TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF APPENDICES

Appendix B: **System Details**

- Process Flow Diagram
- Filter Detail
- Piping Detail
- Nitrification Detail
- Control Panel Detail
- Denitrification Detail
- Low Pressure Grinder Pump System Details

Appendix C: **Miscellaneous Documentation**

- SSA Summary Spreadsheet
- VRGF Design Spreadsheet

This report was executed on behalf of:
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651 West Main Street
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Funded by:
The Suffolk County Water Quality Fund
County of Suffolk Department of Economic Development and Planning

1.0 EXECUTIVE SUMMARY

On behalf of Peconic Green Growth, Inc., Natural Systems Utilities (NSU) has prepared this preliminary technical report, which evaluates the implementation of a wastewater collection system and wastewater treatment plant (WWTP) as a means of mitigating nitrogen loadings that are affecting the quality of the Peconic Estuary.

This report evaluates a decentralized wastewater collection, treatment and disposal system that would serve the existing residential community referred to herein as "North Sea". The portion of the North Sea community that was targeted in this study consists of 169 connections and is located in the Hamlet of North Sea, Town of Southampton, Suffolk County, NY. The sewer service area is located along the south end of North Sea Harbor. The area to be served is shown on Figure 1 of Chapter 9 - Appendix A. This location was selected by Peconic Green Growth, Inc. (PGG) after careful analysis of existing communities surrounding the Peconic Estuary.

An analysis was performed in order to determine a recommended solution for sewering the North Sea community. Collection system and treatment system alternatives were identified and compared. High-level capital and operational cost estimates were completed for the system components, including the collection system, treatment system, and disposal system. The analysis concluded that a low pressure sewer system with grinder pumps coupled with a recirculating gravel filter system with MBBR technology was determined to be the lowest cost alternative of the options considered. The projected capital cost of the system is estimated at $5.7M with an annual operating expense of $113,100.

The costs were utilized in a financial evaluation that estimated the cost per user that would be required in order to deploy a decentralized sewer system at this location. Five (5) funding scenarios were developed. Monthly user fees ranged between $56 and $173, depending on the availability of grant funding and the percentages of public and private capital. Cost savings alternatives, which are discussed in the report, may provide a means of further reducing user fees.

2.0 SEWER SERVICE AREA

The properties included within the proposed North Sea Sewer Service Area (SSA) are shown on the Sewer Service Area Map (Figure 1 of Chapter 9 - Appendix A). The SSA is located on the southern shore of North Sea Harbor, which is located on the northern coast of the south fork of Long Island in the Town of Southampton, Suffolk County, NY. The SSA consists of approximately 163 occupied lots and 6 vacant lots (169 lots in total). The proposed SSA totals approximately 55 acres, exclusive of right-of-ways. The average parcel size is 0.27 acres (11,760 SF). 100% of the SSA connections are located within zone R-10 (Residence – minimum lot area 10,000 sq. ft). The proposed WWTP parcel is located within zone R-40 (minimum lot area 40,000 sq. ft). Approximately 98% of the properties within the SSA consists of single-family homes. Only three (3) parcels are institutional properties and are all owned and occupied by the North Sea Fire Department and one (1) parcel in the SSA is categorized as commercial and is occupied by a restaurant.

The SSA is located within Groundwater Management Zone IV. Suffolk County specifies a minimum lot size of 20,000 square feet for an individual sewerage system for parcels within this groundwater management zone as per §760-607 in Article 6 of the Suffolk County Sanitary Code. This size limit was established to provide some level of nitrogen attenuation in the wastewater prior to it migrating off-site through the groundwater. 155 (approximately 92%) of the parcels within the SSA do not meet this minimum requirement and are therefore categorized as non-conforming lots (See Figure 7 of Chapter 9 - Appendix A). This supports the need for a decentralized treatment system at this location.

Existing topography is shown on the Topography map (Figure 6 of Chapter 9 - Appendix A). The SSA ranges in elevation between 0 and 25 ft amsl. The depth to groundwater within the SSA limits ranges from 0 to greater than 13 ft. The majority of the SSA has a groundwater depth greater than or equal to 9 ft with depths between 0 and 9 ft occurring just along the coastal areas of the community where it meets North Sea Harbor.

Wastewater generated by the homes within the community currently discharges to individual cesspools or septic systems, depending on when the home was built. There are no existing sewer districts located within several miles of the proposed SSA. The small lot sizes, impairment of waters in adjacent creeks, and the lack of sewer systems within the vicinity of the project supports the concept of a decentralized system to mitigate nitrogen.

The closest existing wastewater treatment factility is identified as the Courtyards at Southampton WWTP (P-SH-01), a 0.015 MGD tertiary sewer plant (SPDES Permit #NY0254941) located 0.9 miles from the North Sea SSA. This private factiliy does not have the available capacity to serve the North Sea SSA. No other wastewater facilities are located within a 3 mile radius. The lack of adequate wastewater systems nearby supports the concept of a decentralized system to mitigate nitrogen. However, the Courtyards at Southampton site should be investigated to determine if this is a viable option for a new facility that could serve both North Sea and the Courtyards at Southampton sites.

3.0 WASTEWATER DESIGN PARAMETERS

The wastewater design parameters used in this analysis are detailed in the following sections of this report.

