
| Extend existing walkway from exit to screenings dumpster | 200 | SF | $ 50.00 | $ 10,000.00 |
| Extend hand rails around new walkway | 60 | LF | $ 100.00 | $ 6,000.00 |
| Aeration Basin Expansion | | | | |
| Base Slab | 480 | CY | $ 1,200.00 | $ 576,000.00 |
| Side Walls | 250 | CY | $ 1,200.00 | $ 300,000.00 |
| MBR Building Expansion | | | | |
| Base Slab | 140 | CY | $ 1,200.00 | $ 168,000.00 |
| Stormwater PS | | | | |
| Base Slab | 10 | CY | $ 1,200.00 | $ 12,000.00 |
| Side Walls | 10 | CY | $ 1,200.00 | $ 12,000.00 |
| | | | | |
| Architectural and HVAC | | | | |
| MBR Building Expansion | | | | |
| Architectural Allowance | 3,520 | SF | $ 150.00 | $ 528,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $35,000.00 | $ 35,000.00 |
| Unit Heater | 4 | 1000 SF | $1,500.00 | $ 6,000.00 |

| | |
|---|---|
| Lewes Board of Public Works and Sussex County | Updated By: K Beaudoin |
| WWTF Long Range Planning Study | Date: 10/21/2022 |
| Option 1: Existing WWTF Hardening | Checked By: T Biagioli |
| Preliminary Capital Cost Estimate | Date: 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Mechanical/Equipment and Process Piping | | | | |
| Demolition & Disposal | | | | |
| Dispose of existing grit equipment at headworks | 1 | EA | $10,000.00 | $ 10,000.00 |
| Dispose of existing suction pumps and motors at LS-4 | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| Equipment: | | | | |
| Fuel tank, 4000 gal | 1 | LS | $ 40,400.00 | $ 40,400.00 |
| Steep slope lawnmower | 1 | EA | $ 10,000.00 | $ 10,000.00 |
| Stormwater Pump Station | | | | |
| Stormwater Pump | 1 | LS | $ 117,039.00 | $ 117,039.00 |
| Headworks | | | | |
| Flow EQ Pumps | 3 | EA | $127,920.00 | $ 383,760.00 |
| Refurbish Existing 5mm Screen | 1 | EA | $ 121,836.00 | $ 121,836.00 |
| New Compactor for 5mm Screen, incl. control panel | 1 | EA | $ 300,456.00 | $ 300,456.00 |
| New JETA Grit Unit installed in existing structure, new control panel | 1 | EA | $ 183,768.00 | $ 183,768.00 |
| New Grit Pump | 2 | EA | $ 48,516.00 | $ 97,032.00 |
| New Grit Classifier and Cyclone | 1 | EA | $ 143,364.00 | $ 143,364.00 |
| Refurbish Existing 2mm Screen | 1 | EA | $ 131,040.00 | $ 131,040.00 |
| New 2mm Screen to be installed in ex. Bypass channel, new control pane | 1 | EA | $ 583,596.00 | $ 583,596.00 |
| New Compactor for 2mm Screen | 2 | EA | $ 75,660.00 | $ 151,320.00 |
| New Control Panel for 2mm screen compactors | 1 | EA | $ 171,756.00 | $ 171,756.00 |
| MBR Building | | | | |
| Additional MBR Casette | 1 | LS | $1,131,825.00 | $ 1,131,825.00 |
| UV disinfection system replacement | 1 | LS | $347,880.00 | $ 347,880.00 |
| Plumbing Allowance | 1 | LS | $ 20,000.00 | $ 20,000.00 |
| Electrical/Instrumentation | | | | |
| Electrical Allowance (20% of project costs, ex. land purchase) | 1 | LS | $1,842,081.15 | $ 1,842,081.15 |
| Instrumentation Allowance (10% of project costs, ex. land purchase) | 1 | LS | $452,907.20 | $ 452,907.20 |
| | | | Subtotal (rounded to nearest $1,000): | $ 13,461,000.00 |
| | | | Contingency (rounded to nearest $1,000): | $ 4,711,000.00 |
| | | | Total (rounded to nearest $1,000): | $ 18,172,000.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2a - Relocation and Spray Irrigation and/or RIBS
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| General Contract Conditions | | | | |
| General Conditions (12% of Total) | 1 | LS | $9,486,375.19 | $ 9,486,375.19 |
| Mobilization/Demobilization (5% of Total) | 1 | LS | $3,952,656.33 | $ 3,952,656.33 |
| Land Purchase | 250 | AC | $ 50,000.00 | $ 12,500,000.00 |
| Network Upgrades | | | | |
| Excavation and Backfill | | | | |
| Excavation for new LS-8 | 1,210 | CY | $ 30.00 | $ 36,300.00 |
| Excavation for new Influent Force Main piping | 16,140 | CY | $ 30.00 | $ 484,192.59 |
| Excavation for new effluent force main piping | 2,670 | CY | $ 30.00 | $ 80,100.00 |
| Off-site disposal of soil material | 3,140 | CY | $ 40.00 | $ 125,600.00 |
| Backfill - Onsite Material, for FM pipe excavation | 16,880 | CY | $ 30.00 | $ 506,400.00 |
| Influent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 74,800 | SF | $ 10.00 | $ 748,000.00 |
| Aggregate Base for Asphalt Paving | 74,800 | SF | $ 5.00 | $ 374,000.00 |
| Influent Force Main: Temporary Traffic Management | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Bypass Pumping | | | | |
| LS-4 Bypass | 3 | MO | $ 24,000.00 | $ 72,000.00 |
| LS-8 Bypass | 6 | MO | $ 24,000.00 | $ 144,000.00 |
| Influent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 32,100 | LF | $ 123.24 | $ 3,956,004.00 |
| 16" HDPE 90° elbow | 7 | EA | $ 1,950.00 | $ 13,650.00 |
| 16" HDPE 45° elbow | 3 | EA | $ 1,177.80 | $ 3,533.40 |
| Effluent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 5,280 | LF | $ 123.24 | $ 650,707.20 |
| New Wet and Dry Wells at LS-8 | | | | |
| Below grade precast concrete vault for new grinder arrangement | 1 | EA | $ 10,000.00 | $ 10,000.00 |
| Base Slab | 120 | CY | $ 1,200.00 | $ 144,000.00 |
| Walls | 170 | CY | $ 1,200.00 | $ 204,000.00 |
| Cover Slab | 60 | CY | $ 1,200.00 | $ 72,000.00 |
| Bypass vault | 12 | CY | $ 1,200.00 | $ 14,400.00 |
| Equipment pads - generator and odor control | 26 | CY | $ 1,200.00 | $ 31,200.00 |
| Sheeting for temporary excavation support (salvageable) | 10,310 | SF | $ 90.00 | $ 927,900.00 |
| Dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| LS-8 Equipment | | | | |
| Raw Wastewater Pumps | 2 | EA | $329,160.00 | $ 658,320.00 |
| Odor control system | 1 | LS | $12,500.00 | $ 12,500.00 |
| 115 kW generator | 1 | LS | $ 67,080.00 | $ 67,080.00 |
| Grinder arrangement on wet well influent (16") | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| Civil | | | | |
| Decommissioning of existing WWTF | | | | |
| Process equipment building | 1 | LS | $ 900,000.00 | $ 900,000.00 |
| Headworks | 1 | LS | $ 600,000.00 | $ 600,000.00 |
| Aeration basins | 1 | LS | $ 420,000.00 | $ 420,000.00 |
| Aerobic digester | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Chemical building & pump station | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Service building | 1 | LS | $ 180,000.00 | $ 180,000.00 |
| Anoxic & membrane tanks | 1 | LS | $ 150,000.00 | $ 150,000.00 |
| Belt filter press building | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| EQ tank | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| Control building | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Emergency storage tank | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Sludge drying beds | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Sludge storage | 1 | LS | $ 60,000.00 | $ 60,000.00 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Meter vault | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Plant pump station | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Diesel fuel storage | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Generator pad | 1 | LS | $ 12,000.00 | $ 12,000.00 |
| Pavement | 6,350 | SY | $ 18.00 | $ 114,300.00 |
| Excavation and Backfill | | | | |
| Excavation for new WWTF piping | 1,240 | CY | $ 30.00 | $ 37,200.00 |
| Excavation for Biolac lagoons | 8,670 | CY | $ 30.00 | $ 260,100.00 |
| Excavation for clarifiers | 910 | CY | $ 30.00 | $ 27,300.00 |
| Effluent storage lagoons | | | | |
| Excavation for effluent storage lagoons | 97,300 | CY | $ 30.00 | $ 2,919,000.00 |
| Backfill for effluent storage lagoons | 100,800 | CY | $ 30.00 | $ 3,024,000.00 |
| HDPE Liner for effluent storage lagoons, 60 mm thick | 752,300 | SF | $ 3.13 | $ 2,354,699.00 |
| Excavation for effluent pump station | 390 | CY | $ 30.00 | $ 11,700.00 |
| Off-site disposal of soil material | 6,720 | CY | $ 40.00 | $ 268,800.00 |
| Backfill - Onsite Material, for WWTF excavation | 990 | CY | $ 30.00 | $ 29,700.00 |
| Sheeting for temporary excavation support (salvageable) | | | | |
| Aeration lagoons | 16,020 | SF | $ 90.00 | $ 1,441,800.00 |
| Clarifiers | 8,150 | SF | $ 90.00 | $ 733,500.00 |
| Effluent pump station | 4,650 | SF | $ 90.00 | $ 418,500.00 |
| Dewatering | | | | |
| Aeration lagoons | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| Clarifiers | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| Effluent pump station | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| WWTF Site Roads | | | | |
| Asphalt Pavement (7.5 inches) | 138,000 | SF | $ 10.00 | $ 1,380,000.00 |
| Aggregate Base for Asphalt Paving | 138,000 | SF | $ 5.00 | $ 690,000.00 |
| WWTF Yard Piping | | | | |
| 20" DIP, mechanical | 330 | LF | $ 180.00 | $ 59,400.00 |
| 14" DIP, mechanical | 2,160 | LF | $ 105.00 | $ 226,800.00 |
| 6" DIP, mechanical | 190 | LF | $ 45.00 | $ 8,550.00 |
| 20" DIP tee, mechanical | 1 | EA | $ 2,400.00 | $ 2,400.00 |
| 20" DIP 90° elbow, mechanical | 2 | EA | $ 3,225.00 | $ 6,450.00 |
| 14" DIP tee, mechanical | 5 | EA | $ 1,305.00 | $ 6,525.00 |
| 14" DIP 90° elbow, mechanical | 10 | EA | $ 915.00 | $ 9,150.00 |
| 6" DIP tee, mechanical | 1 | EA | $ 495.00 | $ 495.00 |
| 6" DIP 90° elbow, mechanical | 1 | EA | $ 270.00 | $ 270.00 |
| Erosion and Sedimentation Control | 1 | LS | $ 50,000.00 | $ 50,000.00 |
| Stormwater Management Basin | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| | | | | |
| Architectural and HVAC | | | | |
| Admin Building | | | | |
| Architectural Allowance | 3,000 | SF | $ 150.00 | $ 450,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $35,000.00 | $ 35,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| Headworks | | | | |
| Architectural Allowance | 4,000 | SF | $ 150.00 | $ 600,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 2 | 1000 SF | $1,500.00 | $ 3,000.00 |
| Effluent Filter/UV Building | | | | |
| Architectural Allowance | 2,700 | SF | $ 150.00 | $ 405,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $35,000.00 | $ 35,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| Effluent Pump Station | | | | |
| Architectural Allowance | 625 | SF | $ 150.00 | $ 93,750.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2a - Relocation and Spray Irrigation and/or RIBS
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 1 | 1000 SF | $1,500.00 | $ 1,500.00 |
| Digester Building | | | | |
| Architectural Allowance | 3,000 | SF | $ 150.00 | $ 450,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| | | | | |
| Structural | | | | |
| Headworks | | | | |
| Base Slab | 80 | CY | $ 1,200.00 | $ 96,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| EQ Tanks | | | | |
| Base Slab | 2,010 | CY | $ 1,200.00 | $ 2,412,000.00 |
| Tank Walls | 470 | CY | $ 1,200.00 | $ 564,000.00 |
| Walkways and Stairs | 2 | LS | $ 250,000.00 | $ 500,000.00 |
| Parkson Biolac Lagoons | | | | |
| Base Slab | 1,160 | CY | $ 1,200.00 | $ 1,392,000.00 |
| Tank Walls | 400 | CY | $ 1,200.00 | $ 480,000.00 |
| Walkways and Stairs | 2 | LS | $ 250,000.00 | $ 500,000.00 |
| Secondary Clarifiers | | | | |
| Base Slab | 160 | CY | $ 1,200.00 | $ 192,000.00 |
| Tank Walls | 110 | CY | $ 1,200.00 | $ 132,000.00 |
| Walkways and Stairs | 2 | LS | $ 100,000.00 | $ 200,000.00 |
| Effluent Filter/UV Building | | | | |
| Base Slab | 100 | CY | $ 1,200.00 | $ 120,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Anoxic + Membrane Tank | | | | |
| Base Slab | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Cover Slab | 30 | CY | $ 1,200.00 | $ 36,000.00 |
| Tank Walls | 110 | CY | $ 1,200.00 | $ 132,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Effluent Pump Station | | | | |
