COMMUNITY WASTEWATER SYSTEM DESKTOP EVALUATION FOR THE OLD SAYBROOK, CT WATER POLLUTION CONTROL AUTHORITY

JANUARY 2019

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FOR THE

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January 16, 2019
W-P Project No. 13171B

Mr. Stephen A. Mongillo, B.A., M.S.
Program Manager, Old Saybrook WPCA
302 Main Street
Old Saybrook, CT 06475

Subject: Old Saybrook Waste Water Management Project
Community Wastewater System Desktop Evaluation Final Report

Dear Mr. Mongillo:

We have revised the Community Wastewater System Desktop Evaluation Report to incorporate the additional comments received from both the Old Saybrook Water Pollution Control Authority (WPCA) and the Connecticut Department of Energy and Environmental Protection (CT DEEP). The objective of this desktop study was to compare the cost of completion of the current wastewater management program with the alternatives of installing a community system with either subsurface dispersal or a surface water discharge to the Connecticut River of the treated effluent. These alternatives were evaluated to address wastewater management on the estimated 840 parcels that are anticipated to be remaining after the end of 2018. It was assumed for the community system alternatives that 740 parcels would be serviced by the community system and the remaining 100 parcels would receive conventional on-site upgrades.

The results indicate that a community wastewater system with a discharge to the Connecticut River is a technically feasible, cost-effective alternative to completing the current program. This alternative provides additional benefits to the Town including locating the wastewater treatment facilities outside of areas that are subject to coastal impacts and sea level rise. The community system will also provide additional environmental benefits to Long Island Sound over the current program relative to the amount of nitrogen that would be removed.

The next steps are to refine the process components and programmatic elements of a community wastewater system with a surface water discharge and develop a financial program for implementation of any recommended changes to the current wastewater management program, including the specific anticipated financial impacts to individual property owners. Once this information is developed, public meetings should be held to present recommended modifications to the current wastewater management program and obtain public input and acceptance.

We appreciate the time and effort that you and your staff has contributed to complete this desktop study phase. We look forward to continuing to work with the WPCA to aid in implementation of the recommended plan. Should you have any questions or require additional information, please call.

Sincerely,
WRIGHT-PIERCE

Christopher N. Pierce, PE
Vice President
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FOR THE
OLD SAYBROOK, CT
WATER POLLUTION CONTROL AUTHORITY

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DISCLAIMER

The desktop evaluation of selected properties in this report has been performed to evaluate the feasibility of a subsurface dispersal alternative and/or the feasibility of locating a community wastewater treatment system in a particular area. The evaluation has been performed using publicly available site details including soil maps, flood maps and other available data. This subsurface dispersal alternative includes a conceptual planning level estimate of the potential cost for comparison with other alternatives to determine if this alternative is worth further consideration. None of the private lands evaluated have been purchased, leased or otherwise encumbered and there are no agreements with the Town of Old Saybrook for use or sale of those properties which are privately held. No final plan has been developed utilizing any of the properties considered. ***The status and availability of specific parcels may have changed over the course of this evaluation. Specific parcels considered for this evaluation may no longer be available to the Town.***

EXECUTIVE SUMMARY

ES.1 BACKGROUND

Most residential and commercial properties in the Town of Old Saybrook rely on conventional individual on-site septic systems for wastewater management. Under the Second Modified Judgment in Accordance with Stipulation of January 2011 (Stipulated Judgement), the Old Saybrook Water Pollution Control Authority (WPCA) is addressing substandard and failing on-site wastewater systems in 15 specific focus areas within the Old Saybrook Wastewater Management District (WWMD). The 15 focus areas include 2,037 parcels of which 1,921 were required to be addressed under the program in the Stipulated Judgement. A total of 233 parcels are identified in the Stipulated Judgement mapping as "Waterfront Lots" that require an advanced treatment (AT) component. The remaining 1,688 parcels are non-AT parcels requiring conventional on-site upgrades.

The WPCA has been implementing the decentralized wastewater management program and upgrading individual on-site systems in multiple focus areas within the WWMD since the Stipulated Judgment was executed. It is anticipated that through the end of 2018, the WPCA will have completed approximately 732 conventional upgrades. An additional 355 parcels are either upgrade compliant (U/C) or the homeowner opted out for a total of 1,087 U/C non-AT parcels, primarily located in ten of the 15 focus areas. This would leave a total of 602 non-AT parcels and 233 AT parcels (total of 835 parcels, rounded to 840 parcels for this study) that are estimated as remaining to be completed under the Stipulated Judgement after 2018.

Of the remaining 840 parcels to be upgraded, the WPCA staff has indicated that approximately 600 parcels either require Advanced Treatment (AT) components and/or will be difficult to upgrade with conventional on-site systems due to site constraints. Therefore, the WPCA requested Wright-Pierce to perform a desktop feasibility evaluation for the potential of providing a community collection, treatment and dispersal/discharge system to serve all parcels from the remaining five focus areas (Chalker Beach, Indiantown, Saybrook Manor, Great Hammock Beach, and Plum Bank). The WPCA has also identified six parcels on Plum Bank Road (with 8 homes) in Cornfield Point that would be complicated and costly to upgrade that are included in the evaluation of the community system.

A summary of parcels yet to be addressed after year end 2018 is presented in Table ES-1.

TABLE ES-1

SUMMARY OF PARCELS REQUIRING ACTION AFTER 2018

Item	In Five Focus Areas	In other Focus Areas	Total
W Parcels Requiring AT Components	160	80	240
Parcels Requiring only Conventional Upgrades	570	30	600
Total	**730**	**110**	**840**

Based on the assumed number of parcels remaining to be addressed after 2018, the community system evaluation is based on a system that can serve the 730 parcels in the remaining five focus areas plus the additional eight homes on Plum Bank Road in Cornfield Point for a total of 738 parcels. This was rounded to 740 parcels for the purpose of this evaluation. The remaining 100 parcels would be addressed by conventional on-site upgrades.

ES.2 BASIS OF DESIGN

To determine the capacity and associated capital and operating costs for the various community wastewater system alternatives being considered as part of the desktop evaluation, it was necessary to develop a projection of the anticipated wastewater flows and loads to be conveyed to these systems. It is also necessary to identify the effluent quality/treatment requirements to determine the level of treatment to be provided. These preliminary flow and load projections and treatment requirements were used as the basis of design to develop preliminary system sizing and design criteria. Water consumption data were used to estimate the wastewater discharge from each parcel. Based on an evaluation of these data, the following wastewater flows were utilized to size the community wastewater collection and treatment systems:

- Annual average daily flow 77,000 gpd
- Maximum day flow 244,000 gpd

While the sizing of the collection system piping and pump stations and the water pollution control facility (WPCF) is based on the above flow rates, the Department of Public Health (DPH) requires that subsurface dispersal systems be sized to accept maximum day flows of 150 gpd per bedroom. The WPCA provided information indicating that there is an average of 2.84 bedrooms per parcel in the five remaining focus areas. Therefore, the subsurface dispersal system sizing used in this desktop evaluation was based on a maximum day flow capacity of 318,200 gpd. This design flow includes safety factors to ensure sewage systems for individual homes and other residential buildings operate satisfactorily during peak flow conditions. Applying this design flow criteria to a community system can be considered somewhat conservative.

In addition to the design flows presented above, discussions were held with CT DEEP to determine the required effluent quality from a community system WPCF. The community system and remaining on-site upgrades, including any AT system components, are also required to be protected against flooding and coastal storm impacts. While this desktop evaluation was being performed, Old Saybrook was also working with GZE GeoEnvironmental, Inc. (GZA) to perform a Coastal Resiliency Study. Preliminary flood level and sea level rise data provided by GZA were used in evaluating necessary flood protection elevations.

ES.3 DISPERSAL SITE SCREENING AND CAPACITY ANALYSIS

To determine if there is subsurface dispersal capacity available for the disposal of treated effluent from a community system, the WPCA staff and Wright-Pierce identified a total of 43 properties as candidates for potential subsurface wastewater effluent dispersal and/or treatment plant sites. These sites were identified based on the lot size, available geological and hydrogeologic characteristics, potential availability of the lot, and the proximity to either the focus areas or to other potential discharge or dispersal sites. A preliminary screening analysis was then conducted, and each lot was ranked from most likely to least likely to be feasible as either dispersal sites and/or treatment facility sites. Of these 43 sites, nine were identified as potentially feasible for subsurface dispersal and included in the desktop evaluation. Based on the preliminary desktop capacity evaluation performed using available published geologic and hydrogeologic data, five of the nine sites appeared to have available capacity and were also potentially available to the Town of Old Saybrook. The potential capacity of these five sites is presented in Table ES-2.

TABLE ES-2

SUMMARY OF POTENTIAL SUBSURFACE DISPERSAL CAPACITY

Site No.	Description	Estimated Capacity, gpd
1	Old Saybrook High School[1]	151,400/219,500
2	Donnelly Property[1]	18,700/27,100
38	Roam Tree Road Parcels (w/fill)	47,000
42	Ingham Hill Road (Town-Owned Site) (w/fill)	41,000
43	Mill Rock Road East Parcels (w/fill)[2]	65,600/100,000
	TOTAL POTENTIAL CAPACITY	**323,700/434,600**

Notes:

1. The estimated capacity of the sites shown in Table 3-2 is based on the use of conventional leaching chambers for the subsurface dispersal systems. In previous work done in 2015 by LBG, it was noted that additional capacity may be available at Site 1 and 2 if a shallower dispersal system, such as drip irrigation, were utilized. The second number shown for Sites 1 and 2 and the total potential capacity is based on the use of a shallower leaching system.
2. The first number shown for Site 43 is based on the addition of one foot of engineered fill being placed on certain areas of the site. The second number for Site 43 is based on the addition of 3.5 feet of engineered fill across the entire dispersal area.

If the five sites considered feasible under this desktop evaluation can accept the dispersal capacity estimated based on preliminary groundwater modeling, and if these sites are obtainable by the WPCA for use as effluent dispersal sites, up to 323,700 gpd of capacity may be available. Depending on the type of dispersal system utilized and amount of additional engineered fill, it may be feasible to increase this capacity to as much as 434,600 gpd. Based on the required design capacity of 318,200 gpd, this would provide for a reserve capacity of between 5,500 gpd and 116,400 gpd, or 1.7% to 36.6% of the required dispersal capacity, which is less than the typical 50% reserve required by DEEP.

While the total estimated capacity of these five sites is considered feasible as part of this desktop evaluation for the 740 parcels to be served by a community wastewater system, no one site is adequate. The capacity of some sites is not assured and would require significant additional field investigations and in-situ hydraulic loading tests to verify capacities. ***In addition, some of the sites may not be available to the Town for use as dispersal sites.***

For the purposes of the cost-effectiveness analysis of a community system with subsurface dispersal, it was assumed that treated effluent would be conveyed to the five dispersal sites in Table ES-2. While it is recognized that these five sites provide slightly less capacity than required when considering reserve capacity, it was determined to be sufficient to demonstrate whether this alternative is cost-effective.

Sites 38 and 42 require a significant dispersal area but provide limited capacity, the capital costs for these sites may be excessive. Because the DEEP has indicated that the use of a treated effluent equalization tank may be allowable to reduce the required reserve capacity requirements, a second cost-effective analysis was conducted assuming that only Site Nos. 1, 2, and 43 would be utilized and that an effluent equalization tank would be provided in lieu of significant reserve capacity. If this alternative is cost-effective, discussions would be initiated with DEEP regarding required reserve capacity and acceptable ways to meet these requirements on the three parcels identified. If it is not cost-effective, the use of additional sites would only serve to increase the capital and present worth cost of this alternative.

ES.4 WASTEWATER TREATMENT TECHNOLOGY EVALUATION

To develop the cost comparison of various alternatives, Wright-Pierce developed preliminary sizing criteria for the water pollution control facility (WPCF) to treat the wastewater for the community system. A preliminary screening analysis was conducted, and three technologies were selected for additional evaluation:

- Membrane Bioreactor (MBR)
- Sequencing Batch Reactor (SBR)
- Oxidation Ditch

Based on the evaluation, the SBR technology and oxidation ditch technology with a denitrification filter and UV disinfection have similar present worth costs. For the purposes of the cost comparison of alternatives, the SBR technology was recommended because it could be designed to better accommodate expected seasonal flow variations.

ES.5 COLLECTION SYSTEM EVALUATION

To develop the cost comparison of various alternatives, Wright-Pierce developed preliminary layouts of three different collection system alternatives including:

- Gravity system with pump stations
- Low pressure system
- Vacuum system

As part of the evaluation, potential sewer routing layouts were prepared to determine the length of piping required and number of pump or vacuum stations necessary to convey wastewater from the five focus areas to each of two different WPCF sites being considered.

Based on the cost evaluation, low-pressure sewers and vacuum sewers appear to have similar present worth costs. Based on the similarity between present worth costs, long-term reliable operating history of low-pressure sewer systems in the northeast, problems experienced by vacuum sewer systems in other municipalities in the northeast, and comparison of other criteria, it is recommended that the collection system associated with a community treatment system in Old Saybrook be designed around a low-pressure sewer system.

ES.6 RIVER DISCHARGE EVALUATION

To develop the cost comparison for the surface water discharge alternative, the following three outfall locations for the treated wastewater effluent discharge to the Connecticut River were evaluated based on the discussions with the WPCA and DEEP.

- Ferry Point North
- Ferry Point South
- Saybrook Point

Based on the DEEP surface water discharge regulations, the Connecticut River is the only water body in Old Saybrook where treated wastewater effluent could be discharged based on its water body classification (i.e., SB). Each of these alternative outfall locations has different potential advantages based on location selected for the WPCF.

As part of the evaluation, potential sewer routing layouts were prepared to determine the length of transmission piping required to convey wastewater from each WPCF site to each outfall location.

Based on the present worth cost estimate, the wastewater effluent discharge from the Roam Tree WPCF site to the outfall location at Ferry Point North has the lowest present worth cost.

However, the cost of conveying wastewater to a treatment facility location at the Donnelly site is estimated to be lower than the cost of conveying wastewater to the Roam Tree site and the overall present worth cost of a surface water discharge, when considering both the collection system costs and discharge system costs, slightly favors locating the WPCF at the Donnelley site and the outfall at Saybrook Point. Prior to making the final selection for the location of the WPCF and the discharge location for a surface water discharge, additional issues should be considered that are not captured in the present worth cost evaluation. These issues include the availability of the different parcels and other benefits associated with each location such as the ability to provide for future economic development or the ability to locate other town facilities on the same site at the WPCF. For the purposes of the overall cost comparison between the community system with surface water discharge and the other two alternatives, the cost of locating the WPCF at the Roam Tree site and discharging to Ferry Point North was utilized as these costs were considered to be slightly more conservative and due to other potential benefits to the Town of selecting the Roam Tree site.

ES.7 SUBSURFACE DISPERSAL EVALUATION

As an alternative to a surface water discharge, the other evaluated disposal option for the treated wastewater effluent is discharge to a subsurface dispersal system. Based on the site screening analysis, hydraulic capacity estimates were prepared for the nine sites identified for the desktop evaluation. Of these, five sites appeared to both have capacity and could potentially be available to the Town while the other four sites were determined to be unlikely to be available. Therefore, for the purposes of developing the capital and present worth cost analysis of the subsurface effluent dispersal alternative, it was assumed that the treated effluent would be conveyed to the five feasible dispersal sites.

Because the Donnelley WPCF site is the closest to the focus areas to be served and the five potential dispersal sites, only the dispersal costs from this treatment site are included in the evaluation of the subsurface dispersal alternative.

Due to the need to convey wastewater to multiple sites and the need to construct subsurface dispersal areas on multiple sites, the capital costs associated with subsurface dispersal is significantly greater than a river discharge. Two of the five sites, in particular, had very high capital costs compared with the dispersal capacity provided and these two sites were considered to not be cost-effective. A second cost capital and present worth cost analysis was conducted assuming that three sites would be used for effluent dispersal and that a post-equalization/treated effluent storage tank would be provided to reduce peak flows discharged to the dispersal system. The cost of this second subsurface dispersal alternative is still greater than the river discharge alternative. The capital and present worth costs for subsurface dispersal on three sites with a post-equalization/treated effluent storage tank was used as the basis for the comparison with other alternatives.

ES.8 REVIEW OF ONGOING PROGRAM

To compare the cost of a community wastewater system with the cost of completing the current program, Wright-Pierce worked with WPCA staff to develop a preliminary opinion of probable costs including both capital costs and annual operations and maintenance costs. To complete the current program, after 2018, the WPCA is anticipated to be required to complete conventional upgrades on 600 parcels and conventional upgrades with AT components for nitrogen removal on 240 parcels.

The per-parcel unit costs were developed primarily from information provided by the WPCA staff regarding septic system upgrades performed to date within the wastewater management district, together with Wright-Pierce experience with on-site treatment systems in other New England areas. The conventional upgrades are expected to cost an average of $25,400 to construct and $200 per year to operate and maintain. For those parcels requiring both a conventional upgrade and AT components, the construction cost is estimated to be $54,500 per parcel, with an annual O&M cost of $5,000 per year.

The waterfront location of these systems in Old Saybrook will likely result in periodic storm damage. Considering this and other factors, a 15-year service life was assumed for the AT components, compared to the traditional 20-year life of the community system. To account for that early replacement expense, the expected replacement cost at year 15 has been converted to a present worth and added to the initial capital cost.

ES.9 COST COMPARISON OF ALTERNATIVES

The overall objective of this desktop evaluation is to compare the cost of continuing with the current wastewater management program with the cost of providing a community wastewater treatment system for the five remaining focus areas. As discussed above, preliminary opinions of the probable capital and annual operations and maintenance costs for three alternatives were developed. These costs were utilized to calculate 20-year present worth costs at 2% interest rate for all three alternatives for comparison to use as a basis to recommend an alternative for the WPCA's consideration.