3.1 Design Flow

The SSA consists of 171 buildable lots in total. The lot use was evaluated based on the "Town of Southampton, North Sea, Land Use" Map prepared by the Town of Southampton GIS Department on 7/3/2013. Approximately 161 of the existing lots are occupied by single-family homes. Three (3) lots are classified for institutional use and are all used by the North Sea Fire Department. One (1) lot is classified as commercial and is used by a restaurant. The remaining 6 lots are vacant. For purposes of this report, it is assumed that a single family home will be built on each of these vacant lots. A build out analysis will be completed to determine the feasibility of constructing future homes on vacant parcels. A summary of all lots can be found in Chapter 9 - Appendix C.

Wastewater flow estimates provided in Table 1 below were calculated using the hydraulic load unit flow criteria provided in the "Standards for Approval of Plans and Construction for Sewage Disposal Systems for Other Than Single-Family Residences" issued by the Suffolk County Department of Health Services (SCDHS).

Suffolk County provides a means of establishing sewer design flows for existing facilities. This procedure is described in the Suffolk County Department of Health Services (SCDHS) "General Guidance Memorandum #26 – Procedure for Evaluation of Mass Loading in Wastewater Generated by and Existing Commercial Facility". The procedure involves the collection of water use records over a period of three years to establish design flow. The design flow is subject to a sewage strength analysis which involves the sampling of wastewater to compare actual waste strength versus theoretical design criteria. Depending on the results of the analysis, design flow may increase if the actual waste strength is beyond theoretical values.

Guidance Memorandum #26 is intended for existing systems that utilize a treatment facility and does not provide specific direction on how to apply this for new, decentralized sewer systems that would replace numerous conventional treatment systems. Suffolk County guidance on this matter should be provided prior to design.

Table 1 below provides an estimate of the actual average daily flow for this community. Typically, actual flows can be 55%-70% of theoretical. This estimate was formulated based on knowledge of other existing residential applications in Suffolk County and was not established based on actual water use records. Although water use records were obtained and reviewed, the data was not detailed enough to accurately determine daily or seasonal usage. Furthermore, it should be noted that the actual flow estimates for vacant lots equal theoretical values since water use records for such properties are unavailable.

Table 1: Design Flow Calculation

Design Flow from Existing Uses:				
Lot Type	Quantity	Unit Flow Criteria	Projected Theoretical Flow (GPD)	Projected Actual Flow (GPD)**
Single-Family Home	161	300 GPD/unit	48,300	31,395
Restaurant	50*	30 GPD/seat	1,500	975
North Sea Fire Department	2,000 SF*	0.03 GPD/SF	60	39
North Sea Fire Department	300*	7.5 GPD/Occupant	2,250	1,463
		Subtotal	52,110	33,872
Future Flow from Vacant Lots:				
Lot Type	Quantity	Unit Flow Criteria	Projected Theoretical Flow(GPD)	Projected Actual Flow (GPD)**
Single-Family Home	6	300 GPD/unit	1,800	1,170
		Subtotal	1,800	1,170
		Total at Buildout	53,910	35,042

* SF and occupancy were not able to be confirmed and have been conservatively estimated

**assumes 65% of theoretical

The table above identifies a design flow of 53,910 gpd when theoretical unit flow criteria are applied. The design flow is calculated to be 35,042 gpd when actual flows are considered. The ability to use actual flows will have a substantial impact on the economics for this project. The financial impact is discussed in later sections of this report. More detailed water usage data should be evaluated prior to full design. Theoretical flows are established to account for fluctuations in flow resulting from seasonal or user variability. Typically, a treatment plant can operate at 30% of theoretical flows without substantial changes in operation and performance. The WWTP for North Sea will be able to accommodate the full design flow for the SSA.

<u>Population Estimate</u>

The total population served by the wastewater treatment system at final build out is estimated to be 490 persons based on 2.93 persons per household as provided in the report titled “Suffolk County – Comprehensive Plan 2035” and the following calculation:

167 households X 2.93 persons per household = 490 persons

3.2 Influent Characteristics

The SCDHS recommended design influent characteristics as summarized in Table 2 were used for this project.

Table 2: Design Influent Characteristics

Characteristic	Units	Design Influent Concentration [2)]
Biochemical Oxygen Demand (BOD_5)	mg/L	272
Total Nitrogen (TN) [1)]	mg/L	65
Total Suspended Solids (TSS)	mg/L	300

1) For the purpose of this evaluation, it is assumed that there are no nitrites and nitrates in the influent and that TN is equal to Total Kjeldahl Nitrogen (TKN).
2) Influent characteristics based on typical values provided by "Wastewater Engineering - Treatment, Disposal, and Reuse", Metcalf and Eddy, Inc., Third Edition and adjusted from past experience. These values have been used and accepted for previous projects presented to the SCDHS.

3.3 Treated Effluent Quality

The decentralized system will include a wastewater treatment facility that will incorporate advanced treatment to comply with effluent treatment requirements stipulated by the Suffolk County Department of Health Services (Table 3).

Table 3: Design Effluent Characteristics

Characteristic	Design Effluent Concentration
Biochemical Oxygen Demand (BOD_5)	<10 mg/L*
Total Nitrogen (TN)	<10 mg/L
Total Suspended Solids (TSS)	<15 mg/L*
pH	6 – 8.5

*Parameter is not typically regulated by SPDES Permits

4.0 NITROGEN LOADING

The calculation provided below estimates the pounds of nitrogen currently discharged by the existing homes located within the proposed North Sea SSA. The calculation is based on an influent Total Kjeldahl Nitrogen (TKN) concentration of 65 mg/L, which is a SCDHS recommended design influent.