| Wet Well Base Slab | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Wet Well Walls | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Dry Well Base Slab | 10 | CY | $ 1,200.00 | $ 12,000.00 |
| Dry Well Walls | 40 | CY | $ 1,200.00 | $ 48,000.00 |
| Cover Slab | 40 | CY | $ 1,200.00 | $ 48,000.00 |
| | | | | |
| Mechanical/Equipment and Process Piping | | | | |
| WWTF Equipment: | | | | |
| Fuel tank, 4000 gal | 1 | LS | $ 40,400.00 | $ 40,400.00 |
| Headworks | | | | |
| 5 mm screen and compactor | 2 | EA | $702,000.00 | $ 1,404,000.00 |
| Grit removal | 2 | EA | $683,280.00 | $ 1,366,560.00 |
| Grit pumps | 2 | EA | $31,200.00 | $ 62,400.00 |
| Biolac Lagoons | | | | |
| Turbo Blowers | 1 | LS | $509,400.00 | $ 509,400.00 |
| Biolac System | 1 | LS | $608,400.00 | $ 608,400.00 |
| Secondary Clarifier Mechanism | 2 | EA | $234,000.00 | $ 468,000.00 |
| Cloth disc filters | 1 | LS | $1,244,724.00 | $ 1,244,724.00 |
| UV disinfection system | 1 | LS | $347,880.00 | $ 347,880.00 |
| Sludge Dewatering | | | | |
| Belt Filter Press | 1 | LS | $506,532.00 | $ 506,532.00 |
| Polymer Dosing System | 1 | LS | $62,556.00 | $ 62,556.00 |
| Dewatered Cake Conveyor | 1 | LS | $68,796.00 | $ 68,796.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2a - Relocation and Spray Irrigation and/or RIBS
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| WWTF Pumps: | | | | |
| Flow EQ Pumps | 3 | EA | $127,920.00 | $ 383,760.00 |
| Sludge Feed Pumps | 2 | EA | $68,796.00 | $ 137,592.00 |
| Scum Pumps | 2 | EA | $31,200.00 | $ 62,400.00 |
| Effluent pumps | 2 | EA | $241,800.00 | $ 483,600.00 |
| Spray irrigation | 1 | LS | $386,100.00 | $ 386,100.00 |
| Process Piping, Valves, Flow Meter and Plumbing Allowance (15% of project c | 1 | LS | $5,561,336.58 | $ 5,561,336.58 |
| | | | | |
| Electrical/Instrumentation | | | | |
| Electrical Allowance (20% of project costs, ex. land purchase) | 1 | LS | $10,238,942.55 | $ 10,238,942.55 |
| Instrumentation Allowance (10% of project costs, ex. land purchase) | 1 | LS | $5,119,471.28 | $ 5,119,471.28 |
| | | | | |
| | | | Subtotal (rounded to nearest $1,000): | $ 92,492,000.00 |
| | | | Contingency (rounded to nearest $1,000): | $ 32,372,000.00 |
| | | | Total (rounded to nearest $1,000): | $ 124,864,000.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2b - Relocation & Utilization of Existing WWTP Outfall
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| General Contract Conditions | | | | |
| General Conditions (12% of Total) | 1 | LS | $6,930,558.83 | $ 6,930,558.83 |
| Mobilization/Demobilization (5% of Total) | 1 | LS | $2,887,732.84 | $ 2,887,732.84 |
| Land Purchase | 20 | AC | $ 50,000.00 | $ 1,000,000.00 |
| Network Upgrades | | | | |
| Excavation and Backfill | | | | |
| Excavation for new LS-8 | 1,210 | CY | $ 30.00 | $ 36,300.00 |
| Excavation for new Influent Force Main piping | 12,070 | CY | $ 30.00 | $ 362,100.00 |
| Excavation for new Effluent Force Main piping | 12,070 | CY | $ 30.00 | $ 362,100.00 |
| Excavation for effluent pump station | 390 | CY | $ 30.00 | $ 11,700.00 |
| Off-site disposal of soil material | 4,080 | CY | $ 40.00 | $ 163,200.00 |
| Backfill - Onsite Material, for FM pipe excavation | 21,660 | CY | $ 30.00 | $ 649,800.00 |
| Influent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 55,860 | SF | $ 10.00 | $ 558,600.00 |
| Aggregate Base for Asphalt Paving | 55,860 | SF | $ 5.00 | $ 279,300.00 |
| Effluent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 55,860 | SF | $ 10.00 | $ 558,600.00 |
| Aggregate Base for Asphalt Paving | 55,860 | SF | $ 5.00 | $ 279,300.00 |
| Force Mains: Temporary Traffic Management | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Influent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 24,000 | LF | $ 123.24 | $ 2,957,760.00 |
| 16" HDPE 90° elbow | 2 | EA | $ 1,950.00 | $ 3,900.00 |
| 16" HDPE 45° elbow | 2 | EA | $ 1,177.80 | $ 2,355.60 |
| Effluent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 24,000 | LF | $ 123.24 | $ 2,957,760.00 |
| 16" HDPE 90° elbow | 2 | EA | $ 1,950.00 | $ 3,900.00 |
| 16" HDPE 45° elbow | 2 | EA | $ 1,177.80 | $ 2,355.60 |
| Bypass Pumping | | | | |
| LS-4 Bypass | 3 | MO | $ 24,000.00 | $ 72,000.00 |
| LS-8 Bypass | 6 | MO | $ 24,000.00 | $ 144,000.00 |
| New Wet and Dry Wells at LS-8 | | | | |
| Below grade precast concrete vault for new grinder arrangement | 1 | EA | $ 10,000.00 | $ 10,000.00 |
| Base Slab | 120 | CY | $ 1,200.00 | $ 144,000.00 |
| Walls | 170 | CY | $ 1,200.00 | $ 204,000.00 |
| Cover Slab | 60 | CY | $ 1,200.00 | $ 72,000.00 |
| Bypass vault | 12 | CY | $ 1,200.00 | $ 14,400.00 |
| Equipment pads - generator and odor control | 26 | CY | $ 1,200.00 | $ 31,200.00 |
| Sheeting for temporary excavation support (salvageable) | 10,310 | SF | $ 90.00 | $ 927,900.00 |
| Dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| LS-8 Equipment | | | | |
| Raw Wastewater Pumps | 2 | EA | $257,400.00 | $ 514,800.00 |
| Odor control system | 1 | LS | $12,500.00 | $ 12,500.00 |
| 115 kW generator | 1 | LS | $ 67,080.00 | $ 67,080.00 |
| Grinder arrangement on wet well influent (16") | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| Effluent Pump Station | | | | |
| Effluent pumps | 2 | EA | $241,800.00 | $ 483,600.00 |
| Architectural Allowance | 1,800 | SF | $ 150.00 | $ 270,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 2 | 1000 SF | $1,500.00 | $ 3,000.00 |
| Wet Well Base Slab | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Wet Well Walls | 50 | CY | $ 1,200.00 | $ 60,000.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2b - Relocation & Utilization of Existing WWTP Outfall
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Dry Well Base Slab | 10 | CY | $ 1,200.00 | $ 12,000.00 |
| Dry Well Walls | 40 | CY | $ 1,200.00 | $ 48,000.00 |
| Cover Slab | 40 | CY | $ 1,200.00 | $ 48,000.00 |
| Sheeting for temporary excavation support (salvageable) | 4,650 | SF | $ 90.00 | $ 418,500.00 |
| Dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| | | | | |
| Civil | | | | |
| Decommissioning of existing WWTF | | | | |
| Process equipment building | 1 | LS | $ 900,000.00 | $ 900,000.00 |
| Headworks | 1 | LS | $ 600,000.00 | $ 600,000.00 |
| Aeration basins | 1 | LS | $ 420,000.00 | $ 420,000.00 |
| Aerobic digester | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Chemical building & pump station | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Service building | 1 | LS | $ 180,000.00 | $ 180,000.00 |
| Anoxic & membrane tanks | 1 | LS | $ 150,000.00 | $ 150,000.00 |
| Belt filter press building | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| EQ tank | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| Control building | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Emergency storage tank | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Sludge drying beds | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Sludge storage | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Meter vault | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Plant pump station | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Diesel fuel storage | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Generator pad | 1 | LS | $ 12,000.00 | $ 12,000.00 |
| Pavement | 6,350 | SY | $ 18.00 | $ 114,300.00 |
| Excavation and Backfill | | | | |
| Excavation for Biolac lagoons | 8,670 | CY | $ 30.00 | $ 260,100.00 |
| Excavation for clarifiers | 910 | CY | $ 30.00 | $ 27,300.00 |
| Excavation for effluent pump station | 390 | CY | $ 30.00 | $ 11,700.00 |
| Excavation for new WWTF piping | 920 | CY | $ 30.00 | $ 27,600.00 |
| Off-site disposal of soil material | 10,190 | CY | $ 40.00 | $ 407,600.00 |
| Backfill - Onsite Material, for WWTF pipe excavation | 700 | CY | $ 30.00 | $ 21,000.00 |
| Sheeting for temporary excavation support (salvageable) | | | | |
| Aeration lagoons | 16,020 | SF | $ 90.00 | $ 1,441,800.00 |
| Clarifiers | 8,150 | SF | $ 90.00 | $ 733,500.00 |
| Dewatering | | | | |
| Aeration lagoons | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| Clarifiers | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| WWTF Site Roads | | | | |
| Asphalt Pavement (7.5 inches) | 55,100 | SF | $ 10.00 | $ 551,000.00 |
| Aggregate Base for Asphalt Paving | 55,100 | SF | $ 5.00 | $ 275,500.00 |
| WWTF Yard Piping | | | | |
| 20" DIP, mechanical | 330 | LF | $ 180.00 | $ 59,400.00 |
| 14" DIP, mechanical | 1,440 | LF | $ 105.00 | $ 151,200.00 |
| 6" DIP, mechanical | 190 | LF | $ 45.00 | $ 8,550.00 |
| 20" DIP tee, mechanical | 1 | EA | $ 2,400.00 | $ 2,400.00 |
| 20" DIP 90° elbow, mechanical | 2 | EA | $ 3,225.00 | $ 6,450.00 |
| 14" DIP tee, mechanical | 3 | EA | $ 1,305.00 | $ 3,915.00 |
| 14" DIP 90° elbow, mechanical | 6 | EA | $ 915.00 | $ 5,490.00 |
| 6" DIP tee, mechanical | 1 | EA | $ 495.00 | $ 495.00 |
| 6" DIP 90° elbow, mechanical | 1 | EA | $ 270.00 | $ 270.00 |
| Erosion and Sedimentation Control | 1 | LS | $ 50,000.00 | $ 50,000.00 |
| Stormwater Management Basin | 1 | LS | $ 100,000.00 | $ 100,000.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2b - Relocation & Utilization of Existing WWTP Outfall
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Architectural and HVAC | | | | |
| Admin Building | | | | |
| Architectural Allowance | 3,000 | SF | $ 150.00 | $ 450,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $35,000.00 | $ 35,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| Headworks | | | | |
| Architectural Allowance | 4,000 | SF | $ 150.00 | $ 600,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 2 | 1000 SF | $1,500.00 | $ 3,000.00 |
| Effluent Filter/UV Building | | | | |
| Architectural Allowance | 2,700 | SF | $ 150.00 | $ 405,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| Digester Building | | | | |
| Architectural Allowance | 3,000 | SF | $ 150.00 | $ 450,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 2 | 1000 SF | $1,500.00 | $ 3,000.00 |
| Structural | | | | |
| Headworks | | | | |
| Base Slab | 80 | CY | $ 1,200.00 | $ 96,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| EQ Tanks | | | | |
| Base Slab | 2,010 | CY | $ 1,200.00 | $ 2,412,000.00 |
| Tank Walls | 470 | CY | $ 1,200.00 | $ 564,000.00 |
| Walkways and Stairs | 2 | LS | $ 250,000.00 | $ 500,000.00 |
| Parkson Biolac Lagoons | | | | |
| Base Slab | 1,160 | CY | $ 1,200.00 | $ 1,392,000.00 |
| Tank Walls | 400 | CY | $ 1,200.00 | $ 480,000.00 |
| Walkways and Stairs | 2 | LS | $ 250,000.00 | $ 500,000.00 |
| Secondary Clarifiers | | | | |
| Base Slab | 160 | CY | $ 1,200.00 | $ 192,000.00 |
| Tank Walls | 110 | CY | $ 1,200.00 | $ 132,000.00 |
| Walkways and Stairs | 2 | LS | $ 100,000.00 | $ 200,000.00 |
| Effluent Filter/UV Building | | | | |
| Base Slab | 100 | CY | $ 1,200.00 | $ 120,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Anoxic + Membrane Tank | | | | |
| Base Slab | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Cover Slab | 30 | CY | $ 1,200.00 | $ 36,000.00 |
| Tank Walls | 110 | CY | $ 1,200.00 | $ 132,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Mechanical/Equipment and Process Piping | | | | |
| WWTF Equipment: | | | | |
| Fuel tank, 4000 gal | 1 | LS | $ 40,400.00 | $ 40,400.00 |
| Headworks | | | | |
| 5 mm screen and compactor | 2 | EA | $702,000.00 | $ 1,404,000.00 |
| Grit removal | 2 | EA | $683,280.00 | $ 1,366,560.00 |