To provide a uniform basis of analysis for comparison, costs were computed for all remaining 840 parcels that are anticipated to be remaining after December 2018. For the community system alternatives, the cost of completing conventional upgrades to 100 parcels, in addition to the community system serving 740 parcels, were included in the cost comparison. The cost to complete the current program is based on completing conventional upgrades on 600 parcels and conventional upgrades with AT components on 240 parcels. The basis for the costs utilized for each alternative is presented separately below. It is noted that these are preliminary costs with an estimated accuracy range of -30% to +50% and they were developed for the purpose of comparing alternatives only. The final cost of the selected alternative may vary from what is presented in this report based on additional investigations during preliminary and final design based on a number of factors.

ES.9.1 Community System Costs with Subsurface Dispersal

Our preliminary opinion of the probable costs of a community system with subsurface dispersal is based on the following assumptions:

- installation of a low-pressure collection system to convey wastewater to a treatment facility on the Donnelley site.

- construction of a treatment facility including influent screening, advanced secondary treatment utilizing the SBR process, post-equalization, tertiary nitrogen removal using a denitrification filter, and effluent UV disinfection.
- construction of a covered 750,000 gallon nominal operating capacity post-equalization/treated effluent storage tank with odor control.
- installation of a treated effluent pumping system to convey flows to subsurface dispersal systems located at the Old Saybrook High School, Donnelley, and Mill Rock Road East sites.

The preliminary opinion of probable costs for the subsurface dispersal systems is based on the installation of subsurface piping and conventional leaching chambers, site work including surface restoration, and, in some areas, additional fill.

ES.9.2 Community System Costs with River Discharge

Our preliminary opinion of the probable costs of a community system with a surface water discharge to the Connecticut River is based on the following assumptions:

- installation of a low-pressure collection system to convey wastewater to a treatment facility on the Roam Tree Road site.
- construction of a treatment facility including influent screening, advanced secondary treatment utilizing the SBR process, post-equalization, tertiary nitrogen removal using a denitrification filter, and effluent UV disinfection.
- Installation of a treated effluent pumping system to convey flows to a new outfall located at the Ferry Point North location.

ES.9.3 Existing Program Costs with On-Site Upgrades

Our preliminary opinion of the probable costs of continuing with the current wastewater management program is based on the following assumptions for parcels remaining to be addressed after the end of 2018:

- installation of conventional septic tank and leaching system upgrades on 600 parcels.
- Installation of conventional septic tank and leaching system upgrades with AT components for nitrogen reduction on 240 parcels.

ES.9.4 Cost Comparison of Alternatives

A summary of the present worth comparison of the three wastewater management alternatives is presented in Table ES-3 and Figure ES-1 below.

TABLE ES-3

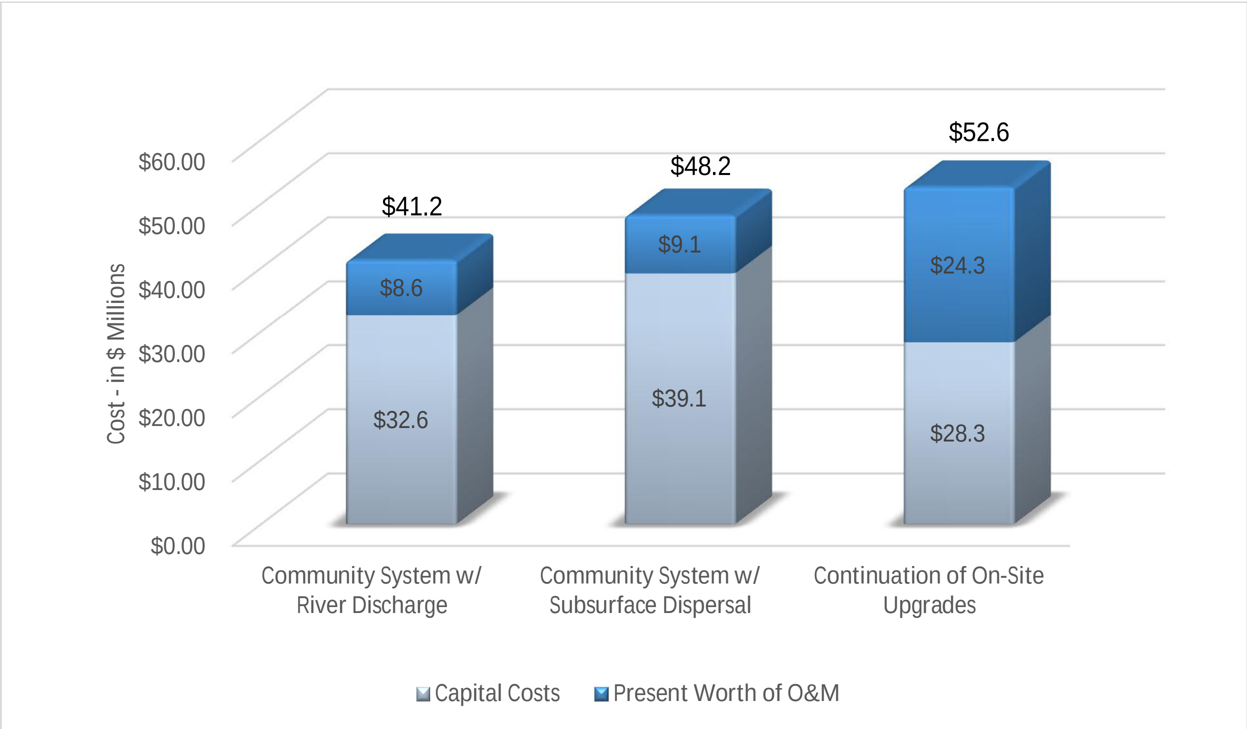
COST SUMMARY OF THREE ALTERNATIVES

Item	Community System/River Discharge	Community System/Subsurface Dispersal	Remaining Current Program
Capital Cost	$32,598,000	$39,130,000	$28,320,000
Present worth of annual O&M Cost	$8,574,000	$9,070,000	$24,344,000[A]
Present Worth Cost	**$41,172,000**	**$48,200,000**	**$52,664,000**

A. Includes present worth of AT component replacement cost for current program costs

FIGURE ES-1

COST SUMMARY OF THREE ALTERNATIVES



Based on the comparison of costs between each of the three alternatives, a community wastewater treatment system serving 740 parcels in the five remaining focus areas, with a river discharge and conventional on-site upgrades to the 100 remaining lots within the 10 focus areas appears to be the most cost-effective and feasible alternative. This alternative would be less costly to implement than either the current program or the community system with subsurface dispersal.

ES.9.5 Environmental Benefits of Community System

The community system will provide additional environmental benefits over the current program because a higher degree of nitrogen removal will be achieved, reducing the amount of nitrogen reaching Long Island Sound. By addressing 740 parcels as part of the community system, it is estimated that a total of 7,500 pounds of nitrogen would be removed annually at the treatment facility. By comparison, if only 240 parcels are provided with AT components as part of the current program, it is estimated that a total of 1,400 pounds of nitrogen would be removed annually.

While the principal goal of the current WWMD program is to achieve compliance with the Public Health Code, nitrogen removal is a secondary but important goal. In addition to being a more cost-effective alternative, the implementation of a community treatment system provides significant additional environmental benefits when compared with the current program with respect to total nitrogen removal.

ES.10 CONCLUSIONS AND RECOMMENDATIONS

Based on the Desktop Evaluation, we have developed the following conclusions:

1. A community wastewater system serving the 740 parcels within the five remaining focus areas with river discharge is the most cost-effective alternative.
2. Approximately 100 parcels within the other 10 focus areas, including the designated waterfront parcels would receive conventional on-site upgrades. No AT components would be included in the remaining on-site upgrades.
3. The use of subsurface dispersal for the disposal of treated effluent from the community system is not considered feasible for the following reasons:

a. No one site has adequate capacity to accommodate the treated effluent from the community wastewater treatment facility.
b. The use of multiple sites results in significantly higher capital costs.
c. The CT DEEP may allow the use of a post-equalization/treated effluent storage tank to reduce the reserve capacity requirements and minimize the number of sites required but this does not result in this alternative being more cost-effective.
d. The dispersal capacities of some sites are not assured and would require field investigation for capacity verification.
e. Some sites considered for subsurface dispersal may not ultimately be available to the Town for use as dispersal sites.

4. The current program involves completing on-site conventional upgrades at approximately 600 parcels and the installation of AT components on up to 240 waterfront parcels. The continuation of the current program is not cost-effective and also may not be feasible for the following reasons:
    a. The AT components have a significant long-term annual operation and maintenance cost which results in this alternative having the highest life cycle cost.
    b. No specific AT components have been identified by DEEP as being acceptable for installation at this time.
    c. The AT components will be required to reduce nitrogen by 50% at each parcel where they are installed. Because this is a biological process, and because many of these parcels are seasonal, it is unlikely that the AT components will meet the 50% reduction requirements at all times. With seasonal properties, if the home is vacant and no wastewater is added to the biological system, it will not develop a steady, consistent nitrogen reduction process for several weeks after wastewater flows are reintroduced.
    d. The 600 parcels in the five remaining focus areas that are to receive conventional on-site upgrades under the current program may not be feasible. The WPCA has completed some emergency upgrades in these areas on sites that have been significantly more costly than other sites. Some upgrades may require significant fill and retaining walls to install which is in conflict with regulations for filling

within flood plain areas. The DEEP has also indicated that they may not continue to fund conventional upgrades in the five remaining focus areas.

5. The proposed AT components would be installed on designated waterfront lots that are potentially subject to storm damage and flooding impacts associated with sea level rise.

Based on our desktop evaluation and the conclusions presented above, we have developed the following recommendations:

1. The Stage 2 Field Investigation work to verify subsurface dispersal capacity should not be completed because subsurface dispersal is not a viable or cost-effective alternative.
2. The Stage 3 Additional Evaluations should be conducted to refine the programmatic elements of a community wastewater system with a surface water discharge.
3. The WPCA should develop a proposed financial program for implementation of any recommended changes to the current wastewater management program, including the specific anticipated financial impacts to individual property owners.
4. The WPCA should conduct public hearings to present recommended modifications to the current wastewater management program and gain public acceptance.

Section 1

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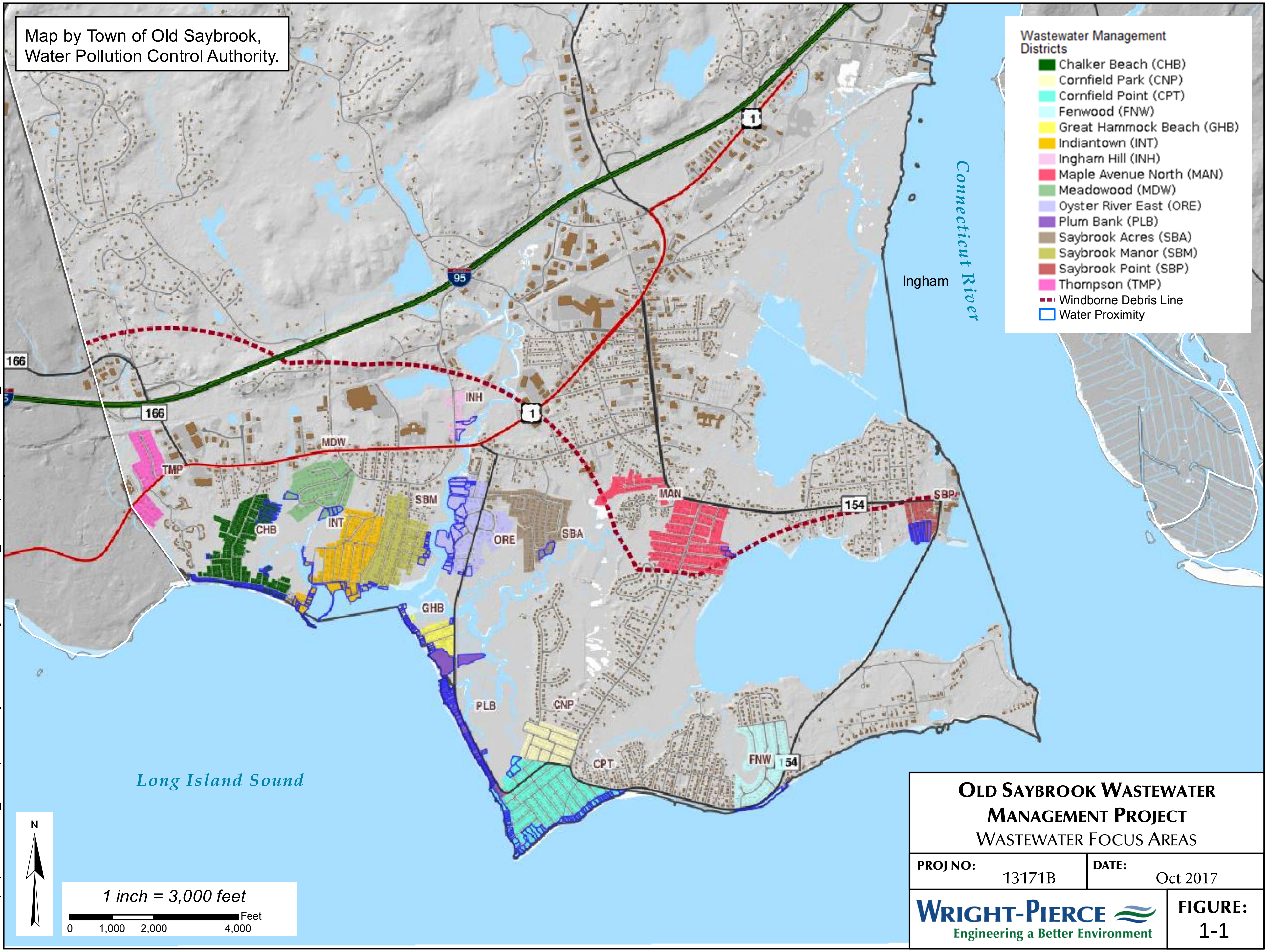
SECTION 1

INTRODUCTION

1.1 BACKGROUND

Most residential and commercial properties in the Town of Old Saybrook rely on conventional individual on-site septic systems for wastewater management. Under the Second Modified Judgment in accordance with Stipulation of January 2011 (Stipulated Judgement), the Old Saybrook Water Pollution Control Authority (WPCA) is addressing substandard and failing on-site wastewater systems in 15 specific focus areas within the Old Saybrook Wastewater Management District (WWMD). Figure 1-1 depicts all 15 focus areas within the WWMD. The 15 focus areas include 2,037 parcels of which 1,921 were required to be addressed under the program in the Stipulated Judgement. A total of 233 parcels are identified in the Stipulated Judgement mapping as “Waterfront Lots” that require an advanced treatment (AT) component.

The WPCA has been implementing the decentralized wastewater management program and upgrading individual on-site systems in multiple focus areas since the Stipulated Judgment was executed. Of the 1,688 non-AT parcels covered by the Stipulated Judgement, the WPCA has determined that 355 parcels require no action either because they have existing septic systems that are upgrade-compliant (U/C) or the property owner opted out of the program and upgraded their systems to be compliant with health-district regulations. The WPCA has also been working on completing conventional upgrades on non-AT parcels, primarily in 10 of the 15 focus areas. It is anticipated that through the end of 2018, the WPCA will have completed approximately 732 conventional upgrades plus the 355 parcels that are either U/C or opted out for a total of 1,087 U/C non-AT parcels. This leaves a total of 602 non-AT parcels and 233 AT parcels (total of 835 parcels) that are estimated as remaining to be completed under the Stipulated Judgement after 2018.



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The precise number of parcels that will require action under the next phase (Phase 3) of the Stipulated Judgment is difficult to determine, because property owners may opt out of the Town program, parcels are found to be upgrade-compliant without action, and parcels may be combined through property transfers. Accordingly, for this evaluation, we have based cost estimates on rounded numbers of 600 non-AT parcels and 240 AT parcels, for a total of 840 parcels still requiring action after completion of the conventional upgrades planed through the end of 2018

A summary of parcels yet to be addressed is presented in Table 1-1.

TABLE 1-1

SUMMARY OF PARCELS REQUIRING ACTION AFTER 2018

Item	In Five Focus Areas	In other Focus Areas	Total
W Parcels Requiring AT Components	160	80	240
Parcels Requiring only Conventional Upgrades	570	30	600
Total	**730**	**110**	**840**

Additional information on the status of the parcels in each of the focus areas is presented in Appendix A.

Of the remaining 840 parcels to be upgraded, the WPCA staff has indicated that approximately 600 parcels either require Advanced Treatment (AT) components and/or will be difficult to upgrade with conventional on-site systems due to site constraints. Therefore, the WPCA requested Wright-Pierce to perform a desktop feasibility evaluation for the potential of providing a community collection, treatment and dispersal/discharge system to serve all parcels from the remaining five focus areas (Chalker Beach, Indiantown, Saybrook Manor, Great Hammock Beach, and Plum Bank). The parcels in the remaining five focus areas include 575 parcels that require a conventional upgrade, and 155 parcels requiring an AT component for a total of 730 parcels to be served by a community system. The WPCA has also identified six parcels on Plum Bank Road in Cornfield Point that would be complicated and costly to upgrade by conventional means. There are a total of eight homes on these parcels and the WPCA would like to include these properties in the evaluation of the community system. Based on the assumed number of parcels remaining to be addressed after 2018, the community system evaluation is based on a system that can serve the 730 parcels in the remaining five focus areas plus the additional eight homes on Plum Bank Road in Cornfield Point for a total of 738 parcels. This was rounded to 740 parcels to be served by the community system.