For purposes of this report, it is assumed that 80% of the existing homes are serviced by cesspools where little to no reduction of nitrogen occurs. The remaining 20% of existing homes are assumed to be on individual septic systems where a 10% reduction of nitrogen is obtained through treatment. This ratio of homes with cesspools to homes with septic systems was determined by reviewing aerial imagery from 1962 and 1978 available on Suffolk County's GIS Viewer to estimate how many homes were built prior to 1973 when the new regulations requiring septic systems went into effect. It is important to note that a portion of the homes built prior to 1973 may have been renovated over the past 40 years. An expansion or extensive renovation could have involved the replacement of the pre-existing cesspool with a septic system, but 80% will be used as a conservative estimate. Table 4 below assumes that cesspool replacement has not occurred since 1973.

Table 4: Existing System Nitrogen Loading

System Description	Number of Connections	Projected Flow (gpd)	Nitrogen Concentration in Influent (mg/L)	Nitrogen Concentration in Effluent (mg/L)	Nitrogen Loading (lb/d)	Nitrogen Loading (lb/yr)
Cesspools	138	41,400	65	65	22.5	8,197
Septics	25*	10,710*	65	58.5	5.2	1,909
Total	163	52,110			27.7	10,106
Adjusted**	163	33,872			18.0	6,569

*Includes fire station, restaurant, and non-vacant residential lots

** Adjusted based on actual flow estimates (see Table 1)

*** Nitrogen Loading calculated as:

N-Loading = gpd X Conc (mg/L) X 8.34 lb/gal X 1 L/1,000,000 mg

Once the remaining buildable lots are constructed with conventional treatment systems (a.k.a. septic systems) the nitrogen loading will further increase to 28.6 lb/d (10,433 lb/yr) based on theoretical values and 18.6 lb/d (6,782 lb/yr) based on adjusted values.

Table 5 below calculates the nitrogen loading that is anticipated following the installation of a decentralized system at full build-out. Note that the calculation is based on a total nitrogen concentration of 10 mg/L, which is a typical requirement of SPDES permitted facilities. Actual total nitrogen concentration in WWTP discharge varies depending on the treatment system design and operator performance. However, in most cases, the system will discharge less than 10 mg/L on a consistent basis.

Table 5: Proposed System Nitrogen Loading

System Description	Number of Connections	Projected Flow (gpd)	Nitrogen Concentration in Influent (mg/L)	Nitrogen Concentration in Effluent (mg/L)	Nitrogen Loading (lb/d)	Nitrogen Loading (lb/yr)
Existing Users	163*	52,110	65	10	4.3	1,570
Existing Users Adjusted	163*	33,872	65	10	2.8	1,022
Full Buildout	169	53,910	65	10	4.5	1,643
Full Buildout Adjusted	169	35,042	65	10	2.9	1,059

*The fire department, which holds three lots, is being counted as one (1) user

The amount of nitrogen that is mitigated on a daily and annual basis is presented in Table 6 below.

Table 6: Nitrogen Mitigation

System Description	Reduction in Nitrogen Loading (lb/d)	Reduction in Nitrogen Loading (lb/yr)	Equivalent Bags of 10-10-10 Fertilizer*
Existing Users	23.4	8,541	1,708
Existing Users Adjusted	15.2	5,548	1,110
Full Buildout	24.1	8,797	1,759
Full Buildout Adjusted	15.7	5,731	1,146

*http://www.floridahealth.gov/environmental-health/onsite-sewage/research/_documents/wekiva-final-report.pdf

5.0 COLLECTION SYSTEM

This report evaluates three options for the proposed wastewater collection system; a gravity system, a low pressure sewer system with grinder pumps (Eone system) and a low pressure sewer system using septic tanks (STEP system).

5.1 Gravity System

A gravity collection system consists of large diameter (>8") mains with 4" PVC laterals connecting to the buildings. Since gravity flow must be maintained, pipes cannot follow the local topography and sometimes excavations can be quite deep. In some cases, pump stations are installed to bring the wastewater back to a higher elevation to reduce the impact of infiltration and avoid costly excavation.

For this SSA, several limitations would prevent the effective implementation of a gravity system. The majority of the SSA is less than 15 feet amsl, and it is generally flat over much of its area. Since the treatment plant is located at a higher elevation than most of the SSA, pump stations would be required to lift the sewage to the plant. Within the SSA limits there are several parallel streets that are gently sloped towards adjacent water bodies. This will increase the depth of sewer lines unless several pump stations are provided. Multiple pump stations would require the purchase of additional land which increases cost.

Regardless, a gravity sewer system in this location would present issues during permitting, construction and operation. Most significant is the impact of infiltration and inflow from high groundwater and the risk of flooding facilities located along the shoreline. During installation, cost increases due to dewatering will likely be encountered as a result of the high groundwater table. Post-installation, groundwater can infiltrate the sewer pipe system at manhole locations and pipe joints. This infiltrate will eventually make its way to the WWTP which will increase pumping cost and has the potential to hydraulically overload the facility, causing loss of treatment. Due to these concerns, a gravity system is not recommended for this application.

5.2 Low Pressure System with Grinder Pumps

Another sewage collection option is based on installing a low pressure sewer (LPS) system with grinder pumps. This system is composed of a closed network of small diameter pipes under pressure. A grinder pump in a small tank at each service connection discharges to the main in the street which eventually reaches the treatment plant. The typical low pressure grinder pump system components are shown in Figure 1 below (image provided by Environment One Corporation).