| | |
|---|---|
| Lewes Board of Public Works and Sussex County | Updated By: K Beaudoin |
| WWTF Long Range Planning Study | Date: 10/21/2022 |
| Option 2b - Relocation & Utilization of Existing WWTP Outfall | Checked By: T Biagioli |
| Preliminary Capital Cost Estimate | Date: 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Grit pumps | 2 | EA | $31,200.00 | $ 62,400.00 |
| Biolac Lagoons | | | | |
| Turbo Blowers | 1 | LS | $509,400.00 | $ 509,400.00 |
| Biolac System | 1 | LS | $608,400.00 | $ 608,400.00 |
| Secondary Clarifier Mechanism | 2 | EA | $234,000.00 | $ 468,000.00 |
| Cloth disc filters | 1 | LS | $1,244,724.00 | $ 1,244,724.00 |
| UV disinfection system | 1 | LS | $347,880.00 | $ 347,880.00 |
| Sludge Dewatering | | | | |
| Belt Filter Press | 1 | LS | $506,532.00 | $ 506,532.00 |
| Polymer Dosing System | 1 | LS | $62,556.00 | $ 62,556.00 |
| Dewatered Cake Conveyor | 1 | LS | $68,796.00 | $ 68,796.00 |
| WWTF Pumps: | | | | |
| Flow EQ Pumps | 3 | EA | $127,920.00 | $ 383,760.00 |
| Sludge Feed Pumps | 2 | EA | $68,796.00 | $ 137,592.00 |
| Scum Pumps | 2 | EA | $31,200.00 | $ 62,400.00 |
| Process Piping, Valves, Flow Meter and Plumbing Allowance (15% of project c | 1 | LS | $5,694,447.18 | $ 5,694,447.18 |
| | | | | |
| Electrical/Instrumentation | | | | |
| Electrical Allowance (20% of project costs, ex. land purchase) | 1 | LS | $8,731,485.68 | $ 8,731,485.68 |
| Instrumentation Allowance (10% of project costs, ex. land purchase) | 1 | LS | $4,365,742.84 | $ 4,365,742.84 |
| | | | Subtotal (rounded to nearest $1,000): | $ 67,573,000.00 |
| | | | Contingency (rounded to nearest $1,000): | $ 23,651,000.00 |
| | | | Total (rounded to nearest $1,000): | $ 91,224,000.00 |