1.2 OBJECTIVES

The overall objective of this desktop evaluation is to determine if a community treatment system to serve 740 lots in the five remaining focus areas is a technically feasible and cost-effective alternative to the current program. The following specific objectives were a focus of this evaluation:

- determine if dispersal sites could be identified that would provide sufficient subsurface dispersal capacity for a community system serving all parcels in the five remaining focus areas. The subsurface dispersal capacity would also consider necessary reserve capacity.
- evaluate the preliminary costs of collection, treatment, effluent distribution, and dispersal from a community system to multiple dispersal sites.
- evaluate the preliminary costs of collection, treatment, and effluent discharge from a community system to the Connecticut River.
- update the opinion of probable costs to complete the existing on-site wastewater management plan including both conventional on-site subsurface disposal systems and on-site systems requiring AT components for the 5 remaining areas. Update this opinion of probable cost to also include upgrades on “W” lots requiring on-site systems with AT components located in the other 10 focus areas.
- compare the capital and present worth costs as well as the technical feasibility of the three alternatives and identify the most technically feasible and cost-effective solution.

1.3 APPROACH

The following approach was utilized to determine the technical feasibility and present worth costs of the three alternatives considered:

- The total number of parcels to be served by a community system (740) was determined and estimates of wastewater flows and loadings from these parcels were developed.
- Potential subsurface dispersal parcels throughout Old Saybrook were reviewed with the OSWPCA staff. A total of 43 potential parcels were identified for consideration and ranked based on their potential feasibility for subsurface dispersal. Based on this review and ranking of potential sites, a total of nine sites were identified for desktop evaluation of potential treated effluent dispersal capacity. Appendix A contains information on the screening analysis for the 43 potential sites and selection of the nine sites for consideration in the desktop evaluation. ***As noted, this evaluation was based on publicly available information and the status and availability of specific parcels may have changed over the course of this evaluation. Specific parcels considered for this evaluation may no longer be available to the Town.***
- Using available information, including published geologic and hydrogeologic data, a preliminary mounding analysis was conducted for each of the nine sites to assess potential treated effluent dispersal capacity. No field work was completed for the desktop evaluation.
- Layouts for collection systems from the five remaining focus areas to a central community water pollution control facility (WPCF) were developed including gravity sewer, low-pressure sewer, and vacuum sewer alternatives.
- Community treatment technologies were evaluated including sequencing batch reactor (SBR), membrane bioreactor (MBR), and oxidation ditch process alternatives.
- Layouts for treated effluent discharge piping from the community WPCF to either subsurface dispersal sites or to the Connecticut River were developed. Dispersal site layouts were also developed showing the potential area for the dispersal system and reserve areas.
- A preliminary opinion of the capital and 20-year present worth costs were developed for each community system alternative.
- Updates to the preliminary on-going program capital costs and 20-year present worth costs were developed utilizing recent bid costs obtained from the WPCA for conventional on-site upgrades. Costs for the AT components of the on-site systems were developed based on similar projects that Wright-Pierce has been involved with on Cape Cod and other coastal areas. and based on our understanding of likely CT DEEP requirements.

- A cost-effectiveness analysis was conducted to compare the alternatives of a community system with subsurface dispersal or a community system with river discharge with the cost of completing the ongoing program utilizing conventional on-site upgrades and AT components.

1.3.1 Preliminary Opinion of Capital and Present Worth Costs

Preliminary order-of-magnitude cost estimates were developed for both initial capital cost as well as annual operations and maintenance costs for the various alternatives. These planning-level costs were developed using standard cost estimating procedures consistent with industry standards utilizing conceptual layouts, unit cost information, budgetary costs provided by equipment and system manufacturers, and cost information from recent previous projects, as appropriate. In addition, preliminary assumed costs for obtaining the necessary property for a community WPCF and for subsurface dispersal sites has been carried with the capital costs. The total project capital costs include an allowance of 40% of the estimated construction cost to allow for a contingency for unforeseen items as well as to allow for costs associated with technical services during the design and construction phases.

Annual operations and maintenance costs for each alternative have been estimated based on assumptions regarding electrical costs, chemical costs, residuals disposal costs, and personnel costs associated with operation and maintenance of each alternative.

The present worth cost for each alternative was developed by calculating the 20-year present worth of the annual operations and maintenance costs using a 2% interest rate. The present worth cost was added to the capital cost to determine the overall present worth of each alternative to allow for comparison and to determine the most cost-effective alternative.

1.3.2 Assumptions Utilized for Cost Comparison

To provide an adequate basis for comparison of the two community system alternatives with the current program, the present worth cost for each community system alternative includes the cost for completing conventional upgrades on the 24 non-AT parcels and 80 AT parcels outside of the five remaining focus areas. These values exclude the 6 parcels in Cornfield Point along Plum Bank Road that the WPCA recently identified for inclusion in the 740 lots to be served by a potential community system. For this cost comparison, it was assumed that if a community wastewater system is installed, the 104 parcels outside of the five remaining focus areas could receive conventional upgrades only based on the additional nitrogen that would be removed in a community wastewater treatment facility.

As shown in Table 1-1, there are a total of 840 parcels remaining to be addressed at the end of 2018 including 240 requiring AT components and 600 requiring conventional on-site upgrades. To compare the relative environmental benefits of a community wastewater system with the current program, it was assumed that for the current program, 600 parcels would achieve typical septic tank effluent total nitrogen concentrations while the 240 parcels requiring AT components would achieve a 50% reduction in effluent total nitrogen over a conventional on-site system. For the community system alternative, it was assumed that 740 parcels would receive advanced secondary treatment to achieve low concentrations of effluent nitrogen while the remaining 100 parcels would achieve conventional on-site system effluent total nitrogen. The assumptions used in this comparison are presented below:

- Conventional on-site septic tank effluent has an average of 50 mg/L of total nitrogen.
- Parcels requiring AT components must reduce nitrogen from 50 mg/L to 25 mg/L.
- The community wastewater system would achieve an effluent total nitrogen of 4 mg/L.
- Each parcel discharges 150 gpd on average (based on summer water consumption records).

Based on the above assumptions, if the current program is maintained, the 840 parcels would discharge an average summer-time nitrogen loading of 45 lb/d. If the community system is installed serving 740 parcels and the remaining 100 parcels outside of the remaining five focus areas only receive conventional upgrades, the average summer-time nitrogen loading would be reduced to 10 lb/d, a 77% reduction over the current program.

Therefore, the community wastewater treatment system would provide a more significant environmental benefit in terms of nitrogen reduction to Long Island Sound than the current program's use of AT components. Based on this evaluation, even if the remaining 80 AT parcels outside the five remaining focus areas are upgraded with a conventional on-site system, the total nitrogen reduction from a program including a community system would be significantly greater than the current wastewater management plan as it would include 160 AT lots and 580 lots that would be upgraded conventionally.

Section 2

Wright-Pierce
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SECTION 2

BASIS OF DESIGN

2.1 INTRODUCTION

To determine the capacity and associated capital and operating costs for the various community wastewater system alternatives being considered as part of the desktop evaluation, it is necessary to develop a projection of the anticipated wastewater flows and loads to be conveyed to these systems. It is also necessary to identify the effluent quality/treatment requirements to determine the level of treatment to be provided. These preliminary flow and load projections and treatment requirements are used as the basis of design to develop preliminary system sizing and design criteria. This section summarizes the basis of design data used to evaluate potential community wastewater collection, treatment and dispersal/discharge systems.

2.2 WASTEWATER FLOW AND LOAD PROJECTIONS

The community wastewater system will be sized to serve all parcels within the five remaining focus areas and six parcels in Cornfield Point including:

- 575 parcels requiring only a conventional upgrade
- 155 parcels requiring AT components with a conventional upgrade
- 6 parcels on Plum Bank Road (Cornfield Point) including 8 homes

Therefore, a total of 738 parcels would be connected to the community wastewater system. For developing the projected flows and loads for a community treatment system, a total of 740 parcels was assumed.

As discussed in Section 1, the purpose of this desktop evaluation is to compare two alternative community wastewater systems (one with subsurface dispersal of treated effluent and one with a surface water discharge) with the current wastewater management plan. The basis of design for these two alternative community systems are similar but will vary in two significant aspects:

- While the annual average daily flow and the maximum day flow used to size the collection system and treatment facility will be the same whether a subsurface dispersal or surface water discharge is used, it is necessary to size the subsurface dispersal system based on maximum day flows calculated based on the Department of Public Health criteria.
- The treated effluent concentration requirements for subsurface dispersal are slightly different than for a surface water discharge for specific parameters.

A discussion of the assumptions used to develop the design criteria for the two community system alternatives is presented below.

2.2.1 Wastewater Flow Projections

As described in the Water Environment Foundation (WEF) Manual of Practice No. 8 *Design of Municipal Wastewater Treatment Plants* (MOP 8), water consumption data should be utilized for estimating flow when available. Projections for the volume of flow to be handled by the community wastewater system collection, conveyance, and treatment components were estimated utilizing quarterly water consumption data obtained from Connecticut Water for the period 2012 to 2016. Based on these data, the annual average water usage was estimated to be 73.2 gpd/parcel. Because these parcels are currently utilizing on-site septic systems, and to account for consumptive water use that would not be discharged to the collection system, the following assumptions were considered when estimating wastewater flow rates from each parcel:

- A consumptive use of 10% was assumed. Therefore, 90% of the water use was assumed to be discharged to the sewer. This is consistent with information in MOP 8 that indicates that between 60% and 90% of water consumption typically reaches the sewer system (with the lower percentage being applicable to more arid regions).
- A growth factor of 35% was applied to account for "pent-up demand" that may exist in residences currently served by on-site systems. Typically, when homes limited in wastewater disposal capacity by an on-site system connect to a sewer, water usage increases. This can be due to the addition of clothes washers or dishwashers that couldn't be accommodated by the on-site system. Data published by Tchobanoglous and Schroeder[1] shows that typical

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[1] Tchobanoglous, G, and E. D. Schroeder (1985) *Water Quality, Characteristics, Modeling, Modification,* Addison-Wesley Publishing Company, Inc.

residential wastewater flows from either older homes or typical homes can vary by between 12.5% and 75%. While there is not specific data available to indicate the "pent-up demand", the 35% estimated growth factor falls within these differences.

- An allowance of 15% was included for infiltration and inflow (I/I). This is to account for clean water flows that may get into the collection system over time. While minimal I/I contributions would be expected within a pressurized collection system (low pressure or vacuum system), there may be sources of I/I to the gravity service connections within the parcels that may over time increase base wastewater flows.
- A peaking factor of 3.18 was applied to the average daily flow to estimate maximum day flows.

Based on these assumptions, the following per-parcel water use has been estimated:

- Annual average flow 102.5 (use 104 gpd/parcel)
- Maximum day flow 325.9 (use 330 gpd/parcel)

Multiplying these rates by 740 parcels, yields design flow rates of approximately 244,000 gpd maximum day and 77,000 gpd annual average flow. Refer to Appendix A for additional information on water consumption data and determination of peaking factors used for this analysis.

2.2.2 Subsurface Dispersal System Design Criteria

As described above, water consumption data are used as the basis of design for the wastewater collection, conveyance, and treatment systems. However, when discharging treated effluent into the ground through subsurface dispersal systems, alternate criteria are used to ensure sufficient capacity to accept peak day flows without overloading the system. Based on discussions with CT DEEP during the desktop evaluation, the Connecticut Department of Public Health (DPH) criteria (Technical Standards for Subsurface Sewage Disposal Systems) were used for sizing the effluent subsurface dispersal systems. These criteria require that subsurface dispersal systems be sized to handle maximum day flows of 150 gpd/bedroom. This design flow includes safety factors to ensure sewage systems for individual homes and other residential buildings operate satisfactorily during peak flow conditions. Applying this design flow criteria to a community system can be considered somewhat conservative.

Based on information provided by the WPCA, the five remaining focus areas have an average of 2.84 bedrooms per parcel. Therefore, the maximum day wastewater flow from each parcel would be approximately 426 gpd. For the purposes of our evaluations, we have assumed 430 gpd/parcel for sizing the subsurface dispersal systems. To accommodate 740 parcels, the maximum flow capacity required for the subsurface dispersal system is approximately 318,200 gpd.

2.2.3 Wastewater Loading Projections

For the purposes of sizing the wastewater treatment system, estimates of the influent characteristics were made. Information presented in MOP 8 indicates that five-day biochemical oxygen demand (BOD_5) ranges between 110 mg/L and 350 mg/L for untreated domestic wastewater and that total suspended solids (TSS) ranges between 120 mg/L and 400 mg/L. The total nitrogen in untreated domestic wastewater ranges between 20 mg/L and 70 mg/L. It is assumed that the influent wastewater will be primarily residential wastewater. Because the collection system is relatively small and will likely not have significant quantities of infiltration and inflow during initial operation, a high-strength domestic wastewater was assumed for this evaluation. Accordingly, the influent parameters were assumed to be as follows:

- Influent BOD_5 – 300 mg/L
- Influent TSS – 300 mg/L
- Influent total nitrogen – 50 mg/L

2.3 EFFLUENT DISCHARGE PERMIT REQUIREMENTS

The types of wastewater treatment processes to be utilized are dependent on the required effluent quality and proposed discharge permit requirements. These parameters were developed based on discussions with the CT DEEP. The effluent criteria and discharge permit requirements for a community system with a surface water discharge are slightly different than for a community system with a subsurface dispersal system. Influent flow and loading projections and effluent criteria for each type of community system are presented separately in Tables 2-1 and 2-2 and are used as the basis of design for the community wastewater system evaluation.

A summary of the anticipated influent characteristics and discharge permit requirements that a community wastewater system's water pollution control facility (WPCF) will be required to meet for a river discharge is presented in Table 2-1 below.

TABLE 2-1

WPCF INFLUENT LOADING AND EFFLUENT DISCHARGE CRITERIA

RIVER DISCHARGE

Parameter	Influent	Effluent Criteria
Maximum Day Flow	244,000 gpd	-
Annual Average Flow	77,000 gpd	-
BOD_5 [1] (Concentration)	300 mg/L 193 lb/day (Annual Average) 610 lb/day (Maximum Day)	30 mg/L (Monthly Average) 50 mg/L (Daily Maximum)
Total Suspended Solids [1] (TSS)	300 mg/L 193 lb/day (Annual Average) 610 lb/day (Maximum Day)	30 mg/L (Monthly Average) 50 mg/L (Daily Maximum)
Total Nitrogen (TN)	50 mg/L 19 lb/day (Monthly Average) 102 lb/day (Maximum Day)	2.57 lb/d[2]
Total Phosphorus (TP)	-	(Monitoring Only)
pH	-	6-9 (Daily Min and Max)
UV Dose (Year-Round)	-	≥30 mW/cm2
Enterococci	-	35 col/100 mL (Monthly Avg) 500 col/100 mL (Daily Max)
Fecal coliform	-	88 col/100 mL (Monthly Avg) 260 col/100 mL (Daily Max)

Notes:

1. The discharge shall be less than or equal to 15% of the average monthly influent BOD_5 and TSS.
2. Nitrogen Permit requirement would be a 12-month rolling average, pounds per day limit, based on 4 mg/L and a design flow of 77,000 gpd.

A summary of the anticipated influent characteristics and the discharge permit requirements that a community wastewater system will be required to meet for subsurface dispersal is presented in Table 2-2.

TABLE 2-2

WPCF INFLUENT LOADING AND EFFLUENT DISCHARGE CRITERIA

SUBSURFACE DISPERSAL

Parameter	Influent	Effluent Criteria
Maximum Day Flow	244,000 gpd	-
Annual Average Flow	77,000 gpd	-
Dispersal System Design Maximum Day Flow	-	318,200 gpd[1]
BOD_5	300 mg/L 193 lb/day (Annual Average) 610 lb/day (Maximum Day)	20 mg/L (Monthly Average) 30 mg/L (Daily Maximum)
TSS	300 mg/L 193 lb/day (Annual Average) 610 lb/day (Maximum Day)	20 mg/L (Monthly Average) 30 mg/L (Daily Maximum)
Total Nitrogen (TN)	50 mg/L 19 lb/day (Monthly Average) 102 lb/day (Maximum Day)	5 mg/L (12-Month Rolling Average)[2]
Total Phosphorus (TP)	-	Downgradient Background Level[3]
pH	-	6-9 (Daily Min and Max)
UV Dose (Year-Round)[4]	-	≥30 mW/cm2
Enterococci[4]	-	35 col/100 mL (Monthly Avg) 500 col/100 mL (Daily Max)
Fecal coliform[4]	-	88 col/100 mL (Monthly Avg) 260 col/100 mL (Daily Max)

Notes:

1. The subsurface dispersal system design is based on an effluent maximum day flow of 430 gpd/parcel.
2. Total Nitrogen permit requirement is based on a 12-month rolling average.
3. Total Phosphorus treatment/sorption as required to ensure no increase above background concentrations at the critical downgradient point of concern.
4. In typical subsurface dispersal systems, disinfection is achieved through separation distance with the groundwater mound and bacteria travel times of either 21 days or 56 days through the soil to downgradient receptor sites. DEEP has indicated that for the community system alternative with subsurface dispersal, a disinfection process would be required. Therefore, a UV disinfection system was assumed.

2.4 STORM RESILIENCY REQUIREMENTS

Old Saybrook is a coastal community where sea-level rise, flooding, and hurricane inundations could have major impacts on the wastewater facilities now and at any time during the entire useful life of the facilities. Therefore, the impacts of coastal flooding, sea-level rise, and storm damage were considered during the evaluation of alternatives.

2.4.1 Flood Protection

According to the New England Interstate Water Pollution Control Commission's Technical Report #16 (TR-16) Guides for the Design of Wastewater Treatment Works and CT Flood Management Act requirements [per CT General Statutes Section 25-68(b)], all community wastewater facilities need to include provisions for protections against flooding.