Figure 1: Typical Low Pressure Grinder Pump System Components

A low pressure system is not adversely affected by variable topography. This is advantageous for this SSA because the discharge point at the treatment plant will be located at a higher elevation than the service connections. A conceptual layout of the system is provided in Figure 6 of Chapter - Appendix A.

The benefits of the LPS system compared to a conventional gravity system include lower construction cost, easier installation, and a significant reduction in the potential for extraneous stormwater or groundwater entering the system. The low pressure system in this application avoids the need to install a pumping station at a lower elevation in the SSA and pumping back up to the treatment plant as would be necessary for a gravity system.

At build-out, a total of 169 properties would connect directly to the collection system (see Figures 6 of Chapter 8 - Appendix A). In an LPS grinder system the wastewater is conveyed from each home to an on-site, individual pump station through a PVC lateral. The pump station collects the wastewater and discharges it through a low pressure piping network which ultimately discharges flow to the proposed WWTP. The LPS network consists of small diameter (2”-4”) PVC pipes that will run down each street within the SSA.

Each individual pump station consists of a buried simplex grinder pump system, check valve, high density polyethylene tank and controls. Duplex systems are available which provides for redundancy in case a pump were to malfunction. The cost differential between a simplex and duplex pump system is approximately $5,000 per station. If simplex systems are selected, SCDHS requires each homeowner to enter into a lifetime maintenance contract with the pump station manufacturer or other qualified service company.

For this SSA, the following approximate quantities for the low pressure grinder system were calculated based on 169 connections:

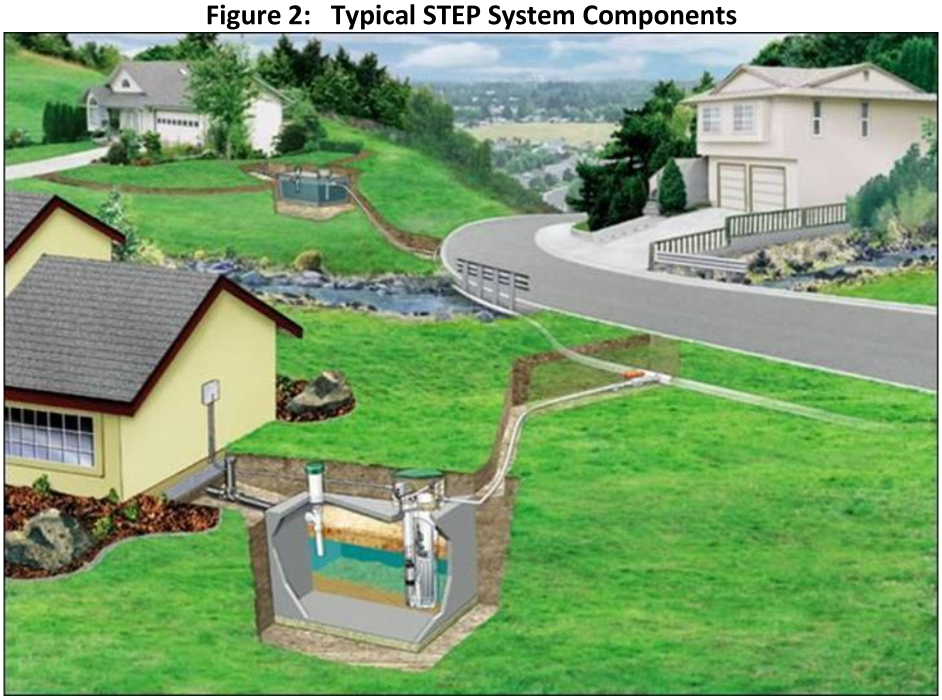
- 5,070 LF of 4” PVC from house to pump stations
- 169 Lateral connections
- 11,500 LF of 2” to 4” HDPE pipe for collection system
- 169 Simplex pump stations with controls
- 18 Flushing connections

A cost estimate for the collection system is provided in Section 8.0 of this report.

5.3 Low Pressure System with Septic Tanks (STEP)

A third option for sewage collection is based on installing a Septic Tank Effluent Pump (STEP) system. As with the grinder pump system described in the previous section, a STEP system is composed of a closed network of small diameter pipes under pressure which aids to eliminates construction and operation concerns over inflow and infiltration. A septic tank with an effluent pump at each residence serves to trap heavy solids/debris while allowing the liquid portion of the sewage to continue to the treatment plant. The typical STEP system components are shown in Figure 2 below (image provided by Orenco Systems, Inc).

Figure 2: Typical STEP System Components



The benefits of the STEP system compared to a conventional gravity system are similar to those of the grinder pump system including lower cost, easier installation, compatibility with variable topography, and a significant reduction in the potential for extraneous stormwater or groundwater to enter the system.

5.4 Collection System Selection

Upon evaluation of the three collection system options, the one most appropriate for this application could be selected. A gravity system was eliminated based on the limiting topography, high groundwater, and increased infiltration and inflow. Construction costs are also likely higher for gravity systems primarily due to the use of larger diameter mains, the need for manholes, potentially detwatering necessary for deep excavations, numerous pump station installations, and possible conflicts with other utilities. A low pressure system is more suited for the proposed SSA because the pipes can follow the ground contours and, as a closed system, infiltration is significantly reduced. The two low pressure systems are compared in the following sections.