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| Lewes Board of Public Works and Sussex County | Updated By: K Beaudoin |
| WWTF Long Range Planning Study | Date: 10/21/2022 |
| Option 2c - Relocation & New Ocean Outfall | Checked By: T Biagioli |
| Preliminary Capital Cost Estimate | Date: 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| General Contract Conditions | | | | |
| General Conditions (12% of Total) | 1 | LS | $11,332,168.41 | $ 11,332,168.41 |
| Mobilization/Demobilization (5% of Total) | 1 | LS | $4,721,736.84 | $ 4,721,736.84 |
| Land Purchase | 20 | AC | $ 50,000.00 | $ 1,000,000.00 |
| Network | | | | |
| Excavation for new LS-8 | 1,210 | CY | $ 30.00 | $ 36,300.00 |
| Excavation for new Influent Force Main piping | 12,070 | CY | $ 30.00 | $ 362,100.00 |
| Excavation for new Effluent Force Main piping | 17,940 | CY | $ 30.00 | $ 538,200.00 |
| Off-site disposal of soil material | 4,290 | CY | $ 40.00 | $ 171,600.00 |
| Backfill - Onsite Material, FM pipe excavation | 26,930 | CY | $ 30.00 | $ 807,900.00 |
| Influent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 55,860 | SF | $ 10.00 | $ 558,600.00 |
| Aggregate Base for Asphalt Paving | 55,860 | SF | $ 5.00 | $ 279,300.00 |
| Effluent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 83,020 | SF | $ 10.00 | $ 830,200.00 |
| Aggregate Base for Asphalt Paving | 83,020 | SF | $ 5.00 | $ 415,100.00 |
| Influent Force Main: Temporary Traffic Management | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Effluent Force Main: Temporary Traffic Management | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Bypass Pumping | | | | |
| LS-4 Bypass | 3 | MO | $ 24,000.00 | $ 72,000.00 |
| LS-8 Bypass | 6 | MO | $ 24,000.00 | $ 144,000.00 |
| Influent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 23,940 | LF | $ 123.24 | $ 2,950,365.60 |
| 16" HDPE 90° elbow | 2 | EA | $ 1,950.00 | $ 3,900.00 |
| 16" HDPE 45° elbow | 2 | EA | $ 1,177.80 | $ 2,355.60 |
| Effluent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 35,580 | LF | $ 123.24 | $ 4,384,879.20 |
| 16" HDPE 90° elbow | 2 | EA | $ 1,950.00 | $ 3,900.00 |
| 16" HDPE 45° elbow | 2 | EA | $ 1,177.80 | $ 2,355.60 |
| New Wet and Dry Wells at LS-8 | | | | |
| Below grade precast concrete vault for new grinder arrangement | 1 | EA | $ 10,000.00 | $ 10,000.00 |
| Base Slab | 120 | CY | $ 1,200.00 | $ 144,000.00 |
| Walls | 170 | CY | $ 1,200.00 | $ 204,000.00 |
| Cover Slab | 60 | CY | $ 1,200.00 | $ 72,000.00 |
| Bypass vault | 12 | CY | $ 1,200.00 | $ 14,400.00 |
| Equipment pads - generator and odor control | 26 | CY | $ 1,200.00 | $ 31,200.00 |
| Sheeting for temporary excavation support (salvageable) | 10,310 | SF | $ 90.00 | $ 927,900.00 |
| Dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| LS-8 Equipment | | | | |
| Raw Wastewater Pumps | 2 | EA | $257,400.00 | $ 514,800.00 |
| Odor control system | 1 | LS | $12,500.00 | $ 12,500.00 |
| 115 kW generator | 1 | LS | $ 67,080.00 | $ 67,080.00 |
| Grinder arrangement on wet well influent (16") | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| Effluent Pump Station | | | | |
| Effluent pumps | 2 | EA | $257,400.00 | $ 514,800.00 |
| Wet Well Base Slab | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Wet Well Walls | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Dry Well Base Slab | 10 | CY | $ 1,200.00 | $ 12,000.00 |
| Dry Well Walls | 40 | CY | $ 1,200.00 | $ 48,000.00 |
| Cover Slab | 40 | CY | $ 1,200.00 | $ 48,000.00 |
| Sheeting for temporary excavation support (salvageable) | 4,650 | SF | $ 90.00 | $ 418,500.00 |
| Dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2c - Relocation & New Ocean Outfall
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Architectural Allowance | 625 | SF | $ 150.00 | $ 93,750.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $35,000.00 | $ 35,000.00 |
| Unit Heater | 1 | 1000 SF | $1,500.00 | $ 1,500.00 |
| Ocean Outfall | | | | |
| Maintenance of traffic | 1 | LS | $ 195,000.00 | $ 195,000.00 |
| Staging area, beach dune and land based site restoration | 1 | LS | $ 59,150.00 | $ 59,150.00 |
| Sediment and erosion control | 1 | LS | $ 19,500.00 | $ 19,500.00 |
| HDD monitoring/Fluid specialist | 1 | LS | $ 104,000.00 | $ 104,000.00 |
| Concrete thrust collar | 1 | LS | $ 162,500.00 | $ 162,500.00 |
| Outfall diffuser assembly | 1 | LS | $ 2,210,000.00 | $ 2,210,000.00 |
| Concrete piling and pile caps at diffuser | 1 | LS | $ 3,770,000.00 | $ 3,770,000.00 |
| HDD entry pit | 1 | LS | $ 130,000.00 | $ 130,000.00 |
| HDD exit pit | 1 | LS | $ 1,326,000.00 | $ 1,326,000.00 |
| 16" HDPE outfall pipe via HDD | 3,000 | LF | $ 1,885.00 | $ 5,655,000.00 |
| 16" HDPE via marine open-cut trench | 3,000 | LF | $ 6,240.00 | $ 18,720,000.00 |
| Concrete ballast collars for open-cut | 165 | EA | $ 4,810.00 | $ 793,650.00 |
| Parking lot | 70,000 | SF | $ 2.60 | $ 182,000.00 |
| Connection between outfall and force main | 1 | LS | $ 130,000.00 | $ 130,000.00 |
| Misc. excavation and replacement of sand | 100 | CY | $ 130.00 | $ 13,000.00 |
| Silt fence | 300 | LF | $ 32.50 | $ 9,750.00 |
| Beach sand fencing | 50 | LF | $ 130.00 | $ 6,500.00 |
| | | | | |
| Civil | | | | |
| Decommissioning of existing WWTF | | | | |
| Process equipment building | 1 | LS | $ 900,000.00 | $ 900,000.00 |
| Headworks | 1 | LS | $ 600,000.00 | $ 600,000.00 |
| Aeration basins | 1 | LS | $ 420,000.00 | $ 420,000.00 |
| Aerobic digester | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Chemical building & pump station | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Service building | 1 | LS | $ 180,000.00 | $ 180,000.00 |
| Anoxic & membrane tanks | 1 | LS | $ 150,000.00 | $ 150,000.00 |
| Belt filter press building | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| EQ tank | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| Control building | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Emergency storage tank | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Sludge drying beds | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Sludge storage | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Meter vault | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Plant pump station | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Diesel fuel storage | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Generator pad | 1 | LS | $ 12,000.00 | $ 12,000.00 |
| Pavement | 6,350 | SY | $ 18.00 | $ 114,300.00 |
| Excavation and Backfill | | | | |
| Excavation for Biolac lagoons | 8,670 | CY | $ 30.00 | $ 260,100.00 |
| Excavation for clarifiers | 910 | CY | $ 30.00 | $ 27,300.00 |
| Excavation for effluent pump station | 390 | CY | $ 30.00 | $ 11,700.00 |
| Excavation for new WWTF piping | 920 | CY | $ 30.00 | $ 27,600.00 |
| Off-site disposal of soil material | 10,190 | CY | $ 40.00 | $ 407,600.00 |
| Backfill - Onsite Material, for WWTF pipe excavation | 700 | CY | $ 30.00 | $ 21,000.00 |
| Sheeting for temporary excavation support (salvageable) | | | | |
| Aeration lagoons | 16,020 | SF | $ 90.00 | $ 1,441,800.00 |
| Clarifiers | 8,150 | SF | $ 90.00 | $ 733,500.00 |
| Dewatering | | | | |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2c - Relocation & New Ocean Outfall
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Aeration lagoons | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| Clarifiers | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| WWTF Site Roads | | | | |
| Asphalt Pavement (7.5 inches) | 55,100 | SF | $ 10.00 | $ 551,000.00 |
| Aggregate Base for Asphalt Paving | 55,100 | SF | $ 5.00 | $ 275,500.00 |
| WWTF Yard Piping | | | | |
| 20" DIP, mechanical | 330 | LF | $ 180.00 | $ 59,400.00 |
| 14" DIP, mechanical | 1,440 | LF | $ 105.00 | $ 151,200.00 |
| 6" DIP, mechanical | 190 | LF | $ 45.00 | $ 8,550.00 |
| 20" DIP tee, mechanical | 1 | EA | $ 2,400.00 | $ 2,400.00 |
| 20" DIP 90° elbow, mechanical | 2 | EA | $ 3,225.00 | $ 6,450.00 |
| 14" DIP tee, mechanical | 3 | EA | $ 1,305.00 | $ 3,915.00 |
| 14" DIP 90° elbow, mechanical | 6 | EA | $ 915.00 | $ 5,490.00 |
| 6" DIP tee, mechanical | 1 | EA | $ 495.00 | $ 495.00 |
| 6" DIP 90° elbow, mechanical | 1 | EA | $ 270.00 | $ 270.00 |
| Erosion and Sedimentation Control | 1 | LS | $ 50,000.00 | $ 50,000.00 |
| Stormwater Management Basin | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| | | | | |
| Architectural and HVAC | | | | |
| Admin Building | | | | |
| Architectural Allowance | 3,000 | SF | $ 150.00 | $ 450,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $35,000.00 | $ 35,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| Headworks | | | | |
| Architectural Allowance | 4,000 | SF | $ 150.00 | $ 600,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 2 | 1000 SF | $1,500.00 | $ 3,000.00 |
| Effluent Filter/UV Building | | | | |
| Architectural Allowance | 2,700 | SF | $ 150.00 | $ 405,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 3 | 1000 SF | $1,500.00 | $ 4,500.00 |
| Digester Building | | | | |
| Architectural Allowance | 3,000 | SF | $ 150.00 | $ 450,000.00 |
| AC for Control/Blower/Electrical Rooms | 1 | LS | $25,000.00 | $ 25,000.00 |
| Ventilation System | 1 | LS | $10,000.00 | $ 10,000.00 |
| Unit Heater | 2 | 1000 SF | $1,500.00 | $ 3,000.00 |
| | | | | |
| Structural | | | | |
| Headworks | | | | |
| Base Slab | 80 | CY | $ 1,200.00 | $ 96,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| EQ Tanks | | | | |
| Base Slab | 2,010 | CY | $ 1,200.00 | $ 2,412,000.00 |
| Tank Walls | 470 | CY | $ 1,200.00 | $ 564,000.00 |
| Walkways and Stairs | 2 | LS | $ 250,000.00 | $ 500,000.00 |
| Parkson Biolac Lagoons | | | | |
| Base Slab | 1,160 | CY | $ 1,200.00 | $ 1,392,000.00 |
| Tank Walls | 400 | CY | $ 1,200.00 | $ 480,000.00 |
| Walkways and Stairs | 2 | LS | $ 250,000.00 | $ 500,000.00 |
| Secondary Clarifiers | | | | |
| Base Slab | 160 | CY | $ 1,200.00 | $ 192,000.00 |

Lewes Board of Public Works and Sussex County
WWTF Long Range Planning Study
Option 2c - Relocation & New Ocean Outfall
Preliminary Capital Cost Estimate

Updated By: K Beaudoin
Date: 10/21/2022
Checked By: T Biagioli
Date: 10/24/2022

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Tank Walls | 110 | CY | $ 1,200.00 | $ 132,000.00 |
| Walkways and Stairs | 2 | LS | $ 100,000.00 | $ 200,000.00 |
| Effluent Filter/UV Building | | | | |
| Base Slab | 100 | CY | $ 1,200.00 | $ 120,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Anoxic + Membrane Tank | | | | |
| Base Slab | 50 | CY | $ 1,200.00 | $ 60,000.00 |
| Cover Slab | 30 | CY | $ 1,200.00 | $ 36,000.00 |
| Tank Walls | 110 | CY | $ 1,200.00 | $ 132,000.00 |
| Walkways and Stairs | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| | | | | |
| Mechanical/Equipment and Process Piping | | | | |
| WWTF Equipment: | | | | |
| Fuel tank, 4000 gal | 1 | LS | $ 40,400.00 | $ 40,400.00 |
| Headworks | | | | |
| 5 mm screen and compactor | 2 | EA | $702,000.00 | $ 1,404,000.00 |
| Grit removal | 2 | EA | $683,280.00 | $ 1,366,560.00 |
| Grit pumps | 2 | EA | $31,200.00 | $ 62,400.00 |
| Biolac Lagoons | | | | |
| Turbo Blowers | 1 | LS | $509,400.00 | $ 509,400.00 |
| Biolac System | 1 | LS | $608,400.00 | $ 608,400.00 |
| Secondary Clarifier Mechanism | 2 | EA | $234,000.00 | $ 468,000.00 |
| Cloth disc filters | 1 | LS | $1,244,724.00 | $ 1,244,724.00 |
| UV disinfection system | 1 | LS | $347,880.00 | $ 347,880.00 |
| Sludge Dewatering | | | | |
| Belt Filter Press | 1 | LS | $506,532.00 | $ 506,532.00 |
| Polymer Dosing System | 1 | LS | $62,556.00 | $ 62,556.00 |
| Dewatered Cake Conveyor | 1 | LS | $68,796.00 | $ 68,796.00 |
| WWTF Pumps: | | | | |
| Flow EQ Pumps | 3 | EA | $127,920.00 | $ 383,760.00 |
| Sludge Feed Pumps | 2 | EA | $68,796.00 | $ 137,592.00 |
| Scum Pumps | 2 | EA | $31,200.00 | $ 62,400.00 |
| Process Piping, Valves, Flow Meter and Plumbing Allowance (15% of project co | 1 | LS | $6,014,918.40 | $ 6,014,918.40 |
| | | | | |
| Electrical/Instrumentation | | | | |
| Electrical Allowance (20% of project costs, ex. land purchase & ocean outfall) | 1 | LS | $9,222,874.88 | $ 9,222,874.88 |
| Instrumentation Allowance (10% of project costs, ex. land purchase & ocean ou | 1 | LS | $4,611,437.44 | $ 4,611,437.44 |
| Subtotal (rounded to nearest $1,000): | | | | $ 110,489,000.00 |
| Contingency (rounded to nearest $1,000): | | | | $ 38,671,000.00 |
| Total (rounded to nearest $1,000): | | | | $ 149,160,000.00 |