Based on these statutes and guidelines, the WPCF, pump stations and subsurface dispersal systems are considered critical facilities required to be protected against flooding to either an elevation greater than three feet above the 1% annual chance base flood elevation (100-year base flood elevation) or above the 0.2% annual chance flood (500-year flood) elevation, whichever is greater.

2.4.2 Coastal Storm Impacts

In a coastal community like Old Saybrook, flooding concerns can be more complex due to wave action and associated flood currents, which can be severe during major storm events.

2.4.2.1 Areas of Velocity Wave Action

Areas along the shoreline can be subject to not only flooding, but also severe scour effects due to the strong waves and currents often associated with the severe storms that cause flooding. Areas subject to high velocity water including waves are denoted as "Zone V" or "Zone VE" on FEMA Flood Insurance Rate Maps (FIRMs). These zones can be affected by waves three feet or greater. Facilities and structures designed in these areas should be protected against flood water impacts, scouring of soils, and from the impact forces of debris and waves. These requirements may impose many restrictions and result in significant additional construction costs.

2.4.2.2 Areas of Limited Wave Action

Just inland from the Wave Action Zones V and VE, there are Limit of Moderate Wave Action (LiMWA) areas. These are typically denoted on FIRMs as a "Coastal A Zone" or "Zone AE." These areas are impacted by waves more than 1.5 feet, but less than the 3-foot waves in the velocity zones. These smaller waves still can cause significant damage and often construction in these areas must meet the same or similar standards as facilities in the V or VE zones.

2.4.2.3 Hurricane Inundation Areas

The town and state authorities have also created maps depicting areas where hurricanes either have or are likely to cause inundations based on storm surge, wave action, high winds, and similar factors. Care should be taken during the design and construction of wastewater facilities in these areas to mitigate the effects from submersion and salt water intrusion, as standing water could exist in these areas for extended periods during and after hurricane events.

2.4.3 Impacts of Sea Level Rise

As part of a separate study, the Town of Old Saybrook hired GZA GeoEnvironmental Inc. (GZA) to perform a Coastal Resiliency Study to look at the impacts of sea level rise on Town facilities. Per the request of the WPCA, GZA provided a draft of their Coastal Resiliency Study memorandum to Wright-Pierce. Our evaluation of flood protection requirements for the community system alternatives is based on the flood level data included in this draft memorandum.

As a result of the GZA study, information regarding potential sea level rise has been reviewed to verify the critical elevations for the design of flood protection required by TR-16 and by the state. The GZA study and recommendations focused on the US Army Corps of Engineers (USACE) intermediate and high projections for sea level rise. The sea level rise projections predict changes for 100 years into the future; however, based on the typical life-cycle for new wastewater facilities, this study focused on sea level rise projections between 25 and 50-years into the future. Appendix A contains a memorandum regarding flooding and storm resiliency requirements based upon the GZA report and subsequent discussions with the DEEP.

Based on information provided in the GZA report for the 5 focus areas, the difference between the 100-year base flood elevation and the 500-year flood elevations is approximately 2.7 feet. Therefore, for critical facilities, a 500-year plus 1-foot elevation will generally be the higher elevation against which to protect the critical facilities. For “non-critical” facilities, the 100-year base flood elevation plus 2 feet would generally be the governing elevation. These flood elevation locations have been included on the figures in this report when practical based on the scale and locations.

Section 3

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SECTION 3

SUBSURFACE DISPERSAL SITE SCREENING AND PRELIMINARY CAPACITY ANALYSIS

3.1 SUBSURFACE SITE SCREENING ANALYSIS

As the initial step in conducting the desktop evaluation, the Old Saybrook WPCA staff and Wright-Pierce reviewed the Town's parcel maps and identified a total of 42 properties as candidates for potential subsurface wastewater effluent dispersal and/or treatment plant sites. These sites were identified based on the lot size, available geological and hydrogeologic characteristics, potential availability of the lot, and the proximity to either the focus areas or to other potential discharge or dispersal sites. A preliminary screening analysis was then conducted, and each lot was ranked from most likely to least likely to be feasible as either dispersal sites and/or treatment facility sites. A memo summarizing the site screening analysis and presenting the criteria utilized to evaluate each site is included in Appendix A.

During the desktop evaluation, one additional site became available, was considered to be suitable and potentially feasible as a dispersal site to be evaluated and was added as Site No. 43. This site is not discussed in the original site screening memo provided in Appendix A. The characteristics of each site are listed in Table 3-1 and the location of these sites are shown in Figure 3-1. Table 3-1 and Figure 3-1 include the added site identified as Site No. 43.

Eight sites were originally identified for further desktop evaluation, based on the details obtained during the screening analysis. A ninth site was included during the desktop evaluation. The nine sites included in the desktop evaluation are:

- Site 1 - Old Saybrook High School
- Site 2 - Donnelley property
- Site 18 - Fenwick Golf Course
- Site 29 - The Gardella property
- Site 31 - Spencer Plain Road
- Site 36 - Ingham Hill Road (Private)
- Site 38 - Parcels on Roam Tree Road
- Site 42 - Ingham Hill Road (Town)
- Site 43 – Parcels on Mill Rock Road East

TABLE 3-1
EFFLUENT DISPERSAL AND WWTF SITE SCREENING ANALYSIS

Most Suitable Sites Selected For Additional Study

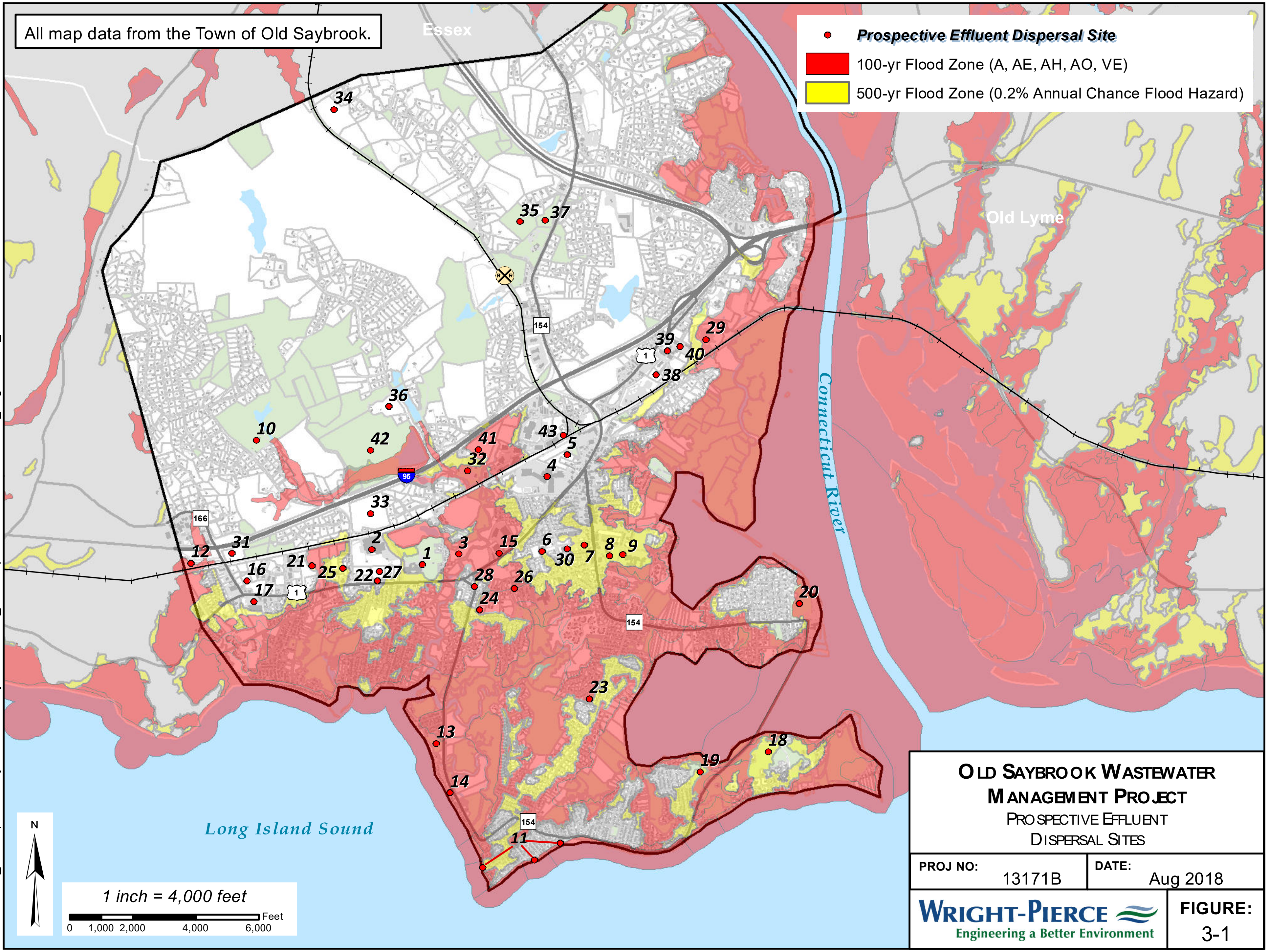
SITE #	NAME	TOWN OWNED?	LOCATION	USABLE ACREAGE	POSSIBLE USE	RATIONALE
1	OS High School	YES	1111 Boston Post Road	~20 Acres	Dispersal and Plant	Town owned, adequate space, has dispersal potential, evaluated earlier
2	Donnelley Property	NO	50 School House Road	~20 Acres	Plant	Adequate space, but limited dispersal potential, evaluated earlier
18	Fenwick Golf Course	NO	Rte. 154 (Borough of Fenwick)	10 Acres	Dispersal and Plant	Adequate size, beneficial combined use, intermunicipal
29	Gardella Property (formerly)	NO	70, 80,90 Mulcahy Road & Boston Post Road	~15 Acres	Dispersal and Plant	Adequate size, needs fill to get dispersal potential, evaluated earlier
31	Spencer Plain Road Parcel	NO	52 Spencer Plain Road	~6 Acres	Plant	Adequate size, needs significant fill to get dispersal potential, evaluated earlier
36	Open Land - Ingham Hill Road	NO	155 Ingham Hill Road	8 Acres	Dispersal and Plant	Adequate size, unsure of current use, appears mostly vacant, beneficial combined use with adjacent parcel
38	Roam Tree Road (Private Road) Properties	NO	330 - 340 Boston Post Road	~10 Acres	Dispersal and Plant	Adequate size, rock and contamination may limit dispersal
42	Open Land - Ingham Hill Road	YES	Ingham Hill Road	~60 Acres	Dispersal and Plant	Adequate size, water body in one corner, elevation changes
43	Fortune Plastics	NO	1 Williams Lane/103 Mill Rock Road East	~12 Acres	Dispersal	Adequate size, beneficial combined use

Moderately Suitable Sites Not Selected

SITE #	NAME	TOWN OWNED?	LOCATION	USABLE ACREAGE	POSSIBLE USE	RATIONALE
6	Private Property with Open Area	NO	37 Lynde Street	5.5 Acres	No	Near Downtown, private owner, would need to be "grouped"
7	Proposed Town Parking and Park	YES	34 Lynde Street; 225 Main St.	~1 Acre	No	Near Downtown, public resistance, would need to be "grouped"
8	Town Green	YES	302 Main Street	~4 Acres	No	Near Downtown, public resistance, would need to be "grouped"
9	Middle School Athletic Fields	YES	60 Sheffield Street	~5 Acres	No	Near Downtown, public resistance, would need to be "grouped"
11	Cornfield Point (Access Lots)	YES	Various locations in street rights-of-way	Unknown	No	Needs regulator review of required/Wick technology for dispersal
30	Police Station Site	YES	36 Lynde Street	3 Acres	No	Near Downtown, would need to be "grouped" and redeveloped
34	Open Land - Bokum Road	YES	185 Bokum Road	~22 Acres	No	Adequate size, Remote, potentially wet, Aquifer nerby
39	Private Business with open area for boat storage	NO	304 Boston Post Road	~2.75 Acres	No	Could be grouped later with Site #38
40	Private Business with buildings and an open area	NO	280 Boston Post Road	4 Acres	No	Could be grouped later with Site #38

Marginal Sites Deemed Not Feasible

SITE #	NAME	TOWN OWNED?	LOCATION	USABLE ACREAGE	POSSIBLE USE	RATIONALE
3	Ingham Hill Road	NO	60 Ingham Hill Road	~2 Acres	No	low, wet, flooding, and limiting constraints
4	Old Saybrook Shopping Center (Stop & Shop)	NO	665 Boston Post Road	Unknown	No	Existing development too extensive, existing on-site leaching fields
5	East Point Location	NO	North Main Street	0 Acres	No	Condominium development project
10	Clark Community Park	YES	170 Schoolhouse Road	~10 Acres	No	Ledge, limited dispersal, nearby lakes
12	Spencer Plain Road Parcel	NO	47 Spencer Plain Road	~2.00 Acres	No	Too small, too remote
13	Harvey's Beach - Parking Lot	YES	Plum Bank Road	3 Acres	No	Too low and shallow groundwater depth
14	Town Beach - Parking Lot	YES	Plum Bank Road	0.94 Acres	No	Too low, too small and shallow groundwater depth
15	Bowling Alley - Parking Lot	NO	923 Boston Post Road	1.8 Acres	No	Too small, large parking lot
16	Max's Place	NO	22 Spencer Plain Road	~ 3 Acres	No	Developed, and likely too small
17	Benny's - Parking Lot	NO	1654 Boston Post Road	3 Acres	No	Small available area, steep slope and muck in back, marginal potential
19	Open space north of Rte. 154	NO	Rte. 154 (Borough of Fenwick)	~7 Acres	No	limited capacity, critical habitat area, intermunicipal
20	Founders Park	YES	115 College Street	~9.5 Acres	No	Floodplain, low lying, public opposition to this site
21	Bushnell Farm	NO	1405 Boston Post Road	8 Acres	No	Owner will not give access
22	Open Land near Donnelley	NO	1241(&1235) Boston Post Road	1.5 Acres	No	small parcel, hilly, rocky, power lines overhead
23	Maple Avenue Playground	YES	105 Maple Avenue	1.73 Acres	No	small, low, and remote
24	Church Parking Area.	NO	36 Great Hammock Road	2.5 Acres	No	some potential, but small
25	Vacant Land	NO	1325 Boston Post Road	2.86 Acres	No	Too small and low lying, wet
26	Private Property with Open Area	NO	134-140 Old Boston Post Road	5 Acres	No	wet, densely wooded, potentially low
27	Land for sale	NO	1237 Boston Post Road	0.8 Acres	No	too small, wetlands on site
28	Vacant Land	NO	192 Old Boston Post Road	1 Acre	No	too small, wetlands on site
32	Fireman's Field	YES	210 Elm Street	~1 Acre	No	small site, low and wet, extensive fill needed
33	North of Donnelley between I-95 and Railroad Tracks	NO	90 Schoolhouse Road	25 Acres	No	previously evaluated, marginal hydraulic capacity
35	Land behind Transfer Station	YES	Bokum Road	~ 1 Acre	No	low area, limited usable space, aquifer protection area
37	Open land - adjacent to Transfer Station	YES	Brenda Lane	< 1 Acre	No	low area, limited usable space, aquifer protection area
41	Open land for sale	NO	215 Elm Street	~2 Acres	No	predominately low areas and tidal wetlands



OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT

PROSPECTIVE EFFLUENT DISPERSAL SITES

PROJ NO:	DATE:
13171B	Aug 2018

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FIGURE: 3-1

JMN W:\GIS_Development\Projects\CT\OldSaybrook\13171_WW-DispersalSites\MXDs\Revised_Aug2018\3-1_EffluentSites.mxd

3.2 PRELIMINARY DISPERSAL SITE CAPACITY ANALYSIS

The goal of this phase of the desktop evaluation was to assess the potential subsurface dispersal capacity of each of these nine sites to accept treated effluent. Sites 1 and 2 were evaluated in 2015 by conducting preliminary field investigations including digging test pits, conducting borings, and installing piezometers to monitor ground water levels. These data were then used to conduct a preliminary groundwater mounding analysis of the available areas to determine potential capacity. The field investigations were overseen by Leggette, Brashears & Graham, Inc. (LBG) and the computer groundwater mounding analysis was also performed by LBG. It is noted that LBG is now part of WSP Global, Inc, however, they will continue to be referred to as LBG throughout this report.

Because these two sites did not have sufficient capacity to meet the needs of a community wastewater system for the five remaining focus areas, additional sites were identified to be included in this desktop evaluation. The additional seven sites were analyzed, and a preliminary groundwater mounding analysis was conducted utilizing available published site information, but no field work was conducted on these seven sites at this time. If, based on the desktop analysis, enough capacity was determined to potentially be available, and it was technically feasible and cost-effective to proceed with subsurface dispersal, additional field investigations would be performed on selected sites to verify available capacity.

3.2.1 Preliminary Site Capacity Analysis Approach

To develop a preliminary capacity assessment of these additional sites, LBG, Wright-Pierce, WPCA staff, and CT DEEP staff first conducted site visits to each site to get an understanding of the existing topography and observable surface features. LBG then worked with Wright-Pierce to obtain available published geologic and hydrogeologic data for the sites including information contained in past studies conducted by the Old Saybrook WPCA as well as available information from the Connecticut Department of Health (CT DPH) and the CT DEEP.