Construction Cost

Both the LPS with grinder pumps and the STEP system have similar components including a collection tank, pump, and lateral to the main. Their construction costs are comparable with the STEP system installation cost for this project being about 2% lower than for the grinder pump system. The primary difference in cost is the on-lot collection and pumping station itself. The grinder pump stations are more expensive than the STEP tanks but this is balanced somewhat by the larger excavation needed for the STEP tanks. STEP system costs may also increase as a result of electrical modifications needed to meet Suffolk County requirements for separating electrical components from possible wet or corrosive environments. Such details will be confirmed during permitting.

Power and Emergency Considerations

Both pressure system options require power at each connection to operate the pumps. The grinder pumps are generally 1½ to 2 horsepower while the STEP systems operate with smaller ½ horsepower pumps so the energy costs are higher for the grinder pumps. In both cases, the systems are impacted by longer power outages. The STEP systems have an advantage in this regard because the tanks provide additional storage capacity. A possible solution to provide additional backup for both systems is to install an overflow from the pump tank to the existing seepage pits at each lot. This overflow would be used very infrequently, but provide system relaibiltiy during a long term power outage. The implementation and cost of such an overflow would need to be evaluated on a lot-by-lot basis. Additionally, it is recommended that the individual pumping stations be supplied with a hookup for an emergency generator to power the pumps during a power outage.

Sludge Management

One difference between grinder pump LPS and STEP is the management of solids. The grinder pump LPS has a small tank and all wastewater, including solids, is sent to the collection system for discharge to the

WWTP. Under this alternative, all solids are pumped and hauled at the WWTP. In a STEP system, a septic tank at each residence captures heavy solids before the waste is pumped to the collection system and WWTP. Here, the WWTP experiences a reduction in pumping and hauling, however, this cost savings is offset by the pumping of individual septic tanks every 2-3 years.

Maintenance and Replacement

General maintenance for both systems is similar and consists of checking the pumps, level sensors and alarms. Additional maintenance for the STEP system includes checking the sludge level in the tank and the effluent filter. The replacement interval for the pumps in both systems is comparable although the cost per pump for the grinder system is higher.

Impacts to Treatment Plant

STEP systems remove approximately 30% of the solids entering the WWTP. This loss of organic matter leads to an increase in supplemental carbon to maintain proper denitrification. This will increase maintenance costs at the WWTP. Grinder pump systems do not present this concern.

Regulatory Considerations

The grinder pump low pressure collection system concept has been approved for use in Suffolk County. The town of Patchogue has recently installed a similar system and other towns in Suffolk County are considering this option as they install or upgrade their sewer collection systems. STEP systems have not yet been installed in Suffolk County. Although the concept is accepted, there may be construction modifications required by the county that can have significant impact to the construction costs as noted above. Additionally, modifications to the treatment plant itself due to reduced organic matter in the wastewater would require regulatory approval.

Recommended System

Due to the existing use of grinder pump systems in Suffolk County, the challenges with reducing nitrogen levels in the treatment plant effluent when using STEP systems, the similarity in construction cost, and the preference of wastewater treatment plant operators to receive as much of the organic matter in the wastewater as possible, this study recommends the use of a grinder pump system to collect wastewater within the community.

6.0 WWTP AND DISPOSAL

6.1 WWTP and Disposal System Location

Parcels in close proximity to the SSA were evaluated for siting the WWTP and disposal system. Those large enough to accommodate the facility are limited. A majority of the larger parcels nearby were found unsuitable because they are either used for active recreation (ball fields), restricted due to wetlands and high groundwater, are preserved as open space, or are restricted by current development.

Additional parcels at greater distance from the SSA, including the landfill/transfer station property, may be suitable but would require a forcemain of over one mile which would increase costs by approximately $275,000 (See Figure 8 of Chapter 9 – Appendix A). After an evaluation of possible properties, a site for the WWTP was identified. The proposed location of the WWTP and disposal system is Section 60 Block 3 Lot 14.1 (Parcel ID 900060000300014001) which is situated east of the SSA. The lot is approximately 18.5 acres in size and has frontage along Noyac Road opposite Bayridge Road. The property currently contains 2 residences along Fish Cove Road on the eastern end of the property. For purposes of this report, it is assumed that the property can either be subdivided or acquired. The property provides adequate space for the NWTS infrastructure. For a conceptual site layout, please refer to Figure 9 of Chapter 9 - Appendix A of this report. As per the Suffolk County Water, there are no public water supply wells within 1,500 ft of the WWTP site.

6.2 Disposal System

The WWTP disposal area has an elevation of 20 to 25 ft amsl. It is assumesd that 15 ft deep leaching pools can be constructed for treated effluent disposal. 18 leaching pools with a 10 ft diameter are proposed to accept the flow from the SSA. More detailed on-site analysis would be necessary to determine the groundwater depth. Please refer to Figures 10 of Chapter 9 - Appendix A for a location of the proposed leaching pools. Note that area is available on each site for additional pools, if needed.

For filtered effluent, leaching pools can provide the highest amount of discharge capacity per square foot, particularly in locations where the groundwater table is deep enough to maximize the effective depth. In areas of high groundwater table, alternative disposal solutions (i.e. drainage basins, chamber leaching system, trenches, ets.) should be pursued however, the footprint requirement of alternative systems will increase which may be a limiting factor depending on the site.