| | | | |
|---|---|---|---|
| Lewes Board of Public Works and Sussex County | | Updated By: | K Beaudoin |
| WWTF Long Range Planning Study | | Date: | 10/21/2022 |
| Option 3a - Partnership with Sussex County & Utilization of Existing WWTP Outfall (BPW Costs) | | Checked By: | T Biagioli |
| Preliminary Capital Cost Estimate | | Date: | 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| General Contract Conditions | | | | |
| General Conditions (12% of Total) | 1 | LS | $1,215,573.86 | $ 1,215,573.86 |
| Mobilization/Demobilization (5% of Total) | 1 | LS | $506,489.11 | $ 506,489.11 |
| Decommissioning of existing WWTF | | | | |
| Process equipment building | 1 | LS | $ 900,000.00 | $ 900,000.00 |
| Headworks | 1 | LS | $ 600,000.00 | $ 600,000.00 |
| Aeration basins | 1 | LS | $ 420,000.00 | $ 420,000.00 |
| Aerobic digester | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Chemical building & pump station | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Service building | 1 | LS | $ 180,000.00 | $ 180,000.00 |
| Anoxic & membrane tanks | 1 | LS | $ 150,000.00 | $ 150,000.00 |
| Belt filter press building | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| EQ tank | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| Control building | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Emergency storage tank | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Sludge drying beds | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Sludge storage | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Meter vault | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Plant pump station | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Diesel fuel storage | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Generator pad | 1 | LS | $ 12,000.00 | $ 12,000.00 |
| Pavement | 6,350 | SY | $ 18.00 | $ 114,300.00 |
| Network Upgrades | | | | |
| Civil | | | | |
| Excavation and Backfill | | | | |
| Excavation for new LS-8 | 1,210 | CY | $ 30.00 | $ 36,300.00 |
| Excavation for new Influent Force Main piping | 940 | CY | $ 30.00 | $ 28,200.00 |
| Off-site disposal of soil material | 1,310 | CY | $ 40.00 | $ 52,400.00 |
| Backfill - Onsite Material, for pipe excavation | 840 | CY | $ 30.00 | $ 25,200.00 |
| LS-8 sheeting for temporary excavation support | 10,310 | SF | $ 90.00 | $ 927,900.00 |
| LS-8 dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| Influent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 4,320 | SF | $ 10.00 | $ 43,200.00 |
| Aggregate Base for Asphalt Paving | 4,320 | SF | $ 5.00 | $ 21,600.00 |
| Influent Force Main: Temporary Traffic Management | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Influent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 1,850 | LF | $ 123.24 | $ 227,994.00 |
| 16" HDPE 90° elbow | 2 | EA | $ 1,950.00 | $ 3,900.00 |
| Bypass Pumping | | | | |
| LS-4 Bypass | 3 | MO | $ 24,000.00 | $ 72,000.00 |
| LS-8 Bypass | 6 | MO | $ 24,000.00 | $ 144,000.00 |
| Erosion and Sedimentation Control | 1 | LS | $ 50,000.00 | $ 50,000.00 |
| New canal outfall | 1 | LS | $ 50,000.00 | $ 50,000.00 |
| Temporary facilities for canal crossing | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Stormwater Management Basin | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Structural | | | | |
| New Wet and Dry Wells at LS-8 | | | | |
| Below grade precast concrete vault for new grinder arrangement | 1 | EA | $ 10,000.00 | $ 10,000.00 |
| Base Slab | 120 | CY | $ 1,200.00 | $ 144,000.00 |
| Walls | 170 | CY | $ 1,200.00 | $ 204,000.00 |
| Cover Slab | 60 | CY | $ 1,200.00 | $ 72,000.00 |
| Bypass vault | 12 | CY | $ 1,200.00 | $ 14,400.00 |

| | |
|---|---|
| Lewes Board of Public Works and Sussex County | Updated By: K Beaudoin |
| WWTF Long Range Planning Study | Date: 10/21/2022 |
| Option 3a - Partnership with Sussex County & Utilization of Existing WWTP Outfall (BPW Costs) | Checked By: T Biagioli |
| Preliminary Capital Cost Estimate | Date: 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Equipment pads - generator and odor control | 26 | CY | $ 1,200.00 | $ 31,200.00 |
| Mechanical/Equipment and Process Piping | | | | |
| LS-8 Raw Wastewater pumps | 2 | EA | $241,800.00 | $ 483,600.00 |
| Odor control system | 1 | LS | $12,500.00 | $ 12,500.00 |
| 115 kW generator | 1 | LS | $ 67,080.00 | $ 67,080.00 |
| Grinder arrangement on wet well influent (16") | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| Process Piping, Valves, Flow Meter and Plumbing Allowance (15% of project c | 1 | LS | $1,016,366.10 | $ 1,016,366.10 |
| Electrical/Instrumentation | | | | |
| Electrical Allowance (20% of project costs, ex. land purchase) | 1 | LS | $1,558,428.02 | $ 1,558,428.02 |
| Instrumentation Allowance (10% of project costs, ex. land purchase) | 1 | LS | $779,214.01 | $ 779,214.01 |
| | | | Subtotal (rounded to nearest $1,000): | $ 11,852,000.00 |
| | | | Contingency (rounded to nearest $1,000): | $ 4,148,000.00 |
| | | | Total (rounded to nearest $1,000): | $ 16,000,000.00 |

| | | | |
|---|---|---|---|
| Lewes Board of Public Works and Sussex County | | Updated By: | K Beaudoin |
| WWTF Long Range Planning Study | | Date: | 10/21/2022 |
| Option 3b - Partnership with Sussex County & Constructed Wetland (BPW Costs) | | Checked By: | T Biagioli |
| Preliminary Capital Cost Estimate | | Date: | 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| General Contract Conditions | | | | |
| General Conditions (12% of Total) | 1 | LS | $1,206,603.86 | $ 1,206,603.86 |
| Mobilization/Demobilization (5% of Total) | 1 | LS | $ 502,751.61 | $ 502,751.61 |
| Civil | | | | |
| Decommissioning of existing WWTF | | | | |
| Process equipment building | 1 | LS | $ 900,000.00 | $ 900,000.00 |
| Headworks | 1 | LS | $ 600,000.00 | $ 600,000.00 |
| Aeration basins | 1 | LS | $ 420,000.00 | $ 420,000.00 |
| Aerobic digester | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Chemical building & pump station | 1 | LS | $ 240,000.00 | $ 240,000.00 |
| Service building | 1 | LS | $ 180,000.00 | $ 180,000.00 |
| Anoxic & membrane tanks | 1 | LS | $ 150,000.00 | $ 150,000.00 |
| Belt filter press building | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| EQ tank | 1 | LS | $ 120,000.00 | $ 120,000.00 |
| Control building | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Emergency storage tank | 1 | LS | $ 96,000.00 | $ 96,000.00 |
| Sludge drying beds | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Sludge storage | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Meter vault | 1 | LS | $ 60,000.00 | $ 60,000.00 |
| Plant pump station | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Diesel fuel storage | 1 | LS | $ 30,000.00 | $ 30,000.00 |
| Generator pad | 1 | LS | $ 12,000.00 | $ 12,000.00 |
| Pavement | 6,350 | SY | $ 18.00 | $ 114,300.00 |
| Excavation and Backfill | | | | |
| Excavation for new LS-8 | 1,210 | CY | $ 30.00 | $ 36,300.00 |
| Excavation for new Influent Force Main piping | 940 | CY | $ 30.00 | $ 28,200.00 |
| Off-site disposal of soil material | 1,310 | CY | $ 40.00 | $ 52,400.00 |
| Backfill - Onsite Material, for pipe excavation | 840 | CY | $ 30.00 | $ 25,200.00 |
| LS-8 sheeting for temporary excavation support | 10,310 | SF | $ 90.00 | $ 927,900.00 |
| LS-8 dewatering | 6 | MO | $ 36,000.00 | $ 216,000.00 |
| Influent Force Main: Reinstatement of Existing Roads | | | | |
| Asphalt Pavement (7.5 inches) | 4,320 | SF | $ 10.00 | $ 43,200.00 |
| Aggregate Base for Asphalt Paving | 4,320 | SF | $ 5.00 | $ 21,600.00 |
| Influent Force Main: Temporary Traffic Management | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Influent Force Main Piping | | | | |
| 16" SDR 11 HDPE Butt-Fusion Welded | 1,850 | LF | $ 123.24 | $ 227,994.00 |
| 16" HDPE 90° elbow | 2 | EA | $ 1,950.00 | $ 3,900.00 |
| Bypass Pumping | | | | |
| LS-4 Bypass | 3 | MO | $ 24,000.00 | $ 72,000.00 |
| LS-8 Bypass | 6 | MO | $ 24,000.00 | $ 144,000.00 |
| Erosion and Sedimentation Control | 1 | LS | $ 50,000.00 | $ 50,000.00 |
| Temporary facilities for canal crossing | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Stormwater Management Basin | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Structural | | | | |
| New Wet Well at LS-8 | | | | |
| Below grade precast concrete vault for new grinder arrangement | 1 | EA | $ 10,000.00 | $ 10,000.00 |
| Base Slab | 120 | CY | $ 1,200.00 | $ 144,000.00 |
| Walls | 170 | CY | $ 1,200.00 | $ 204,000.00 |
| Cover Slab | 60 | CY | $ 1,200.00 | $ 72,000.00 |
| Bypass vault | 12 | CY | $ 1,200.00 | $ 14,400.00 |
| Equipment pads - generator and odor control | 26 | CY | $ 1,200.00 | $ 31,200.00 |

| | |
|---|---|
| Lewes Board of Public Works and Sussex County | Updated By: K Beaudoin |
| WWTF Long Range Planning Study | Date: 10/21/2022 |
| Option 3b - Partnership with Sussex County & Constructed Wetland (BPW Costs) | Checked By: T Biagioli |
| Preliminary Capital Cost Estimate | Date: 10/24/2022 |

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Mechanical/Equipment and Process Piping | | | | |
| LS-8 Raw Wastewater pumps | 2 | EA | $241,800.00 | $ 483,600.00 |
| Grinder arrangement on wet well influent (16") | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| Odor control system | 1 | LS | $12,500.00 | $ 12,500.00 |
| 115 kW generator | 1 | LS | $ 67,080.00 | $ 67,080.00 |
| Process Piping, Valves, Flow Meter and Plumbing Allowance (15% of project c | 1 | LS | $1,008,866.10 | $ 1,008,866.10 |
| | | | | |
| Electrical/Instrumentation | | | | |
| Electrical Allowance (20% of project costs, ex. land purchase) | 1 | LS | $1,546,928.02 | $ 1,546,928.02 |
| Instrumentation Allowance (10% of project costs, ex. land purchase) | 1 | LS | $773,464.01 | $ 773,464.01 |
| | | | Subtotal (rounded to nearest $1,000): | $ 11,764,000.00 |
| | | | Contingency (rounded to nearest $1,000): | $ 4,117,000.00 |
| | | | Total (rounded to nearest $1,000): | $ 15,881,000.00 |