Based on information obtained during the site visits and existing available parcel maps, a preliminary site layout of potentially available areas for effluent dispersal systems was prepared for each of the nine selected sites. LBG then used a simplified computer model to simulate various hydraulic loading conditions on these sites and to evaluate the associated groundwater mound. The model was initially run at the CT DEEP maximum allowable loading rate of 1.2 gpd/ft^2 (gallons per day per square foot) and the resulting impact on the groundwater mound was evaluated. The goal of these computer simulations was to estimate how much flow could be applied to each site while still maintaining a two-foot separating distance between the bottom of the proposed leaching facilities and the top of the groundwater mound that would develop after a sustained loading. When the loading rate was adjusted to the point where there was two-foot separating distance, this was considered the maximum capacity of that site. For some sites, it was not possible to achieve these separating distances at current grade and it was assumed that up to 3.5 feet of engineered fill would be added to the site to achieve the required separation.

It is recognized that the preliminary layouts utilized to conduct the mounding analysis may not reflect required setbacks in all cases and that the analysis does not address travel time. As noted previously, if the desktop evaluation indicates that a community wastewater treatment system with subsurface dispersal is technically feasible and cost-effective, further investigations would be required to verify the actual capacity of each site and to develop subsurface dispersal system layouts that comply with standard design criteria such as required setbacks from property boundaries, existing structures, wetlands and other points of concern, travel time to sensitive receptors, and available reserve capacity. Until and unless these field investigations are completed, the actual capacity of specific parcels cannot be verified, and it is noted that the actual capacity of each site could be less than that predicted as part of this desktop evaluation.

3.2.2 Preliminary Hydraulic Capacity Findings

Technical reports and memoranda prepared by LBG providing additional information on their preliminary groundwater mounding analysis and site capacity analysis are presented in Appendix B. A brief discussion of the results of these evaluations is presented below for each of the sites.

3.2.2.1 Site 1 - Old Saybrook High School

Initially, four separate potential dispersal areas were identified at the Old Saybrook High School site including the front parking lot, baseball field, soccer field, and softball field. The area associated with the softball field was eliminated from consideration due to shallow depth to bedrock determined during field investigations. The preliminary loading rates for the three potential dispersal areas at the Old Saybrook High School were estimated to range between 0.3 and 0.8 gpd/ft^2.

The potential capacity of Site 1 was estimated to be 151,400 gpd. This estimate is based on the use of conventional infiltration chambers. It may be possible to obtain additional capacity by using a shallower subsurface dispersal system. As noted in the LBG report, the ground water mounding analysis allowed for a subsurface dispersal system that was one-foot shallower than for a conventional system. Utilizing a shallow dispersal system, the potential capacity of the High School site could increase to 219,500 gpd. These shallow dispersal systems would be evaluated in more detail if a community system with subsurface dispersal is determined to be technically feasible and cost-effective.

3.2.2.2 Site 2 - Donnelley Property

Three separate potential dispersal areas were identified on the Donnelly property. During subsequent field investigations the depth to bedrock and/or groundwater was less than five feet in several areas. Based on these findings, the area at the southern side of this site was eliminated from consideration and the remaining areas were reduced in size. Additionally, based on the groundwater mounding analysis, the area along the eastern portion of this site was eliminated due to interference with subsurface dispersal in nearby areas on Site 1 (Old Saybrook High School) and maximize the simulated combined capacity between these two adjacent sites.

The preliminary groundwater mounding analysis was conducted for a small portion of the Donnelly property located in the northwest corner. The total capacity of this site was estimated to be 18,700 gpd. As with the High School site, if a shallower subsurface dispersal system could be installed, the capacity of this site could be increased to 27,100 gpd.

3.2.2.3 Site 18 - Fenwick Golf Course

Unlike Sites 1 and 2, the remaining sites were conducted as part of the desktop evaluation using published geologic and hydrogeologic reports. For Site 18, information from a nearby CT DPH well completion report was also available. Published soils data for the site were obtained from the National Resources Conservation Service (NRCS). These data indicate a restrictive layer may be present at a depth of approximately 2.17 feet below grade. It was not possible to conduct field investigations to confirm the presence of this restrictive layer. Therefore, the preliminary groundwater modeling was conducted based on the presence of this layer. Because this layer is only 2.17 feet below grade, it is not possible to meet the mounding separation distance of two feet at any flow rate. Based on the assumption that the bottom of the leaching system would be installed approximately three feet below grade, the top of the mound could not increase to more than five feet below grade.

Assuming a restrictive clay layer at 2.17 feet below grade, LBG conducted the preliminary groundwater modeling assuming that 3.5 feet of engineered fill would need to be added to the site to accept treated effluent. LBG based the preliminary groundwater mounding analysis on 23 subsurface disposal system areas across the site. They estimated that, with 3.5 feet of engineered fill added across the site, a capacity of approximately 134,000 gpd could be realized.

Although Site 18 has significant potential dispersal capacity available, a variety of other issues were considered when evaluating the feasibility of this site including:

- As shown in Figure 3-1, a significant portion of the site is located within the 100-yr flood zone and additional portions are located in the 500-yr flood zone.
- The site is not usable without the addition of a significant depth of engineered fill. The cost of adding this fill would increase the capital cost of this alternative.
- The site is not near the potential community system WPCF location being considered.
- The site is a private golf course, which is open to the public at times. The addition of fill to accommodate a subsurface dispersal system would require significant reconstruction of the golf course and would also result in a significant disruption in the use of the course while construction occurs.
- The Borough of Fenwick and not the Town of Old Saybrook is responsible for overseeing the operation of this facility.

For these reasons, Site 18 has been eliminated from further consideration as a potential subsurface dispersal site.

3.2.2.4 Site 29 - Gardella Property

Dispersal capacity for this site was previously evaluated by Fuss & O'Neill in 1998. As part of the desktop analysis, the prior study report prepared by Fuss & O'Neil and published geologic and hydrogeologic reports were obtained for the Gardella property. These data indicate that there is shallow bedrock and/or depth to water beneath most of this site and that it would not be possible to achieve the required separation distance between the groundwater mound and the bottom of the leaching system. To conduct the preliminary groundwater mound analysis, LBG assumed that 3.5 feet of engineered fill would need to be placed. The model results, based on an additional 3.5 feet of engineered fill across the entire site, predicted a preliminary treated effluent dispersal capacity of 40,500 gpd.

Site 29 has limited potential dispersal capacity available. In addition, the following issues were also considered when evaluating the feasibility of this site including:

- As shown in Figure 3-1, this site is located within the 100-yr flood zone.
- The site is not usable without the addition of a significant depth of engineered fill. The cost of adding this fill would increase the capital cost of this alternative.
- The site privately owned, currently in use and is likely not available to the Town.

For these reasons, Site 29 has been eliminated from further consideration as a potential subsurface dispersal site.

3.2.2.5 Site 31 – Spencer Plain Road

Dispersal capacity for this site was previously evaluated by Fuss & O'Neill in 2002. A preliminary design report was developed for a subsurface dispersal system at this site, however, it would require significant quantities of engineered fill (up to 20 feet) and would require the construction of retaining walls to direct the treated effluent away from adjacent properties.

As part of the desktop analysis, the prior study report was reviewed to understand the site constraints. A site visit was also conducted with the WPCA staff, CT DEEP staff, LBG, and Wright-Pierce. Standing water was observed throughout the areas available for subsurface dispersal during the site visit. These observations along with the significant quantities of engineered fill and the need for retaining walls resulted in a consensus among all parties that this site would not have capacity to accept treated effluent for subsurface dispersal. Therefore, this site was removed from further consideration.

3.2.2.6 Site 36 – Ingham Hill Road (Private)

Four potential dispersal areas were identified on the property at 155 Ingham Hill Road. As part of the desktop evaluation, available published geologic and hydrogeologic data were reviewed and a preliminary mounding analysis was developed by LBG. Based on available data, LBG indicated that there is a restrictive layer under most of the potential subsurface dispersal system area at a depth of approximately 2.2 feet below grade. Because of this restrictive layer, it would be necessary to place 3.5 feet of engineered fill across the site to provide the required two-foot separation distance between the bottom of the leaching system and the groundwater mound.

The model results, based on an additional 3.5 feet of engineered fill across the entire site, predicted a preliminary treated effluent dispersal capacity of 28,000 gpd.

Site 36 has limited potential dispersal capacity available. In addition, the following issues were also considered when evaluating the feasibility of this site including:

- The site is not usable without the addition of a significant depth of engineered fill. The cost of adding this fill would increase the capital cost of this alternative.
- Even with significant fill, the capacity of the site is limited.
- The site privately owned and currently in use and is likely not available to the Town.

For these reasons, Site 36 has been eliminated from further consideration as a potential subsurface dispersal site.

3.2.2.7 Site 38 - Roam Tree Road Properties

The Roam Tree Road properties include eight parcels (306, 330, 332, 334, 338, 340, 342 and 344 Boston Post Road) near Route 1. As part of this evaluation, LBG reviewed the available published geologic and hydrogeologic data for the site, including hydrogeologic investigations conducted by the United States Geologic Survey (USGS) (Handman and Bingham, 1980). LBG also reviewed data from an environmental site investigation conducted by Tighe & Bond, Inc. in 2017, which included 47 soil borings that were performed for environmental testing without laboratory soil sampling. During the site visit with WPCA staff, CT DEEP, LBG, and Wright-Pierce, it was noted that large portions of the properties are covered with large boulders and cobbles.

Based on available data, LBG indicated that there is shallow bedrock and/or depth to groundwater beneath most of this site that is less than five feet below grade. Because of this limitation, it would be necessary to place 3.5 feet of engineered fill across the site to provide the required two-foot separation distance between the bottom of the leaching system and the groundwater mound. Based on the available site information and preliminary groundwater modeling, LBG estimated that this site has a capacity of approximately 47,000 gpd if an additional 3.5 feet of engineered fill is used.

3.2.2.8 Site 42 - Ingham Hill Property (Town Owned)

The Town of Old Saybrook owns a parcel along Ingham Hill Road just south of the privately-owned parcel identified as Site 36. During the site visit, it was observed that there are bedrock outcrops visible and that Lake Rockview occupies the southeast portion of the site. Based on available NRCS data, LBG indicated that there are restrictive layers of soils averaging approximately 1.93 feet below grade under most of the potential subsurface dispersal system area. Because of these restrictive soils, it would be necessary to place 3.5 feet of engineered fill across the site to provide the required two-foot separation distance between the bottom of the leaching system and the groundwater mound. The model results, based on an additional 3.5 feet of engineered fill across the entire site, predicted a preliminary treated effluent dispersal capacity of 41,000 gpd.

3.2.2.9 Site 43 – Parcels on Mill Rock Road East

Site 43 consists of three separate parcels totaling over 12 acres, bounded by Mill Rock Road East, North Main Street and the Amtrak Railroad tracks. LBG conducted a site visit with the WPCA staff and obtained information from previous site investigations from the public records at the DEEP. Preliminary groundwater modeling was conducted using this information and the assumptions previously discussed for modeling on the other sites.

Based on the preliminary groundwater modeling LBG indicated that the site has an estimated capacity of 66,500 gpd but that a minimum of one foot of engineered fill needs to be incorporated into certain areas of the site west of the potential subsurface dispersal systems. The capacity of Site 43 could be increased to approximately 100,000 gpd if 3.5 feet of engineered fill is added to the site.

3.3 SUMMARY OF POTENTIAL EFFLUENT DISPERSAL CAPACITY

As discussed in Section 2, approximately 318,200 gpd of dispersal capacity is required to dispose of effluent from a community wastewater system serving 740 parcels. Additional capacity is also required at each site for hydraulic reserve capacity. The DEEP typically requires a 50% hydraulic reserve capacity, although less capacity may be warranted if the wastewater design flow for the dispersal system is considered to be conservative. As noted in Section 2, the required dispersal capacity was calculated based on the DPH design flow criteria of 150 gpd per bedroom. This design flow includes safety factors to ensure that sewage systems for individual homes and other residential buildings operate satisfactorily under peak flow conditions. The conservative nature of these safety factors is cumulative when applied to a large community system as it is unlikely that all of the parcels served by the system would experience peak flow conditions at the same time. Because of the conservative nature of the sizing criteria utilized, the DEEP may be willing to consider a reduction in the hydraulic reserve requirements during the preliminary design phase if a community system with subsurface dispersal is the recommended alternative. A summary of the potentially available capacity for each site evaluated is presented in Table 3-2 below.

TABLE 3-2

SUMMARY OF POTENTIAL SUBSURFACE DISPERSAL CAPACITY

Site No.	Description	Estimated Capacity, gpd
1	Old Saybrook High School[1]	151,400/219,500
2	Donnelly Property[1]	18,700/27,100
18	Fenwick Golf Course	(not feasible)
29	Gardella Property	(not available)
31	Spencer Plain Road Parcel	(not feasible)
36	Ingham Hill Road (Private Site)	(not available)
38	Roam Tree Road Parcels (w/fill)	47,000
42	Ingham Hill Road (Town-Owned Site) (w/fill)	41,000
43	Mill Rock Road East Parcels (w/fill)[2]	65,600/100,000
	TOTAL POTENTIAL CAPACITY	**323,700/434,600**

Notes:

1. The estimated capacity of the sites shown in Table 3-2 is based on the use of conventional leaching chambers for the subsurface dispersal systems. In previous work done in 2015 by LBG, it was noted that additional capacity may be available at Site 1 and 2 if a shallower dispersal system, such as drip irrigation, were utilized. The second number shown for Sites 1 and 2 and the total potential capacity is based on the use of a shallower leaching system.
2. The first number shown for Site 43 is based on the addition of one foot of engineered fill being placed on certain areas of the site. The second number for Site 43 is based on the addition of 3.5 feet of engineered fill across the entire dispersal area.

If the five sites considered feasible under this desktop evaluation can accept the dispersal capacity estimated based on preliminary groundwater modeling, and if these sites are obtainable by the WPCA for use as effluent dispersal sites, up to 323,700 gpd of capacity may be available. Depending on the type of dispersal system utilized and amount of additional engineered fill, it may be feasible to increase this capacity to as much as 434,600 gpd. Based on the required design capacity of 318,200 gpd, this would provide for a reserve capacity of between 5,500 gpd and 116,400 gpd, or 1.7% to 36.6% of the required dispersal capacity, which is less than the typical 50% reserve required by DEEP.

While the total estimated capacity of these five sites is considered feasible as part of this desktop evaluation for the 740 parcels to be served by a community wastewater system, no one site is adequate. The capacity of some sites is not assured and would require significant additional field investigations and in-situ hydraulic loading tests to verify capacities. ***In addition, some of the sites may not be available to the Town for use as dispersal sites. These sites were utilized for the***

purpose of developing preliminary cost comparisons between various alternatives. Sites were identified that were potentially available at the beginning of the study, however, the status of some sites may have changed over the course of the evaluation.

The use of multiple sites for effluent dispersal will result in added capital costs both to convey treated effluent to the dispersal sites and for installation of the dispersal systems. For the present worth cost analysis of a community system with subsurface dispersal included in Section 7 of this report, it was assumed that treated effluent would be conveyed to the five dispersal sites identified in Table 3-2 (Old Saybrook High School, Donnelly property, Roam Tree Road parcels, Ingham Hill Road Town-owned parcel, and the Mill Rock Road East parcels). While it is recognized that these five sites provide slightly less capacity than required when considering reserve capacity, it was determined to be sufficient to demonstrate whether or not this alternative is cost-effective.

Following completion of the draft report, the DEEP had indicated that it may be possible to reduce the number of sites utilized for subsurface dispersal through the inclusion of a post-equalization/treated effluent storage tank to minimize peak flows discharged to the dispersal systems. As shown in Table 3-2, Sites 38 and 42 provide just over 20% of the available capacity but require a significant dispersal area with potentially excessive capital costs. Because the DEEP has indicated that the use of a treated effluent storage tank may be allowable to reduce the required reserve capacity requirements, a present worth cost analysis was conducted assuming that only Site Nos. 1, 2, and 43 would be utilized and that an effluent equalization tank would be provided in lieu of significant reserve capacity. This second cost-effective analysis is also presented in Section 7 of this report.

Section 4

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SECTION 4

WASTEWATER TREATMENT TECHNOLOGY EVALUATION

4.1 APPROACH

The community wastewater treatment system will consist of a centralized Water Pollution Control Facility (WPCF) to treat wastewater collected from the five remaining focus areas. Two proposed sites for the WPCF were selected as part of the site screening analysis based on their proximity to the focus areas, availability, and distance from the proposed dispersal sites and Connecticut River discharge sites. ***As noted previously, the status of these sites may have changed over the course of the evaluation and some sites may no longer be available to the Town.***

4.2 TREATMENT TECHNOLOGY ALTERNATIVES

To develop the preliminary opinion of capital cost and annual operation and maintenance costs for a community treatment system water pollution control facility (WPCF), five different treatment technologies were considered that can meet the effluent quality criteria identified in Section 2. These technologies included:

- Sequencing Batch Reactors (SBR),
- Membrane Bioreactors (MBR),
- Moving Bed Biofilm Reactors (MBBR),
- Amphidrome®, and
- Oxidation Ditch.

A preliminary screening evaluation of each technology was conducted. Specific criteria were ranked on a scale from 1 to 5 for each alternative. Ranking criteria are separated into two categories to scale their importance in the rankings. Primary criteria have higher rankings (from 3 to 5) and secondary criteria have lower rankings (1 to 3).

The resulting rankings are presented in Table 4-1.