7.0 WASTEWATER TREATMENT

Chapter 10 (Meeting House Creek) of this document provides an in-depth cost anaylsis of four different wastewater technologies at a design flow of 30,000 gpd. Of the four technologies evaluated, the Natural Wastewater Treatment System (NWTS) provides the lowest cost option by a substantial margin. Similar results are anticipated for the proposed North Sea WWTP, since the scale of this project is quite similar to the proposed system for Meeting House Creek. To further this point, NSU has bid and construction experience of MBR and BESST facitlies of this scale which indicates that a 54,000 gpd SBR, MBR or BESST system will cost in the range of $3.5M-$4.2M whereas a NWTS will cost in the $2.5M range (see section 8.0 of this report).

The cost savings that can be achieved through the NWTS make it the recommended choice for North Sea. The system will be deisgned to meet the effluent criteria defined in Section 3.0. Regrading will be kept to a minimum and the facility will be landscaped to blend into the surrounding area. Because of the larger area of the wetlands cells in the NWTS, each design for such a system is site specific. For these systems, tanks are underground and the most visible components are the wetlands “cells”. An example of what a NWTS may look like is shown in Figure 3.

The NWTS will meet regulatory standards and the requirements of SCDHS for redundancy. Process tankage was assumed to be of concrete construction. The primary WWTP infrastructure that is required for the NWTS is described in Section 7.1. Fencing is typically provided around the WWTP for security but this can be replaced with other means such as cameras and alarms. Security is taken account in the cost estimates.

Advantages of the NWTS system are noted as follows:

- Low capital expense
- Highly energy efficient
- Low maintenance
- NTWS offer operational flexibility and control
- Only sludge production occurs in easily accessible septic tanks
- Visually non-intrusive, blends into the environment, contributes to local ecology

Disadvantages of the NWTS system include the following:

- Larger footprint than conventional technologies

Figure 3: Example of a Natural Wetlands Treatment System (NWTS)

7.1 Process Description: Natural Wastewater Treatment System (NWTS)

The NWTS uses vegetated gravel filters in which biological activity breaks down the solids in the wastewater. Nitrification and denitrification tanks provide for the enhanced removal of nitrogen downstream of the filters to provide additional polishing to the effluent. The proposed 54,000 gpd NWTS facility was sized based on process calculations performed by NSU (see Chapter 9 – Appendix B). The system will include the following main components:

- Three (3) 36,000 gallon non-compartmentalized septic tanks will be installed in series. The third tank shall be fitted with a commercial septic tank filter.
- One (1) 17,000 gal precast concrete recirculation tank w/baffle wall. System overflow from the recirculation tank will go directly to the dispersal field in the event of a power failure or critical system maintenance.
- One (1) 6 X 8 Recirculation Tank Meter Chamber
- Four (4) 3,600 SF gravel filters (60'Lx 60'Wx 4'D) using ¾" pea gravel underlain by 1' of drainfield rock. Each gravel filter shall be fitted with a level control device. The system has been designed to handle the full daily flow with one wetland cell offline to provide a factor of safety and ease of maintenance.
- One (1) 10,000 gal precast concrete Nitrification & Recycle Tank with baffle wall, including:
  - Four (4) Wedge Wire Screens
  - Bioflow 9 MBBR media
  - Aeration Diffusers and Piping
  - Two (2) Recycle Pumps
- One (1) 19,000 gal precast concrete Denitrification Tank with baffle wall and chemical feed system for pH control and supplementing carbon. The supplemental Denitrification tank will also include:
  - Two (2) Mixers
  - Bioflow 9 MBBR media
  - Four (4) Wedge Wire Screens
- A 400 SF prefabricated control building to house the following:
  - Mechanical room
  - Electrical room
  - Laboratory/restroom
  - A blower package that includes two (2) Nitrification & Recycle Tank Blowers and associated diffusers/piping
  - Chemical Feed Systems for supplemental carbon
  - System controller and automatic telephone dialer/alarm system
  - HVAC Equipment
- One (1) subsurface dispersal system - Eighteen (18) 10' Diameter x 10' Effective Depth Leaching Pools
- 50 kW Stand-by Generator

In addition to the above listed components, the system will include:

- Supplemental carbon source feed system (i.e. Micro C) to enhance the denitrification process
- System controller and automatic telephone dialer/alarm system
- Enclosed building to house controls and chemical storage

8.0 COST ESTIMATE

Based on the conceptual design described in previous sections, a summary of the capital and operational costs is presented below.

Table 7: Capital Cost for the Proposed System

CAPITAL COSTS		
NORTH SEA, SOUTHAMPTON, NY		
	Capital Cost	
Collection System	$	1,944,000
WWTP	$	2,445,000
Construction Subtotal	**$**	**4,389,000**
Engineering (15%)	$	658,350
Land Aquisition	$	650,000
TOTAL	**$**	**5,697,350**

Cost Estimate Assumptions:

1. Land acquisition cost estimate is based on a review of similarly sized vacant properties in the area as found on trulia.com. No additional land is needed for the pressure system option.
2. Engineering cost percentages are based on the WWTP and collection system construction costs.
3. The estimate assumes that piping will be installed by conventional excavation under pavement and that no blasting or dewatering will be needed. Costs for traffic control are not included.
4. The estimate includes prevailing wage rates.
5. Cost estimates are accurate to +/- 25% and do not include a contingency.
6. The estimate includes abandoning all existing cesspools and septic tanks.