# Appendix E

## Operation & Maintenance Cost Estimates

**Present Worth Calculations**

**Lifecycle Cost Analysis - Option 1 Existing WWTF Hardening**

| Year | Flow, MGD | WWTF Operations and Maintenance | | Periodic Upgrades | p Station Energy Use | | | Net Annual Cost, $/Year | Inflation Factor | Net Annual Costs (with inflation) | Present Worth (2021 USD) | change to 2022 USD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.87 | $ 1,521,777 | | $ 496,613 | $ - | | | $ 2,018,390 | 103% | $ 2,078,942 | $ 2,018,390 | |
| 2 | 0.89 | $ 1,561,535 | | $ 496,613 | $ - | | | $ 2,058,148 | 106% | $ 2,183,490 | $ 2,058,148 | |
| 3 | 0.92 | $ 1,602,332 | | $ 496,613 | $ - | | | $ 2,098,945 | 109% | $ 2,293,574 | $ 2,098,945 | |
| 4 | 0.94 | $ 1,644,194 | | $ 496,613 | $ - | | | $ 2,140,807 | 113% | $ 2,409,498 | $ 2,140,807 | |
| 5 | 0.97 | $ 1,687,150 | | $ 496,613 | $ - | | | $ 2,183,764 | 116% | $ 2,531,581 | $ 2,183,764 | |
| 6 | 0.99 | $ 1,731,229 | | $ 496,613 | $ - | | | $ 2,227,842 | 119% | $ 2,660,160 | $ 2,227,842 | |
| 7 | 1.02 | $ 1,776,459 | | $ 496,613 | $ - | | | $ 2,273,072 | 123% | $ 2,795,592 | $ 2,273,072 | |
| 8 | 1.04 | $ 1,822,871 | | $ 496,613 | $ - | | | $ 2,319,484 | 127% | $ 2,938,253 | $ 2,319,484 | |
| 9 | 1.07 | $ 1,870,495 | | $ 496,613 | $ - | | | $ 2,367,108 | 130% | $ 3,088,539 | $ 2,367,108 | |
| 10 | 1.10 | $ 1,919,363 | | $ 496,613 | $ - | | | $ 2,415,977 | 134% | $ 3,246,871 | $ 2,415,977 | |
| 11 | 1.13 | $ 1,969,509 | | $ 496,613 | $ - | | | $ 2,466,122 | 138% | $ 3,413,689 | $ 2,466,122 | |
| 12 | 1.16 | $ 2,020,964 | | $ 496,613 | $ - | | | $ 2,517,577 | 143% | $ 3,589,463 | $ 2,517,577 | |
| 13 | 1.19 | $ 2,073,764 | | $ 496,613 | $ - | | | $ 2,570,377 | 147% | $ 3,774,685 | $ 2,570,377 | |
| 14 | 1.22 | $ 2,127,943 | | $ 496,613 | $ - | | | $ 2,624,556 | 151% | $ 3,969,876 | $ 2,624,556 | |
| 15 | 1.25 | $ 2,183,537 | | $ 496,613 | $ - | | | $ 2,680,151 | 156% | $ 4,175,587 | $ 2,680,151 | |
| 16 | 1.28 | $ 2,240,584 | | $ 496,613 | $ - | | | $ 2,737,198 | 160% | $ 4,392,399 | $ 2,737,198 | |
| 17 | 1.32 | $ 2,299,122 | | $ 496,613 | $ - | | | $ 2,795,735 | 165% | $ 4,620,924 | $ 2,795,735 | |
| 18 | 1.35 | $ 2,359,189 | | $ 496,613 | $ - | | | $ 2,855,802 | 170% | $ 4,861,812 | $ 2,855,802 | |
| 19 | 1.39 | $ 2,420,825 | | $ 496,613 | $ - | | | $ 2,917,438 | 175% | $ 5,115,745 | $ 2,917,438 | |
| 20 | 1.42 | $ 2,484,071 | | $ 496,613 | $ - | | | $ 2,980,684 | 181% | $ 5,383,448 | $ 2,980,684 | |
| 21 | 1.46 | $ 2,548,970 | | $ 496,613 | $ - | | | $ 3,045,583 | 186% | $ 5,665,682 | $ 3,045,583 | |
| 22 | 1.50 | $ 2,615,564 | | $ 496,613 | $ - | | | $ 3,112,178 | 192% | $ 5,963,254 | $ 3,112,178 | |
| 23 | 1.54 | $ 2,683,898 | | $ 496,613 | $ - | | | $ 3,180,512 | 197% | $ 6,277,015 | $ 3,180,512 | |
| 24 | 1.58 | $ 2,754,018 | | $ 496,613 | $ - | | | $ 3,250,631 | 203% | $ 6,607,864 | $ 3,250,631 | |
| 25 | 1.62 | $ 2,825,969 | | $ 496,613 | $ - | | | $ 3,322,583 | 209% | $ 6,956,750 | $ 3,322,583 | |
| 26 | 1.66 | $ 2,899,800 | | $ 496,613 | $ - | | | $ 3,396,414 | 216% | $ 7,324,676 | $ 3,396,414 | |
| 27 | 1.71 | $ 2,975,561 | | $ 496,613 | $ - | | | $ 3,472,174 | 222% | $ 7,712,702 | $ 3,472,174 | |
| 28 | 1.75 | $ 3,053,300 | | $ 496,613 | $ - | | | $ 3,549,913 | 229% | $ 8,121,945 | $ 3,549,913 | |
| **Net Present Worth** | | **$ 61,673,991** | | **$ 13,905,173** | **$ -** | | | | | | **$ 75,579,164** | |

**Present Worth Calculations**

**Lifecycle Cost Analysis - Option 2a Relocation and Spray Irrigation and/or RIBS**

| Year | Flow, MGD | WWTF Operations and Maintenance | | Periodic Upgrades | Station Energy Use | | | Net Annual Cost, $/Year | Inflation Factor | Net Annual Costs (with inflation) | Present Worth (2021 USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.87 | $ 719,830 | | $ 334,973 | $ 32,920 | | $ - | $ 1,087,724 | 103% | $ 1,120,355 | $ 1,087,724 |
| 2 | 0.89 | $ 738,636 | | $ 334,973 | $ 33,780 | | $ - | $ 1,107,390 | 106% | $ 1,174,830 | $ 1,107,390 |
| 3 | 0.92 | $ 757,934 | | $ 334,973 | $ 34,663 | | $ - | $ 1,127,570 | 109% | $ 1,232,126 | $ 1,127,570 |
| 4 | 0.94 | $ 777,736 | | $ 334,973 | $ 35,568 | | $ - | $ 1,148,277 | 113% | $ 1,292,396 | $ 1,148,277 |
| 5 | 0.97 | $ 798,055 | | $ 334,973 | $ 36,498 | | $ - | $ 1,169,526 | 116% | $ 1,355,801 | $ 1,169,526 |
| 6 | 0.99 | $ 818,905 | | $ 334,973 | $ 37,451 | | $ - | $ 1,191,329 | 119% | $ 1,422,509 | $ 1,191,329 |
| 7 | 1.02 | $ 840,299 | | $ 334,973 | $ 38,430 | | $ - | $ 1,213,702 | 123% | $ 1,492,701 | $ 1,213,702 |
| 8 | 1.04 | $ 862,253 | | $ 334,973 | $ 39,434 | | $ - | $ 1,236,660 | 127% | $ 1,566,564 | $ 1,236,660 |
| 9 | 1.07 | $ 884,780 | | $ 334,973 | $ 40,464 | | $ - | $ 1,260,217 | 130% | $ 1,644,298 | $ 1,260,217 |
| 10 | 1.10 | $ 907,896 | | $ 334,973 | $ 41,521 | | $ - | $ 1,284,390 | 134% | $ 1,726,113 | $ 1,284,390 |
| 11 | 1.13 | $ 931,616 | | $ 334,973 | $ 42,606 | | $ - | $ 1,309,195 | 138% | $ 1,812,232 | $ 1,309,195 |
| 12 | 1.16 | $ 955,955 | | $ 334,973 | $ 43,719 | | $ - | $ 1,334,647 | 143% | $ 1,902,888 | $ 1,334,647 |
| 13 | 1.19 | $ 980,930 | | $ 334,973 | $ 44,861 | | $ - | $ 1,360,765 | 147% | $ 1,998,329 | $ 1,360,765 |
| 14 | 1.22 | $ 1,006,558 | | $ 334,973 | $ 46,033 | | $ - | $ 1,387,565 | 151% | $ 2,098,816 | $ 1,387,565 |
| 15 | 1.25 | $ 1,032,855 | | $ 334,973 | $ 47,236 | | $ - | $ 1,415,065 | 156% | $ 2,204,624 | $ 1,415,065 |
| 16 | 1.28 | $ 1,059,840 | | $ 334,973 | $ 48,470 | | $ - | $ 1,443,283 | 160% | $ 2,316,046 | $ 1,443,283 |
| 17 | 1.32 | $ 1,087,529 | | $ 334,973 | $ 49,736 | | $ - | $ 1,472,239 | 165% | $ 2,433,386 | $ 1,472,239 |
| 18 | 1.35 | $ 1,115,942 | | $ 334,973 | $ 51,036 | | $ - | $ 1,501,951 | 170% | $ 2,556,971 | $ 1,501,951 |
| 19 | 1.39 | $ 1,145,097 | | $ 334,973 | $ 52,369 | | $ - | $ 1,532,439 | 175% | $ 2,687,142 | $ 1,532,439 |
| 20 | 1.42 | $ 1,175,014 | | $ 334,973 | $ 53,737 | | $ - | $ 1,563,724 | 181% | $ 2,824,260 | $ 1,563,724 |
| 21 | 1.46 | $ 1,205,712 | | $ 334,973 | $ 55,141 | | $ - | $ 1,595,827 | 186% | $ 2,968,707 | $ 1,595,827 |
| 22 | 1.50 | $ 1,237,212 | | $ 334,973 | $ 56,582 | | $ - | $ 1,628,768 | 192% | $ 3,120,887 | $ 1,628,768 |
| 23 | 1.54 | $ 1,269,536 | | $ 334,973 | $ 58,060 | | $ - | $ 1,662,569 | 197% | $ 3,281,224 | $ 1,662,569 |
| 24 | 1.58 | $ 1,302,704 | | $ 334,973 | $ 59,577 | | $ - | $ 1,697,254 | 203% | $ 3,450,168 | $ 1,697,254 |
| 25 | 1.62 | $ 1,336,738 | | $ 334,973 | $ 61,133 | | $ - | $ 1,732,845 | 209% | $ 3,628,192 | $ 1,732,845 |
| 26 | 1.66 | $ 1,371,662 | | $ 334,973 | $ 62,731 | | $ - | $ 1,769,366 | 216% | $ 3,815,798 | $ 1,769,366 |
| 27 | 1.71 | $ 1,407,498 | | $ 334,973 | $ 64,369 | | $ - | $ 1,806,841 | 222% | $ 4,013,515 | $ 1,806,841 |
| 28 | 1.75 | $ 1,444,270 | | $ 334,973 | $ 66,051 | | $ - | $ 1,845,295 | 229% | $ 4,221,900 | $ 1,845,295 |
| **Net Present Worth** | | **$ 29,172,991** | | **$ 9,379,253** | **$ 1,334,176** | | **$ -** | | | | **$ 39,886,421** |

| | | | |
|---|---|---|---|
| Lewes WWTF Long Range Planning Study | | 10/25/22 | 12582813 |
| Project | | Date | Job No. |
| Lifecycle Cost Analysis - Option 2b Relocation & Utilization of Existing WWTP Outfall | | K Beaudoin | T Biagioli |
| Subject | | Comp. By | Checked By |