TABLE 4-1

INITIAL TREATMENT TECHNOLOGIES RANKINGS

	Ranking				
Criteria	**SBR**	**MBR**	**MBBR**	**Amphidrome®**	**Oxidation Ditch**
PRIMARY CRITERIA					
Land Requirements	4	5	4	4	4
Capital Cost	4	3	3	3	4
O&M Cost	4	3	3	3	4
Energy Usage	5	3	4	4	4
Ease of Operation	5	4	3	3	4
Public Acceptability	4	5	4	4	3
SECONDARY CRITERIA					
Odor Potential	2	2	2	2	1
Noise Potential	2	2	2	2	1
Climatic Vulnerability	2	2	2	2	2
Reliability	3	2	2	2	3
Biosolids Production	2	2	2	2	3
TOTAL	**37**	**33**	**31**	**31**	**32**

Rankings Key:

Primary Criteria
3 – Sub-optimal
4 – Average
5 – Optimal

Secondary Criteria
1 – Sub-optimal
2 – Average
3 – Optimal

Based on the above preliminary screening evaluation, three technologies were selected for use in developing preliminary capital and annual operations and maintenance costs for a community system WPCF. The selected alternatives consist of:

- Sequencing Batch Reactor (SBR)
- Membrane Bioreactor (MBR)
- Alternative No. 3 – Oxidation ditch activated sludge system with secondary clarifiers

To evaluate the capital and operations and maintenance costs of each of these three alternative technologies, system suppliers were contacted and provided with the Basis of Design criteria presented in Tables 2-1 and 2-2. The system suppliers provided preliminary equipment sizing and budgetary costs as well as estimates of chemical and power consumption requirements. A brief description of each of these three technologies is presented below.

4.2.1 Sequencing Batch Reactor (SBR)

The SBR is an activated sludge process that provides for both treatment and solids separation in a single reactor. The reactor operates in batches in which the following stages of treatment occur: fill, react, settle, decant, and idle. To achieve biological nitrogen removal, the fill and react portions of the cycle can be operated under both anoxic and aerobic conditions. Typically, SBR facilities include a minimum of two identically equipped reactors in parallel. This allows one SBR to be operating in the "fill" and "react" portions of the cycle while the second SBR is in a settle or decant cycle. Information received from the system manufacturer indicates that it is possible to utilize the SBR process to achieve the required 12-month average effluent total nitrogen discharge of 2.57 lb/d. However, consistently achieving the equivalent concentration of 4 mg/L may be difficult. Therefore, for the purposes of this cost comparison, it has been assumed that denitrification filters would be incorporated into the process as a tertiary polishing step. If the community system alternative moves forward and the SBR process is selected, a more detailed evaluation of the ability of the SBR to achieve the effluent requirements with and without a denitrification filter will be completed during the preliminary design phase.

A schematic of an SBR process designed for total nitrogen reduction is shown in Figure 4-1. A site layout for a typical SBR process designed to treat an average daily flow of 77,000 gpd is shown in Figure 4-2.

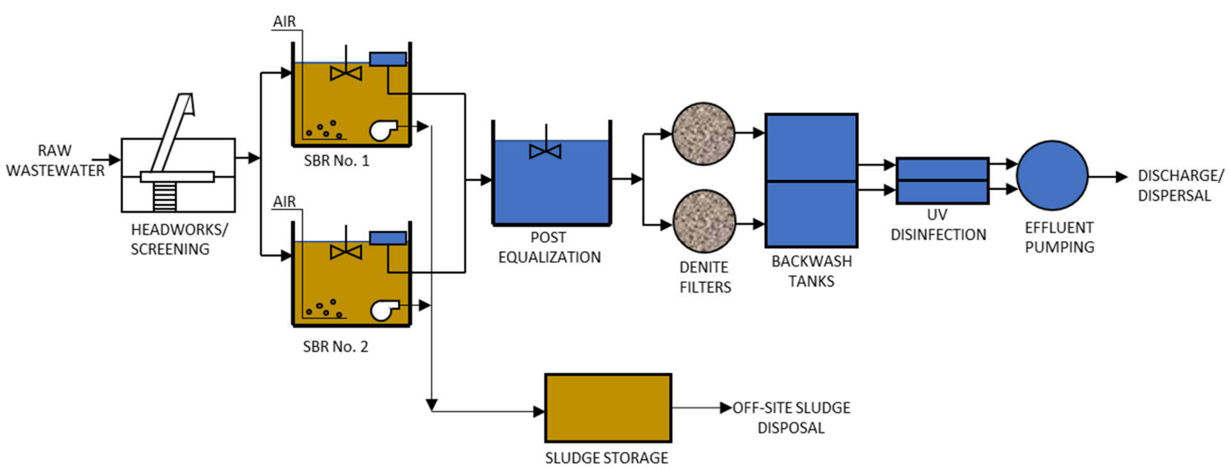
The proposed SBR facility was sized based on process calculations performed by the system manufacturer. The system manufacturer also identified ancillary systems and equipment that would be required. Wright-Pierce developed preliminary sizing criteria for these ancillary systems to develop the cost comparison. The proposed SBR treatment system includes the following unit processes based on recommendations from the system manufacturer:

- A new Headworks Building with the following components:
  - One Mechanically-Cleaned Fine Screen,
  - A by-pass channel with a manually-cleaned bar rack,
  - Electrical/Control room for electrical equipment and control panels
  - Flow distribution to the SBR tanks

- Two SBR tanks equipped with removable diffuser rack, floating mixer, submersible waste sludge pumps, and decant assembly
- One post Equalization tank equipped with mixing and discharge pumps
- A new Effluent Building equipped with the following components:
  - UV disinfection system with redundancy
  - Two effluent denitrification filters and associated backwash system
  - Space for aeration blowers
  - Electrical/Control room for electrical equipment and control panels
- One effluent pump station equipped with duplex discharge pumps (for subsurface dispersal of treated effluent, multiple pumps of varying head/capacity may be required to convey flow to the various dispersal sites, but this was not included in the cost comparison and should be the same for each of the selected treatment technologies)
- One sludge storage tank with mixing

FIGURE 4-1

SBR PROCESS FLOW DIAGRAM



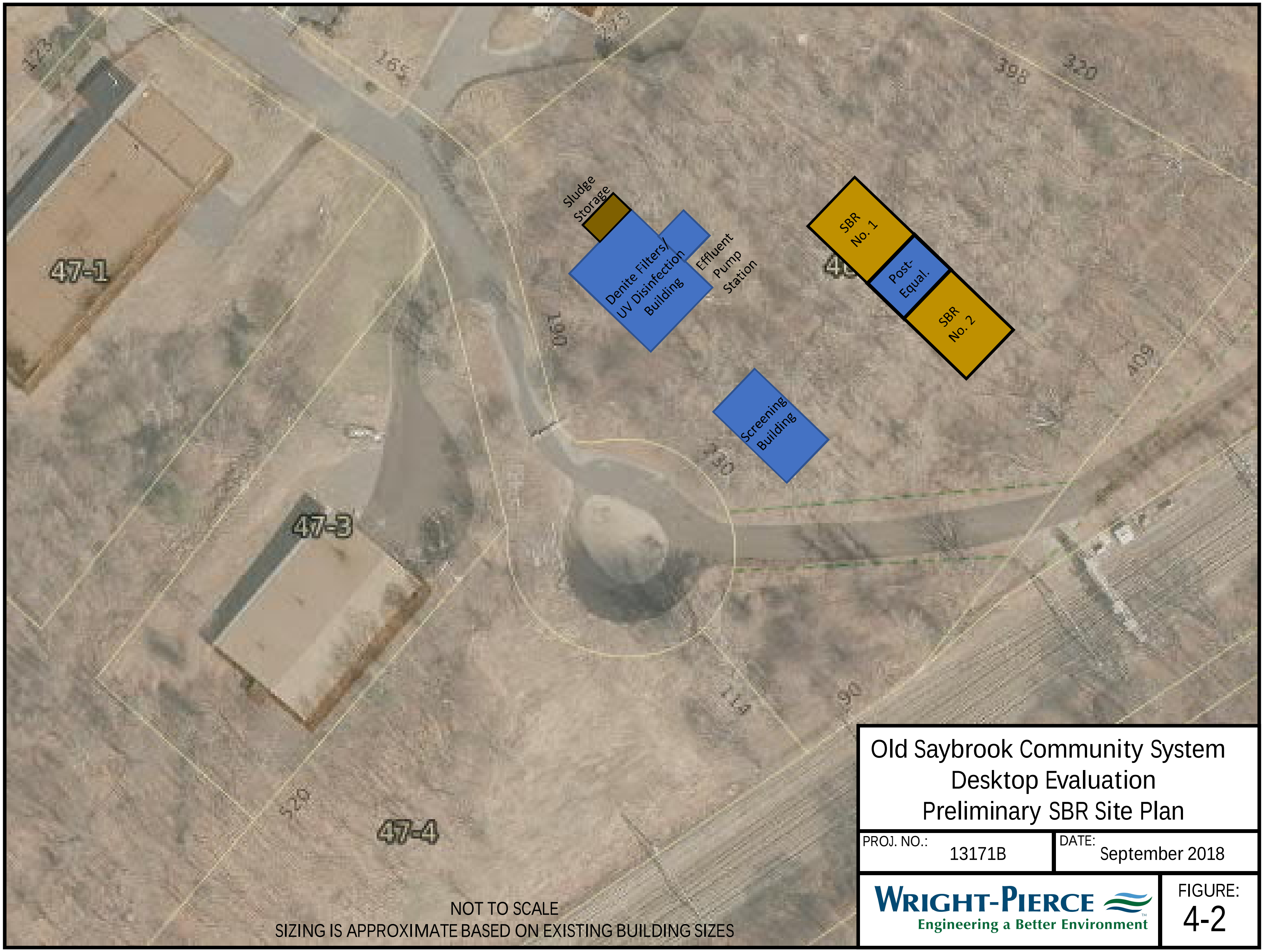


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FIGURE: 4-2

4.2.2 Membrane Bioreactor (MBR)

The MBR system is similar to a conventional activated sludge process with the exception that membranes are used to separate suspended solids from the treated effluent instead of secondary clarifiers. Because the membranes provide for better solids separation than secondary clarifiers, it is possible to carry a higher mass of biosolids in the activated sludge reactors, resulting in smaller tanks. Total nitrogen is removed by a four-stage process utilizing a series of aerobic and anoxic processes to achieve nitrification and denitrification. An internal nitrate recycle system is utilized to return nitrates generated in the aerobic tank back to the first anoxic tank. A return activated sludge loop is provided to return mixed liquor suspended solids back to the head of the process to maintain biological activity. Membrane units located in the membrane tank filter out solids to produce a high-quality effluent. A schematic of a MBR process designed for total nitrogen reduction is shown in Figure 4-3. The site layout for a typical MBR process designed to treat 77,000 gpd is shown in Figure 4-4.

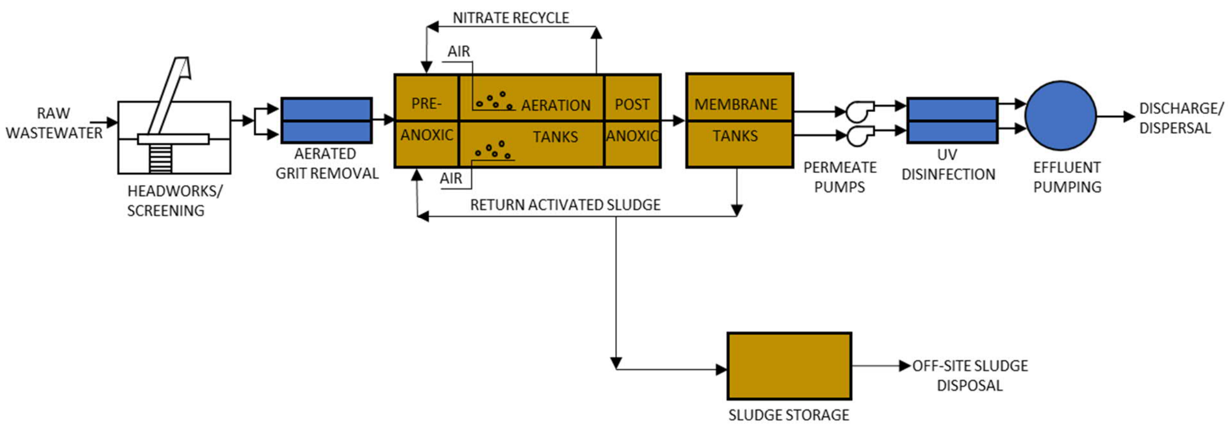
The proposed MBR facility was sized based on process calculations performed by the system manufacturer. The system manufacturer also identified ancillary systems and equipment that would be required. Wright-Pierce developed preliminary sizing criteria for these ancillary systems to develop the cost comparison. The proposed MBR treatment system includes the following unit processes based on recommendations from the system manufacturer:

- A new Headworks Building with the following components:
  - One Mechanically-Cleaned Fine Screen,
  - A by-pass channel with a manually-cleaned bar rack,
  - Electrical/Control room for electrical equipment and control panels
  - Blowers for aerated grit removal
- Two aerated grit tanks
- Two biological treatment trains consisting of:
  - Pre-anoxic tanks
  - Aeration tanks
  - Post-anoxic tanks
  - Membrane tanks

- A new Effluent Building equipped with the following components:
  - UV disinfection system with redundancy
  - Space for aeration blowers for aeration tanks and membrane tanks
  - Electrical/Control room for electrical equipment and control panels
  - Chemical storage / membrane cleaning equipment
- One effluent pump station equipped with duplex discharge pumps (for subsurface dispersal of treated effluent, multiple pumps of varying head/capacity may be required to convey flow to the various dispersal sites, but this was not included in the cost comparison and should be the same for each of the selected treatment technologies)
- One sludge storage tank with mixing

FIGURE 4-3

MBR PROCESS FLOW DIAGRAM



Old Saybrook Community System
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Preliminary MBR Site Plan

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FIGURE: 4-4

4.2.3 Oxidation Ditch

The oxidation ditch is a conventional activated sludge process in which the mixed liquor is circulated around a closed-loop reactor vessel. Aeration and mixing/motion of the mixed liquor is provided by rotating brush aerators. Based on how the aerators are operated, different portions of the reactor can be operated in either anaerobic, anoxic, or oxic modes to provide for biological nitrogen and phosphorus reduction. The use of a closed-loop type oxidation ditch process will also enhance biological nitrogen and phosphorus removal by allowing the reactors to operate in series as well as in parallel. Additional anoxic and/or aeration zones can be added outside of the oxidation ditches for additional biological nutrient removal. Secondary clarifiers are utilized to separate the mixed liquor suspended solids and return them to the reactor. Based on information provided by the system manufacturer, typical nitrogen removal capacity is approximately 5 mg/L. Similar to the SBR treatment technology, consistently achieving the equivalent concentration of 4 mg/L may be difficult with the oxidation ditch. Therefore, for the purposes of this cost comparison, it has been assumed that denitrification filters would be incorporated into the process as a tertiary polishing step. If the community system alternative moves forward and the oxidation ditch process is selected, a more detailed evaluation of the ability of the SBR to achieve the effluent requirements with and without a denitrification filter will be completed during the preliminary design phase.

A schematic of an oxidation ditch process designed for total nitrogen reduction is shown in Figure 4-5. The site layout for a typical oxidation ditch process designed to treat 77,000 gpd is shown in Figure 4-6.

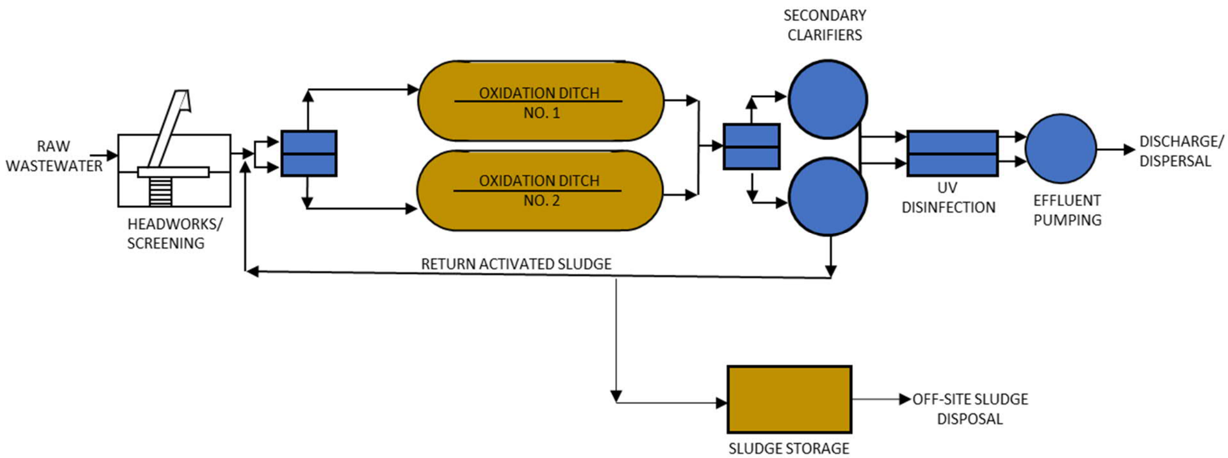
The proposed oxidation ditch facility was sized based on process calculations performed by the system manufacturer. The system manufacturer also identified ancillary systems and equipment that would be required. Wright-Pierce developed preliminary sizing criteria for these ancillary systems to develop the cost comparison. The proposed oxidation ditch treatment system includes the following unit processes based on recommendations by the system manufacturer:

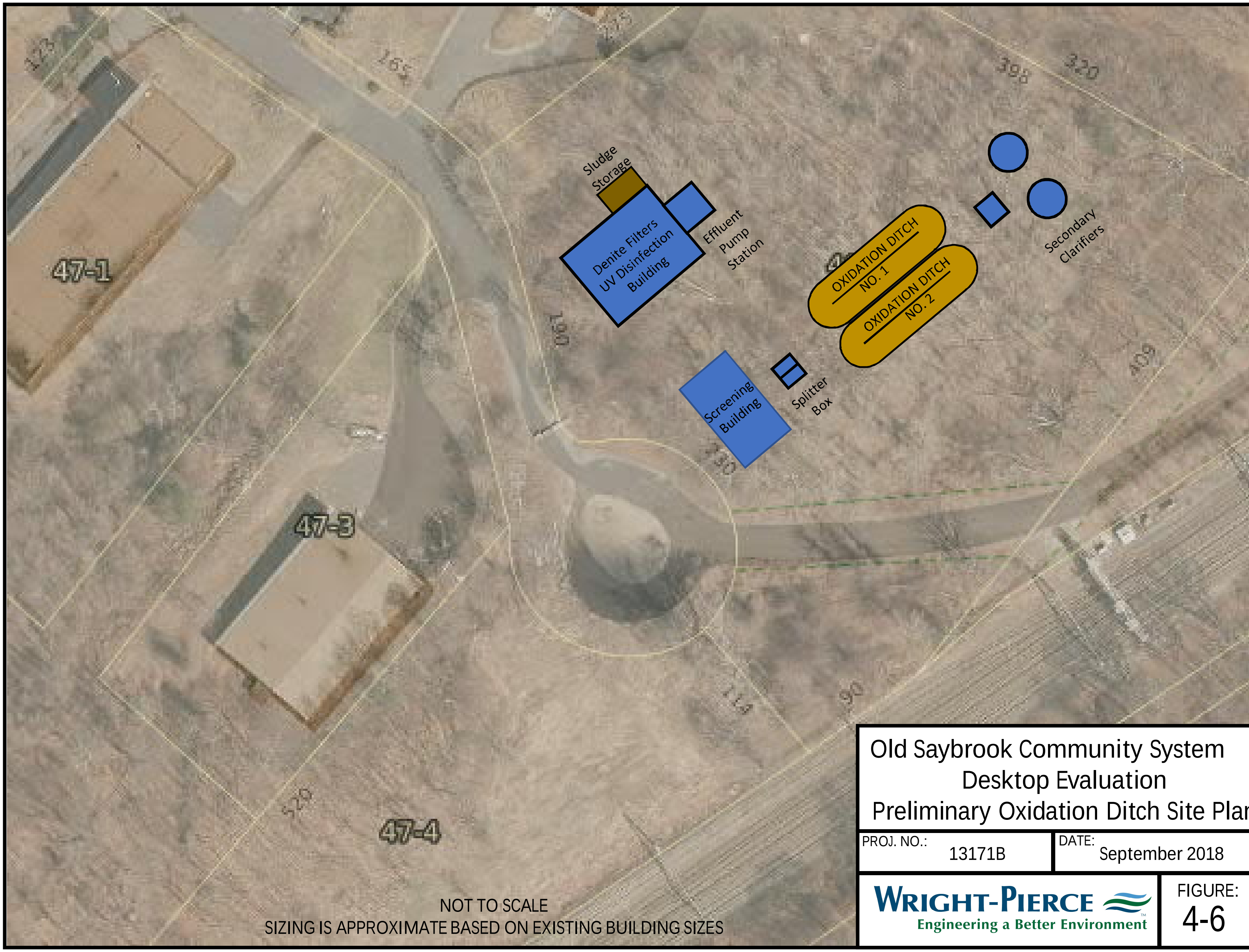
- A new Headworks Building with the following components:
    - One Mechanically-Cleaned Fine Screen,
    - A by-pass channel with a manually-cleaned bar rack,

- o Electrical/Control room for electrical equipment and control panels
- Flow splitter structure with actuated gates
- Two 63-foot long oxidation ditches
- Two 15-foot diameter secondary clarifiers
- A new Effluent Building equipped with the following components:
  - o UV disinfection system with redundancy
  - o Two effluent denitrification filters and associated backwash system
  - o Electrical/Control room for electrical equipment and control panels
- One effluent pump station equipped with duplex discharge pumps (for subsurface dispersal of treated effluent, multiple pumps of varying head/capacity may be required to convey flow to the various dispersal sites, but this was not included in the cost comparison and should be the same for each of the selected treatment technologies)
- One sludge storage tank with mixing

FIGURE 4-5

OXIDATION DITCH PROCESS FLOW DIAGRAM





Old Saybrook Community System
Desktop Evaluation
Preliminary Oxidation Ditch Site Plan

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FIGURE: 4-6

4.3 TREATMENT PLANT LOCATION ALTERNATIVES

Various sites were considered for the WPCF location based on the proximity to the five remaining focus areas, proximity to the potential dispersal/discharge locations, site availability, parcel size, site access, flood plains, etc. The minimum land area needed for the WPCF was estimated to be approximately 3 acres based on the typical layouts presented in Figures 4-2, 4-4, and 4-6. This 3-acre estimate was based on the space needed for the anticipated unit processes and associated buildings. Based on the information presented in these figures, the treatment plant layout requires approximately 1 acre of land. However, additional space should be left for potential future expansion and to account for required setbacks from the property line, assumed to be fifty feet. In addition, space for additional effluent equalization tankage may be required if the subsurface dispersal alternative is selected. Therefore, a minimum of 3-acres should be allowed to account for setbacks and future expansion. Based on these requirements, the following three sites with adequate area for WPCF were evaluated.

4.3.1 Donnelley Property

This parcel includes a commercial operation and large paved area. The entire parcel is 30 acres so only a portion of it would be required for the community system WPCF. It is envisioned that a portion of the parcel could be subdivided for the Town's use of the site for the WPCF. The site's flat topography would result in limited clearing and earthmoving necessary during construction.

4.3.2 Roam Tree Road Properties

These properties have been selected due to their location off Route 1 (Boston Post Road) which is part of a commercial area (known as Mariner's Way) and their proximity to the river discharge locations. In the future, if desired by the WPCA and the Town, the WPCF could be increased in size to allow for additional flows from potential economic development along Route 1. Increasing the number of connections would also help reduce the cost per user. For this location, there are several contiguous parcels owned by the same Owner and appropriate parcels can be purchased to accommodate a WPCF facility with minimal clearing and disturbance to the nearby parcels.

4.4 OPINION OF PROBABLE COSTS

The treatment technology evaluation and the WPCF locations described above formulated the basis for the capital and annual operation and maintenance cost estimates presented below. More detailed backup for these costs is included in Appendix C.

4.4.1 Capital Costs

Cost proposals were obtained from various treatment system manufacturers to develop a preliminary opinion of the WPCF capital costs. The system manufacturers included costs for the equipment and controls associated with their systems. Wright-Pierce developed separate preliminary estimates for ancillary equipment, tankage, site work, structural, electrical, instrumentation and HVAC costs not included in the manufacturer's budgetary cost proposals. The capital costs include an estimate for contractor's overhead and profit, bonds, and insurance, an inflation factor to the anticipated construction period and a contingency for unaccounted for items. The overall project capital costs also include an allowance for engineering design, construction administration, estimated land acquisition of the WPCF site, and a contingency for change orders during construction. The estimated project capital costs of evaluated treatment technologies are presented in Table 4-2.

TABLE 4-2

PRELIMINARY OPINION OF WPCF CAPITAL COSTS

Item/Technology	SBR	MBR	Oxidation Ditch
Headworks	$1,112,000	$1,103,000	$974,000
Grit Removal	N/A	$853,000	N/A
Biological Treatment System	1,642,000	$2,182,000	$1,261,000
Secondary Clarifiers	N/A	N/A	$745,000
Denitrification Filters	$965,000	N/A	$869,000
Disinfection - UV	$781,000	$859,000	$683,000
Process Building/Solids Handling	$1,321,000	$1,564,000	$1,143,000
Miscellaneous sitework	$840,000	$1,018,000	$768,000
Subtotal	**$6,661,000**	**$7,579,000**	**$6,443,000**
Allowance/Contingency	$2,653,000	$2,984,000	$2,578,000
Total	**$9,314,000**	**$10,563,000**	**$9,021,000**

4.4.2 Operation and Maintenance Costs

The operation and maintenance costs were developed utilizing estimates of electrical power, chemical and sludge removal requirements, as well as staffing for routine operation and maintenance based on other existing similarly-sized facilities. The estimated annual operation and maintenance costs for each treatment technology alternative is presented in Table 4-3.

TABLE 4-3

WPCF O&M COST ESTIMATE

Item/Technology	SBR	MBR	Oxidation Ditch
Personnel	$150,000	$150,000	$150,000
Electricity	$55,000	$75,000	$50,000
Chemicals	$15,000	$15,000	$15,000
Solids/Sludge	$24,000	$24,000	$22,000
Vehicle	$40,000	$40,000	$40,000
Maintenance	$20,000	$20,000	$22,000
Building Utilities	$19,000	$22,000	$18,000
Lab/Admin/Misc	$25,000	$25,000	$25,000
Total	**$348,000**	**$371,000**	**$342,000**

4.4.3 Present Worth Analysis

Present worth analysis was developed by calculating the present worth of the annual O&M costs assuming a 2% rate of inflation and a 20-year life cycle. The present worth of the annual O&M costs was then added to the capital costs to estimate the present worth of each alternative. The present worth of the different treatment technologies is presented in Table 4-4.

TABLE 4-4

WPCF PRESENT WORTH COST ESTIMATE

Item/Technology	SBR	MBR	Oxidation Ditch
Capital Cost	$9,314,000	$10,563,000	$9,021,000
Present worth of annual O&M Cost	$5,690,000	$6,066,000	$5,592,000
Present Worth	$15,004,000	$16,629,000	$14,613,000

4.5 RECOMMENDED ALTERNATIVE

The MBR process has the highest life-cycle cost of the three alternative technologies considered. The life-cycle cost of the SBR and oxidation ditch technologies are within less than 3% of each other. This is well within the anticipated accuracy range of the preliminary opinion of probable costs at this conceptual stage of the project. Therefore, other factors were considered in selecting the recommended technology.

As shown in Table 4-1, based on subjective ranking criteria, the SBR had a higher score than the oxidation ditch technology. The SBR and oxidation ditch processes are both relatively simple processes that can be run unattended when the operator is not on site through the use of computerized control systems and remote monitoring alarms. However, the SBR technology can better accommodate flow variations and seasonal variations and produce a consistent effluent quality. In addition, during the preliminary design phase, it may be determined that the SBR can achieve the desired effluent quality without the use of the denitrification filter which would reduce its capital cost to below that of the oxidation ditch technology. Therefore, if a community wastewater system is the selected alternative, it is recommended that the WPCF technology utilize a sequencing batch reactor process. During preliminary design, the need for an effluent denitrification filter can be further evaluated with the SBR system manufacturers.

Section 5

WRIGHT-PIERCE
Engineering a Better Environment™

SECTION 5

COLLECTION SYSTEM EVALUATION

5.1 COLLECTION SYSTEM ALTERNATIVES

Wright-Pierce evaluated three wastewater collection system technology alternatives for the five remaining focus areas, which include gravity, low pressure and vacuum systems. Wright-Pierce engaged Green Site Design, LLC to develop preliminary layouts for each of these collection system alternatives. These layouts are preliminary and were used to estimate the approximate length of piping and number of pump stations necessary to convey wastewater from the five focus areas to a centralized community wastewater facility so that cost comparisons could be developed. Similar routings were used for each of the alternatives so that costs of the different alternatives could be compared. However, modifications to these potential routings will be made during the preliminary design phase to identify a more cost-effective collection and conveyance system layout for the recommended alternative. These alternative layouts could include horizontal direction drilling across certain areas to minimize the length of piping required. Information provided by Green Site Design is included in Appendix D.

5.1.1 Conventional Gravity Sewer System

A conventional gravity sewer collection system is the most common system for municipal wastewater collection, and consists of gravity laterals and sewer mains, leading to localized pumping stations that convey flow via pressurized (force) mains. These systems work well in areas with natural elevation changes that allow for pipe depths to remain reasonably constant and relatively shallow. However, in areas that are flat, such as shoreline communities, these systems can become difficult to construct, as pipe trenches can become deep due to necessary pipe slopes. As the depth of the gravity lines become deeper, the cost and complexity of construction increases. If the pipe depth extends below the groundwater table, dewatering during construction is required. In addition, the systems required to temporarily support the pipe trench during excavation and installation become more complex and costly as well. The pump stations and main gravity sewers are typically owned and operated by the municipality, or an entity operating on behalf of the municipality, and the home owners own most or all of their property's lateral connection.

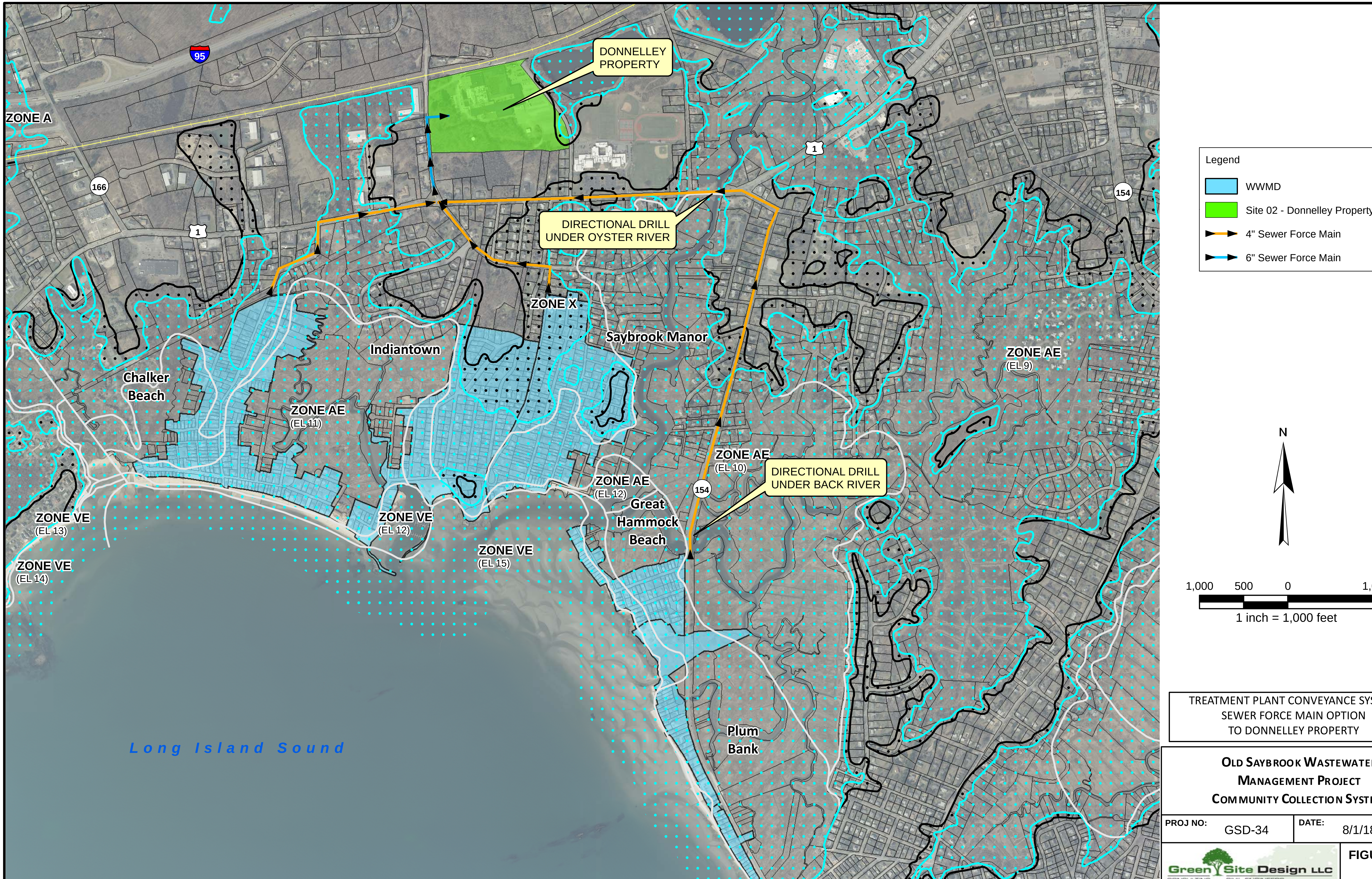
A preliminary gravity sewer, pump station and force main layout was prepared by Green Site Design, to serve the five focus areas. This preliminary layout is presented in Figures 5-1 through 5-4. Under this scenario, a total of four pump stations are anticipated to convey wastewater flows from the five focus areas to the treatment facility. To protect these pumps stations from storm impacts, they would be constructed at raised elevations based on the resiliency requirements presented in Section 2. Pump stations located within flood zones would be protected to one foot above the 500-yr flood elevation while stations closer to the shore may require additional requirements to protect against impacts from waves of 1.5 feet to 3 feet above this elevation.

5.1.2 Low Pressure Sewer System

A low-pressure sewer collection system consists of gravity laterals leading to small grinder pumps, typically with one grinder pump station serving each individual property. The small grinder pump discharge pipes then connect to a common low-pressure sewer main in the road to convey the wastewater flow to a centralized wastewater treatment facility or to a centralized wastewater pumping facility.

Low pressure sewer systems are well suited for flat low-lying areas such as shoreline communities. These systems can have challenges when pumping very-long distances and pumping up large elevation changes, due to the pumping power required, however, these issues are not anticipated to be a concern for Old Saybrook due to the relatively small elevation differences required to be overcome by the pumps. The individual grinder pumps could be owned and maintained by the municipality or by the individual homeowners, with maintenance being the responsibility of the ownership entity. The advantage of municipal ownership is that the construction costs for the grinder pumps would qualify for state funding assistance. A maintenance easement and user charge system are required between the municipality and property owner to provide necessary long-term funds for operation and maintenance of the grinder pumps.

A preliminary low-pressure sewer system layout was prepared by Green Site Design, to serve the five focus areas. This preliminary layout is presented in Figures 5-5 through 5-8.