Table 8: Annual Operating Cost

WWTP - OPERATING COSTS NORTH SEA, SOUTHAMPTON, NY		
	WWTP and Collection System (Cost/Year)	
Labor/Maintenance	$	80,500
Power	$	20,500
Sludge Hauling	$	4,800
Chemicals	$	7,300
TOTAL	**$**	**113,100**

Cost Estimate Assumptions:

1. Labor is based on one operator performing daily site visits (3 hrs/visit). Sampling and compliance are included. Sampling requirements are based on SPDES permit criteria. Collection system labor and maintenance costs are included with the WWTP.
2. Power cost is based on a service rate of $0.2/kWh.
3. Lifecycle replacement costs are considered under Maintenance.
4. Chemical costs for Natural WWTS is based on projected Micro CG 2000 addition at a rate of 9 gpd @ $5/gal.
5. Natural WWTS Sludge hauling costs are based on four septic tank pump outs/year at 6,000 gallons/pumpout.

The entire system is estimated to cost approximately $5.7M to construct. The costs above were used in the financial model discussed further in Section 10.0.

9.0 POTENTIAL COST SAVING MEASURES

The wastewater treatment and collection systems presented in this report were designed based on standard practice and Suffolk County requirements. There are, however, opportunities for substantial cost savings if specific requirements were modified. These cost saving measures are described in more detail below.

1. **Eliminating Process Tank Redundancy** – There are numerous examples of wastewater facilities in the Northeastern US that utilize single train wastewater treatment systems for projects of this scale. Complete redundancy raises the cost of the wastewater treatment systems by increasing costs across the board. Mechanical and electrical materials/installation are impacted the most as equipment (i.e. valves, sensors, pumps, membranes, etc) is duplicated. In addition, concrete costs and building costs are also increased as a result of partion wall installations and a larger footrprint. Dual process trains provide a high degree of reliability, however, single train systems have performed very well for decades. Proper design and operations is the key to effective plant performance. Comparitively speaking, a single train 45,000 MBR plant in Northern NJ was recently bid at $2.2M while a 42,000 gpd dual train MBR in Suffolk County recently cost $3.1M

to construct. For applications where cost is paramount, alternative solutions to reduce price must be considered.

2. **Sharing LPS Pumping Stations** – This evaluation considers that each home connected to low pressure wastewater collection system would have its own individual pumping station. However, each simplex station has a 700 gpd capacity which is suitable to serve up to two single family homes. If the pumping units were owned by a utility so that ownership and maintenance conflicts are eliminated, two homes can be connected to each pump station. Reducing the number of pump stations and lateral connections by 45% would reduce the cost of the collection system by approximatley $400,000.

3. **Design Flow Reduction** – The Suffolk County Department of Health Services (SCDHS) "General Guidance Memorandum #26 – Procedure for Evaluation of Mass Loading in Wastewater Generated by and Existing Commercial Facility" provides a means of utilizing water use records to define wastewater design flow. The procedure involves the collection of water use records over a period of three years to establish design flow. The design flow is subject to a sewage strength analysis which involves the sampling of wastewater to compare actual waste strength versus theoretical design criteria. Depending on the results of the analysis, a lesser design flow for the WWTP may be accepted.

   Historically, actual wastewater flows can range between 55%-70% of theoretical. This could result in a WWTP size that ranges between 30,000 gpd – 38,000 gpd. The design and construction cost savings potential for a system of this size could range between $150,000-$450,000 depending on the findings of the flow analysis.

4. **Connecting Additional Customers** – Connecting additional users to the treatment plant will reduce the per user cost. The proposed WWTP site has adequate area for a larger system in the event surrounding communities connected to the system. If this option is considered during the design phase, the treatment facility could be designed to allow for future expansion. The magnitude of the cost savings will depend on which treatment plant option is chosen and how many additional customers will be connected.

10.0 FINANCING

Development and financing of small-scale decentralized wastewater infrastructure has historically been challenging in Suffolk County. Most municipalities do not have the expertise or the resources to efficiently develop and manage dispersed wastewater infrastructure. Further, these small distributed systems do not fit well into the regulated private utility market because the costs of regulatory compliance is too high to be supported by these small systems without economies of scale (Note: this refers to Public Utility regulation as opposed to Environmental regulation which would be in place at all times). Many municipalities, as well as Suffolk County, have been exploring innovative approaches to delivering decentralized wastewater infrastructure. One approach that is successfully implemented in other states is the public private partnership. This approach leverages the expertise of a private entity that specializes in deploying and managing decentralized wastewater infrastructure, avoids the costly public utility regulatory compliance through the municipality's ability to assess fees, and harnesses a municipality's access to low cost debt and legal right to build infrastructure in public rights of way. Further discussion on this topic is provided in Chapter 7.

There are many different potential funding scenarios with different combinations of grants, municipal debt and private equity.   In considering alternatives, there are three basic advantages to be considered when structuring public private partnerships: 1) Minimizing the cost of capital though public funding, 2) Optimizing the efficiency and risk management capabilities of a private organizations motivated by a profit incentive, and 3) Maintaining the condition of the system for long-term resiliency and public benefit. The ideal structure optimizes these three benefits, but often these objectives are at odds with one another.

For example, full public funding of a project with private operation may result in the lowest cost of capital and optimize operating cost efficiencies, but can remove the motivation for a private organization to manage risk effectively and maintain the plant appropriately if the private entity does not have capital at stake in the project. Alternatively, private funding may motivate the diligent maintenance of the plant, but results in a cost of service that is too high to bear for the users. Ultimately, the best structures balance these competing strategies for capitalization.