**Present Worth Calculations**

**Lifecycle Cost Analysis - Option 2b Relocation & Utilization of Existing WWTP Outfall**

| Year | Flow, MGD | WWTF Operations and Maintenance | | Periodic Upgrades | ıp Station Energy Use | | | Net Annual Cost, $/Year | Inflation Factor | Net Annual Costs (with inflation) | Present Worth (2021 USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.87 | $ 719,830 | | $ 317,873 | $ 50,544 | $ - | $ - | $ 1,088,247 | 103% | $ 1,120,895 | $ 1,088,247 |
| 2 | 0.89 | $ 738,636 | | $ 317,873 | $ 51,865 | $ - | $ - | $ 1,108,374 | 106% | $ 1,175,874 | $ 1,108,374 |
| 3 | 0.92 | $ 757,934 | | $ 317,873 | $ 53,220 | $ - | $ - | $ 1,129,027 | 109% | $ 1,233,718 | $ 1,129,027 |
| 4 | 0.94 | $ 777,736 | | $ 317,873 | $ 54,610 | $ - | $ - | $ 1,150,219 | 113% | $ 1,294,582 | $ 1,150,219 |
| 5 | 0.97 | $ 798,055 | | $ 317,873 | $ 56,037 | $ - | $ - | $ 1,171,965 | 116% | $ 1,358,628 | $ 1,171,965 |
| 6 | 0.99 | $ 818,905 | | $ 317,873 | $ 57,501 | $ - | $ - | $ 1,194,279 | 119% | $ 1,426,031 | $ 1,194,279 |
| 7 | 1.02 | $ 840,299 | | $ 317,873 | $ 59,003 | $ - | $ - | $ 1,217,176 | 123% | $ 1,496,973 | $ 1,217,176 |
| 8 | 1.04 | $ 862,253 | | $ 317,873 | $ 60,545 | $ - | $ - | $ 1,240,671 | 127% | $ 1,571,645 | $ 1,240,671 |
| 9 | 1.07 | $ 884,780 | | $ 317,873 | $ 62,126 | $ - | $ - | $ 1,264,780 | 130% | $ 1,650,251 | $ 1,264,780 |
| 10 | 1.10 | $ 907,896 | | $ 317,873 | $ 63,749 | $ - | $ - | $ 1,289,519 | 134% | $ 1,733,005 | $ 1,289,519 |
| 11 | 1.13 | $ 931,616 | | $ 317,873 | $ 65,415 | $ - | $ - | $ 1,314,904 | 138% | $ 1,820,135 | $ 1,314,904 |
| 12 | 1.16 | $ 955,955 | | $ 317,873 | $ 67,124 | $ - | $ - | $ 1,340,952 | 143% | $ 1,911,877 | $ 1,340,952 |
| 13 | 1.19 | $ 980,930 | | $ 317,873 | $ 68,878 | $ - | $ - | $ 1,367,681 | 147% | $ 2,008,486 | $ 1,367,681 |
| 14 | 1.22 | $ 1,006,558 | | $ 317,873 | $ 70,677 | $ - | $ - | $ 1,395,109 | 151% | $ 2,110,227 | $ 1,395,109 |
| 15 | 1.25 | $ 1,032,855 | | $ 317,873 | $ 72,524 | $ - | $ - | $ 1,423,252 | 156% | $ 2,217,381 | $ 1,423,252 |
| 16 | 1.28 | $ 1,059,840 | | $ 317,873 | $ 74,418 | $ - | $ - | $ 1,452,132 | 160% | $ 2,330,245 | $ 1,452,132 |
| 17 | 1.32 | $ 1,087,529 | | $ 317,873 | $ 76,363 | $ - | $ - | $ 1,481,765 | 165% | $ 2,449,132 | $ 1,481,765 |
| 18 | 1.35 | $ 1,115,942 | | $ 317,873 | $ 78,358 | $ - | $ - | $ 1,512,173 | 170% | $ 2,574,373 | $ 1,512,173 |
| 19 | 1.39 | $ 1,145,097 | | $ 317,873 | $ 80,405 | $ - | $ - | $ 1,543,375 | 175% | $ 2,706,318 | $ 1,543,375 |
| 20 | 1.42 | $ 1,175,014 | | $ 317,873 | $ 82,506 | $ - | $ - | $ 1,575,393 | 181% | $ 2,845,334 | $ 1,575,393 |
| 21 | 1.46 | $ 1,205,712 | | $ 317,873 | $ 84,661 | $ - | $ - | $ 1,608,247 | 186% | $ 2,991,812 | $ 1,608,247 |
| 22 | 1.50 | $ 1,237,212 | | $ 317,873 | $ 86,873 | $ - | $ - | $ 1,641,959 | 192% | $ 3,146,163 | $ 1,641,959 |
| 23 | 1.54 | $ 1,269,536 | | $ 317,873 | $ 89,143 | $ - | $ - | $ 1,676,552 | 197% | $ 3,308,820 | $ 1,676,552 |
| 24 | 1.58 | $ 1,302,704 | | $ 317,873 | $ 91,472 | $ - | $ - | $ 1,712,049 | 203% | $ 3,480,242 | $ 1,712,049 |
| 25 | 1.62 | $ 1,336,738 | | $ 317,873 | $ 93,861 | $ - | $ - | $ 1,748,473 | 209% | $ 3,660,914 | $ 1,748,473 |
| 26 | 1.66 | $ 1,371,662 | | $ 317,873 | $ 96,314 | $ - | $ - | $ 1,785,849 | 216% | $ 3,851,346 | $ 1,785,849 |
| 27 | 1.71 | $ 1,407,498 | | $ 317,873 | $ 98,830 | $ - | $ - | $ 1,824,201 | 222% | $ 4,052,078 | $ 1,824,201 |
| 28 | 1.75 | $ 1,444,270 | | $ 317,873 | $ 101,412 | $ - | $ - | $ 1,863,555 | 229% | $ 4,263,680 | $ 1,863,555 |
| **Net Present Worth** | | **$ 29,172,991** | | **$8,900,453.33** | **$ 2,048,432** | **$ -** | **$ -** | | | | **$ 40,121,877** |

**Present Worth Calculations**

**Lifecycle Cost Analysis - Option 2c Relocation & New Ocean Outfall**

| Year | Flow, MGD | WWTF Operations and Maintenance | | Periodic Upgrades | p Station Energy Use | | | Net Annual Cost, $/Year | Inflation Factor | Net Annual Costs (with inflation) | Present Worth (2021 USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.87 | $ 719,830 | | $ 323,283 | $ 56,973 | | $ - | $ 1,100,086 | 103% | $ 1,133,089 | $ 1,100,086 |
| 2 | 0.89 | $ 738,636 | | $ 323,283 | $ 58,461 | | $ - | $ 1,120,381 | 106% | $ 1,188,612 | $ 1,120,381 |
| 3 | 0.92 | $ 757,934 | | $ 323,283 | $ 59,989 | | $ - | $ 1,141,206 | 109% | $ 1,247,027 | $ 1,141,206 |
| 4 | 0.94 | $ 777,736 | | $ 323,283 | $ 61,556 | | $ - | $ 1,162,575 | 113% | $ 1,308,488 | $ 1,162,575 |
| 5 | 0.97 | $ 798,055 | | $ 323,283 | $ 63,164 | | $ - | $ 1,184,502 | 116% | $ 1,373,163 | $ 1,184,502 |
| 6 | 0.99 | $ 818,905 | | $ 323,283 | $ 64,815 | | $ - | $ 1,207,003 | 119% | $ 1,441,224 | $ 1,207,003 |
| 7 | 1.02 | $ 840,299 | | $ 323,283 | $ 66,508 | | $ - | $ 1,230,091 | 123% | $ 1,512,856 | $ 1,230,091 |
| 8 | 1.04 | $ 862,253 | | $ 323,283 | $ 68,245 | | $ - | $ 1,253,782 | 127% | $ 1,588,253 | $ 1,253,782 |
| 9 | 1.07 | $ 884,780 | | $ 323,283 | $ 70,028 | | $ - | $ 1,278,092 | 130% | $ 1,667,620 | $ 1,278,092 |
| 10 | 1.10 | $ 907,896 | | $ 323,283 | $ 71,858 | | $ - | $ 1,303,037 | 134% | $ 1,751,173 | $ 1,303,037 |
| 11 | 1.13 | $ 931,616 | | $ 323,283 | $ 73,735 | | $ - | $ 1,328,634 | 138% | $ 1,839,141 | $ 1,328,634 |
| 12 | 1.16 | $ 955,955 | | $ 323,283 | $ 75,662 | | $ - | $ 1,354,900 | 143% | $ 1,931,764 | $ 1,354,900 |
| 13 | 1.19 | $ 980,930 | | $ 323,283 | $ 77,638 | | $ - | $ 1,381,852 | 147% | $ 2,029,296 | $ 1,381,852 |
| 14 | 1.22 | $ 1,006,558 | | $ 323,283 | $ 79,667 | | $ - | $ 1,409,508 | 151% | $ 2,132,008 | $ 1,409,508 |
| 15 | 1.25 | $ 1,032,855 | | $ 323,283 | $ 81,748 | | $ - | $ 1,437,887 | 156% | $ 2,240,181 | $ 1,437,887 |
| 16 | 1.28 | $ 1,059,840 | | $ 323,283 | $ 83,884 | | $ - | $ 1,467,007 | 160% | $ 2,354,116 | $ 1,467,007 |
| 17 | 1.32 | $ 1,087,529 | | $ 323,283 | $ 86,076 | | $ - | $ 1,496,888 | 165% | $ 2,474,128 | $ 1,496,888 |
| 18 | 1.35 | $ 1,115,942 | | $ 323,283 | $ 88,324 | | $ - | $ 1,527,550 | 170% | $ 2,600,551 | $ 1,527,550 |
| 19 | 1.39 | $ 1,145,097 | | $ 323,283 | $ 90,632 | | $ - | $ 1,559,012 | 175% | $ 2,733,737 | $ 1,559,012 |
| 20 | 1.42 | $ 1,175,014 | | $ 323,283 | $ 93,000 | | $ - | $ 1,591,297 | 181% | $ 2,874,059 | $ 1,591,297 |
| 21 | 1.46 | $ 1,205,712 | | $ 323,283 | $ 95,429 | | $ - | $ 1,624,425 | 186% | $ 3,021,909 | $ 1,624,425 |
| 22 | 1.50 | $ 1,237,212 | | $ 323,283 | $ 97,923 | | $ - | $ 1,658,418 | 192% | $ 3,177,701 | $ 1,658,418 |
| 23 | 1.54 | $ 1,269,536 | | $ 323,283 | $ 100,481 | | $ - | $ 1,693,300 | 197% | $ 3,341,874 | $ 1,693,300 |
| 24 | 1.58 | $ 1,302,704 | | $ 323,283 | $ 103,106 | | $ - | $ 1,729,093 | 203% | $ 3,514,890 | $ 1,729,093 |
| 25 | 1.62 | $ 1,336,738 | | $ 323,283 | $ 105,800 | | $ - | $ 1,765,821 | 209% | $ 3,697,238 | $ 1,765,821 |
| 26 | 1.66 | $ 1,371,662 | | $ 323,283 | $ 108,564 | | $ - | $ 1,803,509 | 216% | $ 3,889,432 | $ 1,803,509 |
| 27 | 1.71 | $ 1,407,498 | | $ 323,283 | $ 111,400 | | $ - | $ 1,842,181 | 222% | $ 4,092,017 | $ 1,842,181 |
| 28 | 1.75 | $ 1,444,270 | | $ 323,283 | $ 114,311 | | $ - | $ 1,881,864 | 229% | $ 4,305,569 | $ 1,881,864 |
| **Net Present Worth** | | **$ 29,172,991** | | **$ 9,051,933** | **$ 2,308,978** | | **$ -** | | | | **$ 40,533,903** |

**Present Worth Calculations**

**Lifecycle Cost Analysis - Option 3a Partnership with Sussex County & Utilization of Existing WWTP Outfall (BPW Costs)**

| Year | Flow, MGD | WWTF Operations and Maintenance | | Periodic Upgrades | mp Station Energy Use | | | Net Annual Cost, $/Year | Inflation Factor | Net Annual Costs (with inflation) | Present Worth (2021 USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.87 | $ 719,830 | | $ 238,583 | $ 15,740 | | $ - | $ 974,153 | 103% | $ 1,003,378 | $ 974,153 |
| 2 | 0.89 | $ 738,636 | | $ 238,583 | $ 16,151 | | $ - | $ 993,370 | 106% | $ 1,053,867 | $ 993,370 |
| 3 | 0.92 | $ 757,934 | | $ 238,583 | $ 16,573 | | $ - | $ 1,013,090 | 109% | $ 1,107,031 | $ 1,013,090 |
| 4 | 0.94 | $ 777,736 | | $ 238,583 | $ 17,006 | | $ - | $ 1,033,325 | 113% | $ 1,163,016 | $ 1,033,325 |
| 5 | 0.97 | $ 798,055 | | $ 238,583 | $ 17,450 | | $ - | $ 1,054,088 | 116% | $ 1,221,977 | $ 1,054,088 |
| 6 | 0.99 | $ 818,905 | | $ 238,583 | $ 17,906 | | $ - | $ 1,075,394 | 119% | $ 1,284,077 | $ 1,075,394 |
| 7 | 1.02 | $ 840,299 | | $ 238,583 | $ 18,374 | | $ - | $ 1,097,256 | 123% | $ 1,349,487 | $ 1,097,256 |
| 8 | 1.04 | $ 862,253 | | $ 238,583 | $ 18,854 | | $ - | $ 1,119,690 | 127% | $ 1,418,390 | $ 1,119,690 |
| 9 | 1.07 | $ 884,780 | | $ 238,583 | $ 19,346 | | $ - | $ 1,142,710 | 130% | $ 1,490,977 | $ 1,142,710 |
| 10 | 1.10 | $ 907,896 | | $ 238,583 | $ 19,852 | | $ - | $ 1,166,331 | 134% | $ 1,567,452 | $ 1,166,331 |
| 11 | 1.13 | $ 931,616 | | $ 238,583 | $ 20,370 | | $ - | $ 1,190,569 | 138% | $ 1,648,027 | $ 1,190,569 |
| 12 | 1.16 | $ 955,955 | | $ 238,583 | $ 20,903 | | $ - | $ 1,215,441 | 143% | $ 1,732,928 | $ 1,215,441 |
| 13 | 1.19 | $ 980,930 | | $ 238,583 | $ 21,449 | | $ - | $ 1,240,962 | 147% | $ 1,822,395 | $ 1,240,962 |
| 14 | 1.22 | $ 1,006,558 | | $ 238,583 | $ 22,009 | | $ - | $ 1,267,151 | 151% | $ 1,916,679 | $ 1,267,151 |
| 15 | 1.25 | $ 1,032,855 | | $ 238,583 | $ 22,584 | | $ - | $ 1,294,023 | 156% | $ 2,016,045 | $ 1,294,023 |
| 16 | 1.28 | $ 1,059,840 | | $ 238,583 | $ 23,174 | | $ - | $ 1,321,597 | 160% | $ 2,120,776 | $ 1,321,597 |
| 17 | 1.32 | $ 1,087,529 | | $ 238,583 | $ 23,780 | | $ - | $ 1,349,892 | 165% | $ 2,231,166 | $ 1,349,892 |
| 18 | 1.35 | $ 1,115,942 | | $ 238,583 | $ 24,401 | | $ - | $ 1,378,926 | 170% | $ 2,347,529 | $ 1,378,926 |
| 19 | 1.39 | $ 1,145,097 | | $ 238,583 | $ 25,038 | | $ - | $ 1,408,719 | 175% | $ 2,470,197 | $ 1,408,719 |
| 20 | 1.42 | $ 1,175,014 | | $ 238,583 | $ 25,693 | | $ - | $ 1,439,290 | 181% | $ 2,599,517 | $ 1,439,290 |
| 21 | 1.46 | $ 1,205,712 | | $ 238,583 | $ 26,364 | | $ - | $ 1,470,659 | 186% | $ 2,735,859 | $ 1,470,659 |
| 22 | 1.50 | $ 1,237,212 | | $ 238,583 | $ 27,053 | | $ - | $ 1,502,848 | 192% | $ 2,879,613 | $ 1,502,848 |
| 23 | 1.54 | $ 1,269,536 | | $ 238,583 | $ 27,759 | | $ - | $ 1,535,879 | 197% | $ 3,031,189 | $ 1,535,879 |
| 24 | 1.58 | $ 1,302,704 | | $ 238,583 | $ 28,485 | | $ - | $ 1,569,772 | 203% | $ 3,191,023 | $ 1,569,772 |
| 25 | 1.62 | $ 1,336,738 | | $ 238,583 | $ 29,229 | | $ - | $ 1,604,550 | 209% | $ 3,359,572 | $ 1,604,550 |
| 26 | 1.66 | $ 1,371,662 | | $ 238,583 | $ 29,992 | | $ - | $ 1,640,237 | 216% | $ 3,537,322 | $ 1,640,237 |
| 27 | 1.71 | $ 1,407,498 | | $ 238,583 | $ 30,776 | | $ - | $ 1,676,857 | 222% | $ 3,724,784 | $ 1,676,857 |
| 28 | 1.75 | $ 1,444,270 | | $ 238,583 | $ 31,580 | | $ - | $ 1,714,433 | 229% | $ 3,922,500 | $ 1,714,433 |
| **Net Present Worth** | | **$29,172,991** | **$ -** | **$ 6,680,333** | **$ 637,889** | **$ -** | **$ -** | | | | **$ 36,491,214** |

| Lewes WWTF Long Range Planning Study | 10/25/22 | 12582813 |
|---|---|---|
| Project | Date | Job No. |
| Lifecycle Cost Analysis - Option 3b Partnership with Sussex County & Constructed Wetland (BPW Costs) | K Beaudoin | T Biagioli |
| Subject | Comp. By | Checked By |

**Present Worth Calculations**

**Lifecycle Cost Analysis - Option 3b Partnership with Sussex County & Constructed Wetland (BPW Costs)**

| Year | Flow, MGD | WWTF Operations and Maintenance | | Periodic Upgrades | Station Energy Use | | | Net Annual Cost, $/Year | Inflation Factor | Net Annual Costs (with inflation) | Present Worth (2021 USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.87 | $ 719,830 | $ - | $ 238,583 | $ 15,740 | $ - | $ - | $ 974,153 | 103% | $ 1,003,378 | $ 974,153 |
| 2 | 0.89 | $ 738,636 | $ - | $ 238,583 | $ 16,151 | $ - | $ - | $ 993,370 | 106% | $ 1,053,867 | $ 993,370 |
| 3 | 0.92 | $ 757,934 | $ - | $ 238,583 | $ 16,573 | $ - | $ - | $ 1,013,090 | 109% | $ 1,107,031 | $ 1,013,090 |
| 4 | 0.94 | $ 777,736 | $ - | $ 238,583 | $ 17,006 | $ - | $ - | $ 1,033,325 | 113% | $ 1,163,016 | $ 1,033,325 |
| 5 | 0.97 | $ 798,055 | $ - | $ 238,583 | $ 17,450 | $ - | $ - | $ 1,054,088 | 116% | $ 1,221,977 | $ 1,054,088 |
| 6 | 0.99 | $ 818,905 | $ - | $ 238,583 | $ 17,906 | $ - | $ - | $ 1,075,394 | 119% | $ 1,284,077 | $ 1,075,394 |
| 7 | 1.02 | $ 840,299 | $ - | $ 238,583 | $ 18,374 | $ - | $ - | $ 1,097,256 | 123% | $ 1,349,487 | $ 1,097,256 |
| 8 | 1.04 | $ 862,253 | $ - | $ 238,583 | $ 18,854 | $ - | $ - | $ 1,119,690 | 127% | $ 1,418,390 | $ 1,119,690 |
| 9 | 1.07 | $ 884,780 | $ - | $ 238,583 | $ 19,346 | $ - | $ - | $ 1,142,710 | 130% | $ 1,490,977 | $ 1,142,710 |
| 10 | 1.10 | $ 907,896 | $ - | $ 238,583 | $ 19,852 | $ - | $ - | $ 1,166,331 | 134% | $ 1,567,452 | $ 1,166,331 |
| 11 | 1.13 | $ 931,616 | $ - | $ 238,583 | $ 20,370 | $ - | $ - | $ 1,190,569 | 138% | $ 1,648,027 | $ 1,190,569 |
| 12 | 1.16 | $ 955,955 | $ - | $ 238,583 | $ 20,903 | $ - | $ - | $ 1,215,441 | 143% | $ 1,732,928 | $ 1,215,441 |
| 13 | 1.19 | $ 980,930 | $ - | $ 238,583 | $ 21,449 | $ - | $ - | $ 1,240,962 | 147% | $ 1,822,395 | $ 1,240,962 |
| 14 | 1.22 | $ 1,006,558 | $ - | $ 238,583 | $ 22,009 | $ - | $ - | $ 1,267,151 | 151% | $ 1,916,679 | $ 1,267,151 |
| 15 | 1.25 | $ 1,032,855 | $ - | $ 238,583 | $ 22,584 | $ - | $ - | $ 1,294,023 | 156% | $ 2,016,045 | $ 1,294,023 |
| 16 | 1.28 | $ 1,059,840 | $ - | $ 238,583 | $ 23,174 | $ - | $ - | $ 1,321,597 | 160% | $ 2,120,776 | $ 1,321,597 |
| 17 | 1.32 | $ 1,087,529 | $ - | $ 238,583 | $ 23,780 | $ - | $ - | $ 1,349,892 | 165% | $ 2,231,166 | $ 1,349,892 |
| 18 | 1.35 | $ 1,115,942 | $ - | $ 238,583 | $ 24,401 | $ - | $ - | $ 1,378,926 | 170% | $ 2,347,529 | $ 1,378,926 |
| 19 | 1.39 | $ 1,145,097 | $ - | $ 238,583 | $ 25,038 | $ - | $ - | $ 1,408,719 | 175% | $ 2,470,197 | $ 1,408,719 |
| 20 | 1.42 | $ 1,175,014 | $ - | $ 238,583 | $ 25,693 | $ - | $ - | $ 1,439,290 | 181% | $ 2,599,517 | $ 1,439,290 |
| 21 | 1.46 | $ 1,205,712 | $ - | $ 238,583 | $ 26,364 | $ - | $ - | $ 1,470,659 | 186% | $ 2,735,859 | $ 1,470,659 |
| 22 | 1.50 | $ 1,237,212 | $ - | $ 238,583 | $ 27,053 | $ - | $ - | $ 1,502,848 | 192% | $ 2,879,613 | $ 1,502,848 |
| 23 | 1.54 | $ 1,269,536 | $ - | $ 238,583 | $ 27,759 | $ - | $ - | $ 1,535,879 | 197% | $ 3,031,189 | $ 1,535,879 |
| 24 | 1.58 | $ 1,302,704 | $ - | $ 238,583 | $ 28,485 | $ - | $ - | $ 1,569,772 | 203% | $ 3,191,023 | $ 1,569,772 |
| 25 | 1.62 | $ 1,336,738 | $ - | $ 238,583 | $ 29,229 | $ - | $ - | $ 1,604,550 | 209% | $ 3,359,572 | $ 1,604,550 |
| 26 | 1.66 | $ 1,371,662 | $ - | $ 238,583 | $ 29,992 | $ - | $ - | $ 1,640,237 | 216% | $ 3,537,322 | $ 1,640,237 |
| 27 | 1.71 | $ 1,407,498 | $ - | $ 238,583 | $ 30,776 | $ - | $ - | $ 1,676,857 | 222% | $ 3,724,784 | $ 1,676,857 |
| 28 | 1.75 | $ 1,444,270 | $ - | $ 238,583 | $ 31,580 | $ - | $ - | $ 1,714,433 | 229% | $ 3,922,500 | $ 1,714,433 |
| **Net Present Worth** | | **$29,172,991** | **$ -** | **$ 6,680,333** | **$ 637,889** | **$ -** | **$ -** | | | | **$ 36,491,214** |