For perspective on private financing for distributed wastewater systems, Minnesota and Georgia both permit full private ownership of distributed systems without price regulation. These structures have been relatively successful, but expose the users to unpredictable price increases and questionable long-term resiliency. Massachusetts has a modified approach whereby the state permits private system ownership, but requires a financial assurance mechanism (FAM). The FAM is effectively an escrowed reserve under control of the environmental regulator to cover emergency maintenance and capital replacement should the private entity default on their obligations, and some entity needs to step in and take over the system. This FAM helps mitigate concerns regarding the private entity's failure to properly maintain the system for resilient long-term service delivery, but does not protect the users from price increases.

For decentralized sewer systems in Suffolk County, the municipality would own the sewer asset and assess fees for sewer service. The municipality would enter into a long-term (20-40 year) fixed rate contract with a private entity to design, construct, operate, and maintain the system. This structure could provide rate stability, utilize low cost public financing for the design, construction, and long-term operation of the system, and still take advantage of the private entity's abilities to operate the system most efficiently. The long-term nature of the contract and exposure to loss of capital through the FAM would encourage the private entity to optimize life-cycle costs that minimize user fees over the long-term, as opposed to making short-term profit motivated decisions, but still leverage the low cost of capital the public can access.

Below is a summary alternative funding scenarios under the above structure and their estimated impact on user fees. The rates below include both the cost of the wholesale service contract and the cost of financing the system for a 20 year term. A residual value of the system at 60% of its initial cost, municipal debt costs 3% per annum, private equity capital costs 15% per annum, and inflation averages 2% per annum were assumed. For all of the scenarios other than the 100% debt financing scenario, the residual value of the system exceeds the amount of debt deployed for the project. In these scenarios, it was assumed that the debt is not amortized, but rather would be renewed at the end of the 20 year term for a new contract. Under the 100% debt financing scenario, it was assumed that the debt is amortized down to the amount of the residual value. Further it was assumed that the municipality absorbs the cost of invoicing users and providing insurance coverage for the system at no cost to the project.

Table 9: Financial Model

	Capital Expenses			Operating Expenses[4]	Combined Capital and Operating Expenses		
Description	**Residual Value**	**Annual Capital Service[1,2]**	**Residual Value in Excess of Debt after 20 yrs[3]**	**Total Operating Expense**	**Total Annual Cash Flow**	**Required Annual User Fee**	**Required Monthly User Fee**
100% Grant Financing[4]	$ 3,418,410	$ -	$ 3,418,410	$ 113,100	$ 113,100	$ 670	$ 56
80% Grant / 20% Debt [4]	$ 3,418,410	$ 36,618	$ 2,386,246	$ 113,100	$ 149,718	$ 886	$ 74
50% Grant / 50% Debt [4]	$ 3,418,410	$ 91,545	$ 838,000	$ 113,100	$ 209,645	$ 1,211	$ 101
90% Grant / 10% Private Equity[5]	$ 3,418,410	$ 97,428	$ 3,418,410	$ 113,100	$ 210,528	$ 1,246	$ 104
100% Grant / 10% FAM[6]	$ 3,418,410	$ 92,252	$ 3,418,410	$ 113,100	$ 205,352	$ 1,215	$ 101
100% Debt Financing [7]	$ 3,418,410	$237,525	$ 0	$ 113,100	$ 350,625	$ 2,075	$ 173

[1] Estimate of return on capital and capital paydown adjusted to cover reserves during construction period and presumed inflation of user fees

[2] Reflects first year cash flows which are expected to increase by an inflationary escalator each year.

[3] Represents the net worth of the system at the end of 20 years

[4] Assumes no debt amortization because residual value is greater than debt amount

[5] Amortizes Private Equity down to $0 over 20 years and turns plant over to Municipality at no cost

[6] No amortization of Private Equity Financial Assurance Mechanism (FAM), but returns total amount to manager at end of term

[7] Amortizes principal down to the residual value over 20 years

Despite the cost of a FAM, it is recommended that one be required to avoid the municipality having to bail out failed system owners at the public's expense. Alternate mechanisms may be considered that would reduce the cost of capital, or the magnitude of the FAM may be reduced to make it more affordable.

It is important to note that these economics assume the costs are spread over 169 users. If alternatively the costs were allocated to all customers of the town (households and commercial), then the individual cost per user would be significantly reduced. Table 10 below provides an estimate of how sewer rates can be reduced if the sewer fees were applied throughout the Town of Riverhead and the Hamlet of Aquebogue.

Table 10: Annual User Fees

Funding Options	User Fee SSA Only ($/year/customer)	User Fee* Town Based ($/year/customer)	
		Connected User	Unconnected User
100% Grant	$1,061	$ 500	$ 1.34
80% Grant / 20% Debt	$1,296	$ 500	$ 3.06
100% Grant / 10% FAM	$1,653	$ 500	$ 5.66
100% Debt	$2,585	$ 500	$ 12.47

* Based on 21,504 households within the Town of Southampton (2000 census). This number does not take into account commercial properties which would further reduce in user fees for unconnected users.

11.0 CONCLUSIONS

The wastewater generated by the proposed North Sea Sewer Service Area in Southampton, NY can be treated cost effectively via a decentralized collection system and wastewater treatment plant located near the community. Assuming an average daily flow of approximately 54,000 gpd, the proposed system would result in a drastic reduction in the total amount of pollutants discharged each year. Such a system would reduce the discharge of total nitrogen to local waterways by 8,797 lbs annually over the existing wastewater management methods and provide immense environmental benefit to the community, North Sea Harbor, and the Peconic Estuary.

* * *

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