TREATMENT PLANT CONVEYANCE SYSTEM
SEWER FORCE MAIN OPTION
TO DONNELLEY PROPERTY

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT COMMUNITY COLLECTION SYSTEM

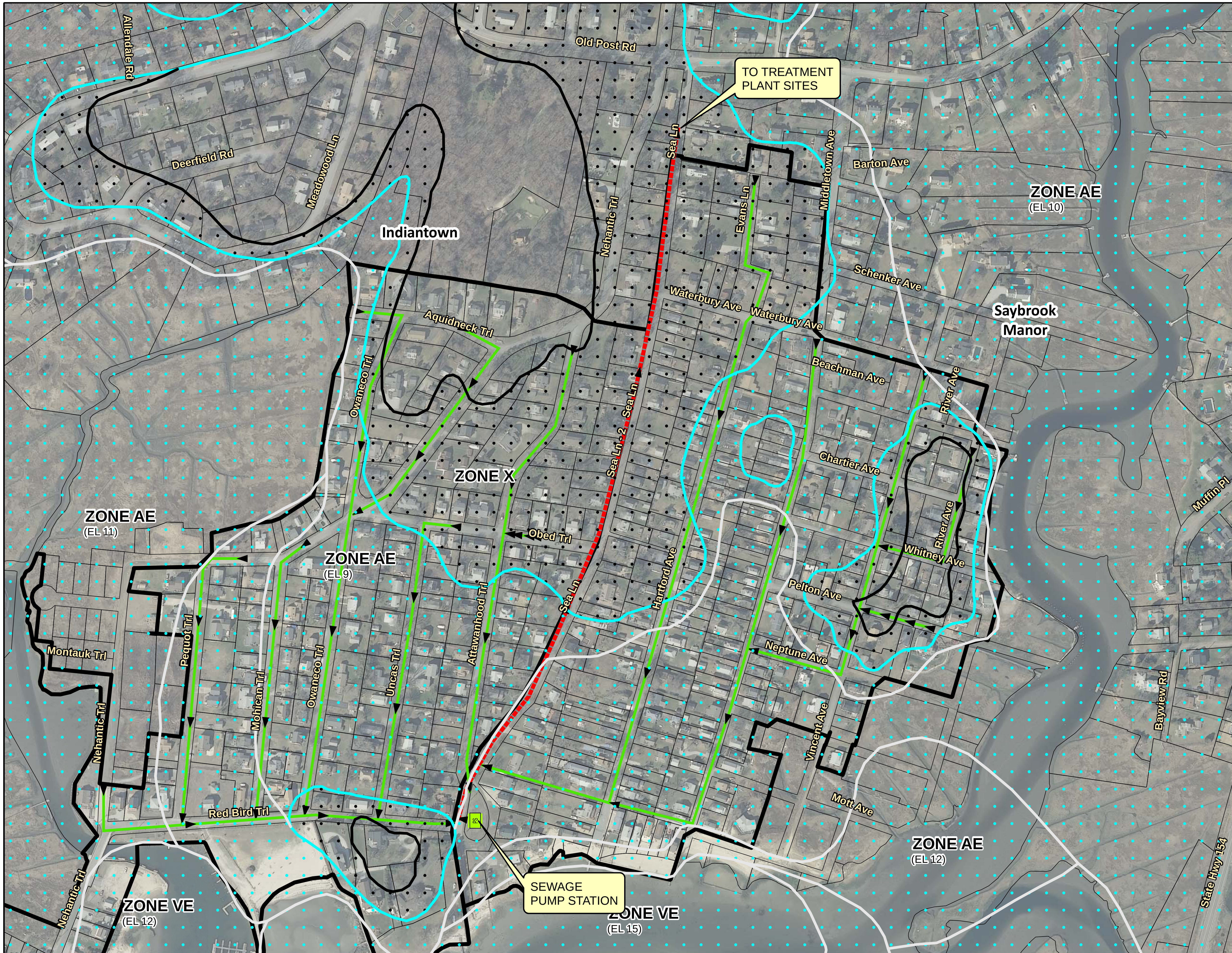
PROJ NO: GSD-34	DATE: 8/1/18
Green Site Design LLC CONSULTING CIVIL ENGINEERS	FIGURE: 5-1

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-4 - Force Main to Donnelley Prop.mxd

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO: GSD-34	DATE: 8/1/18
Green Site Design LLC, CONSULTING CIVIL ENGINEERS	FIGURE: 5-2

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-1 - Great Hammock Plum Bank Gravity S Option.mxd



Legend
- WWMD
- Sewage Pump Station
- 4" Sewer Force Main
- 8" Gravity Sewer

N

300 150 0 300

1 inch = 300 feet

INDIANTOWN / SAYBROOK MANOR
GRAVITY SEWER OPTION

OLD SAYBROOK WASTEWATER
MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO:	DATE:
GSD-34	8/1/18

Green Site Design LLC
CONSULTING CIVIL ENGINEERS

FIGURE:
5-3

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-3 - Chalker Beach Gravity Sewer Option.mxd

Legend

- WWMD
- Sewage Pump Station
- 4" Sewer Force Main
- 8" Gravity Sewer

N

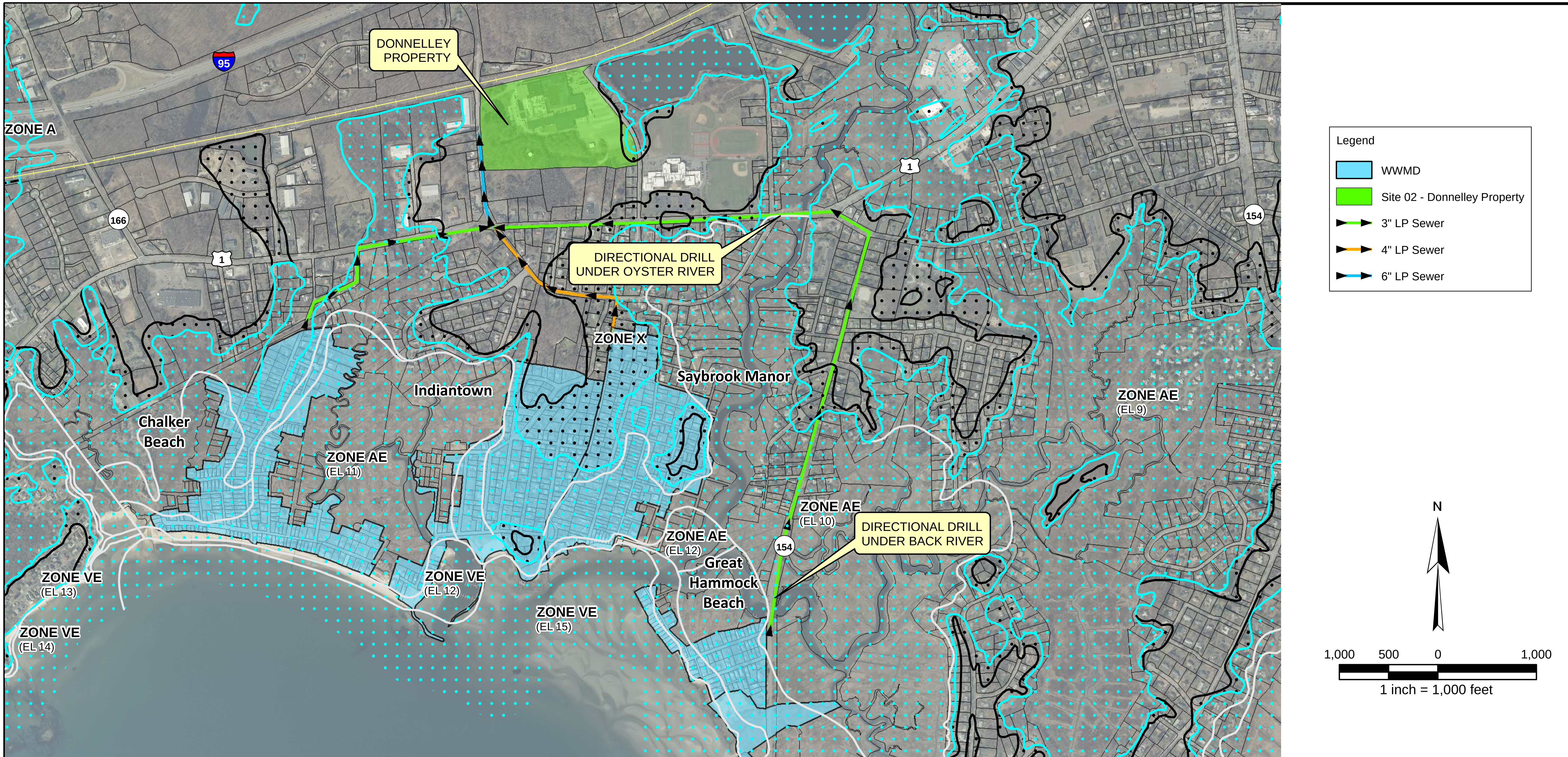
300 150 0 300

1 inch = 300 feet

CHALKER BEACH GRAVITY SEWER OPTION

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO: GSD-34	DATE: 8/1/18
Green Site Design LLC CONSULTING CIVIL ENGINEERS	FIGURE: 5-4



TREATMENT PLANT CONVEYANCE SYSTEM
LOW PRESSURE SEWER OPTION TO
DONNELLEY PROPERTY

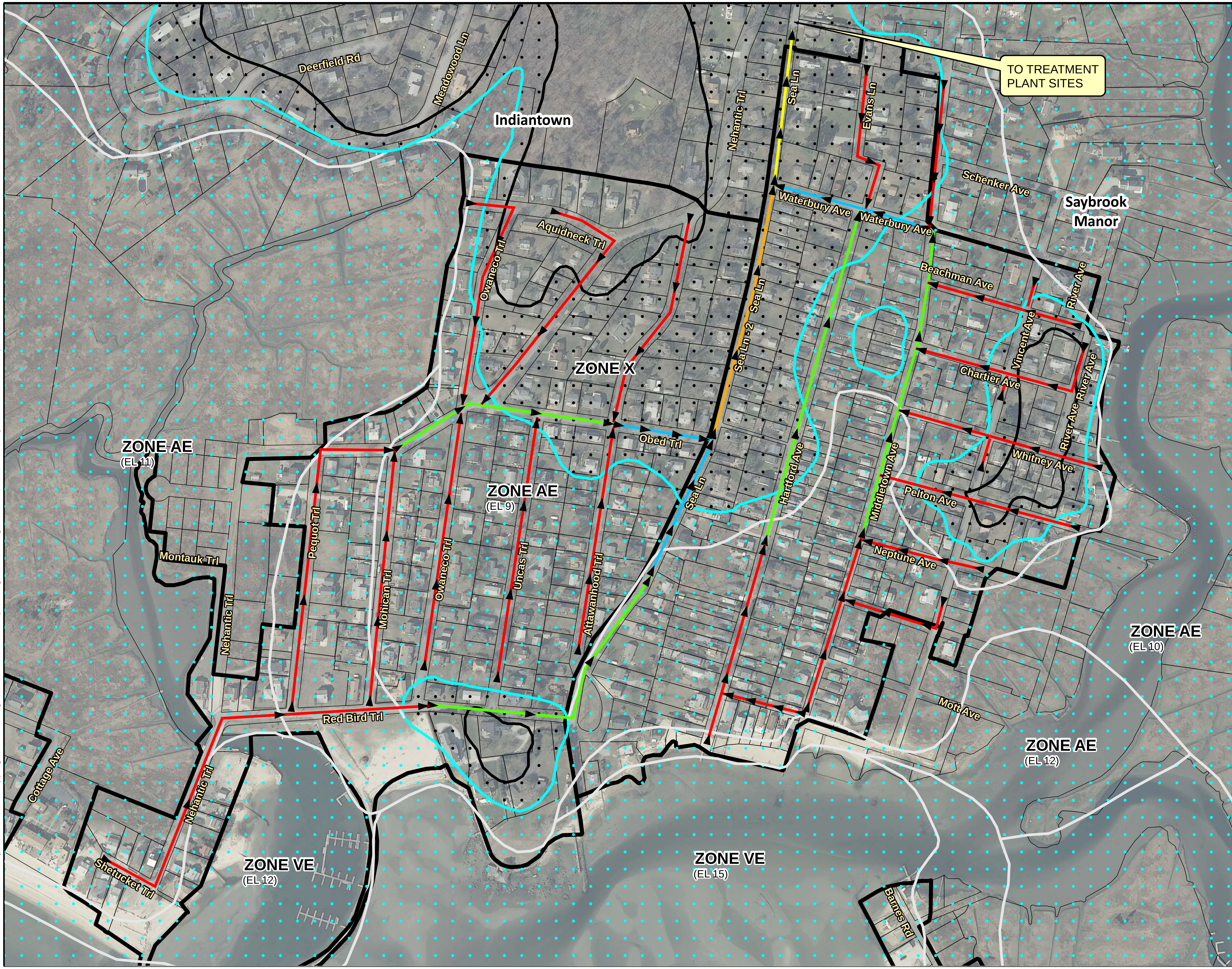
OLD SAYBROOK WASTEWATER
MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO:	DATE:
GSD-34	8/1/18

Green Site Design LLC
CONSULTING CIVIL ENGINEERS

FIGURE: 5-5

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-5 - Great Hammock Plum Bank LP Sewer Opt.mxd



Legend

- WWMD
- 1.5" LP Sewer
- 2" LP Sewer
- 2.5" LP Sewer
- 3" LP Sewer
- 4" LP Sewer

N

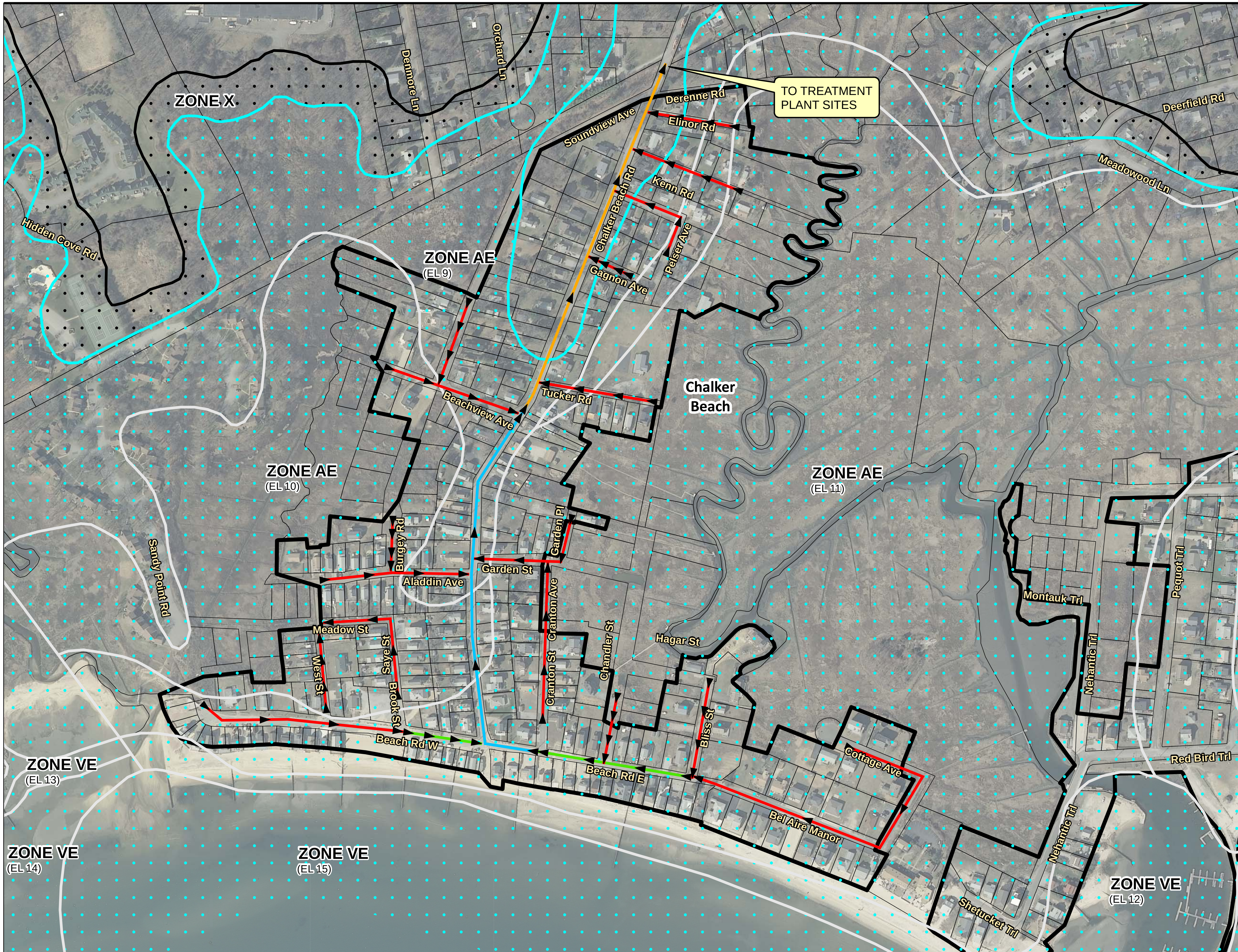
300 150 0 300

1 inch = 300 feet

INDIANTOWN / SAYBROOK MANOR
LOW PRESSURE SEWER OPTION

Old Saybrook Wastewater Management Project
Community Collection System

PROJ NO: GSD-34	DATE: 8/1/18
Green Site Design LLC — Consulting Civil Engineers	FIGURE: 5-7



CHALKER BEACH
LOW PRESSURE SEWER OPTION

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO: GSD-34
DATE: 8/1/18
FIGURE: 5-8

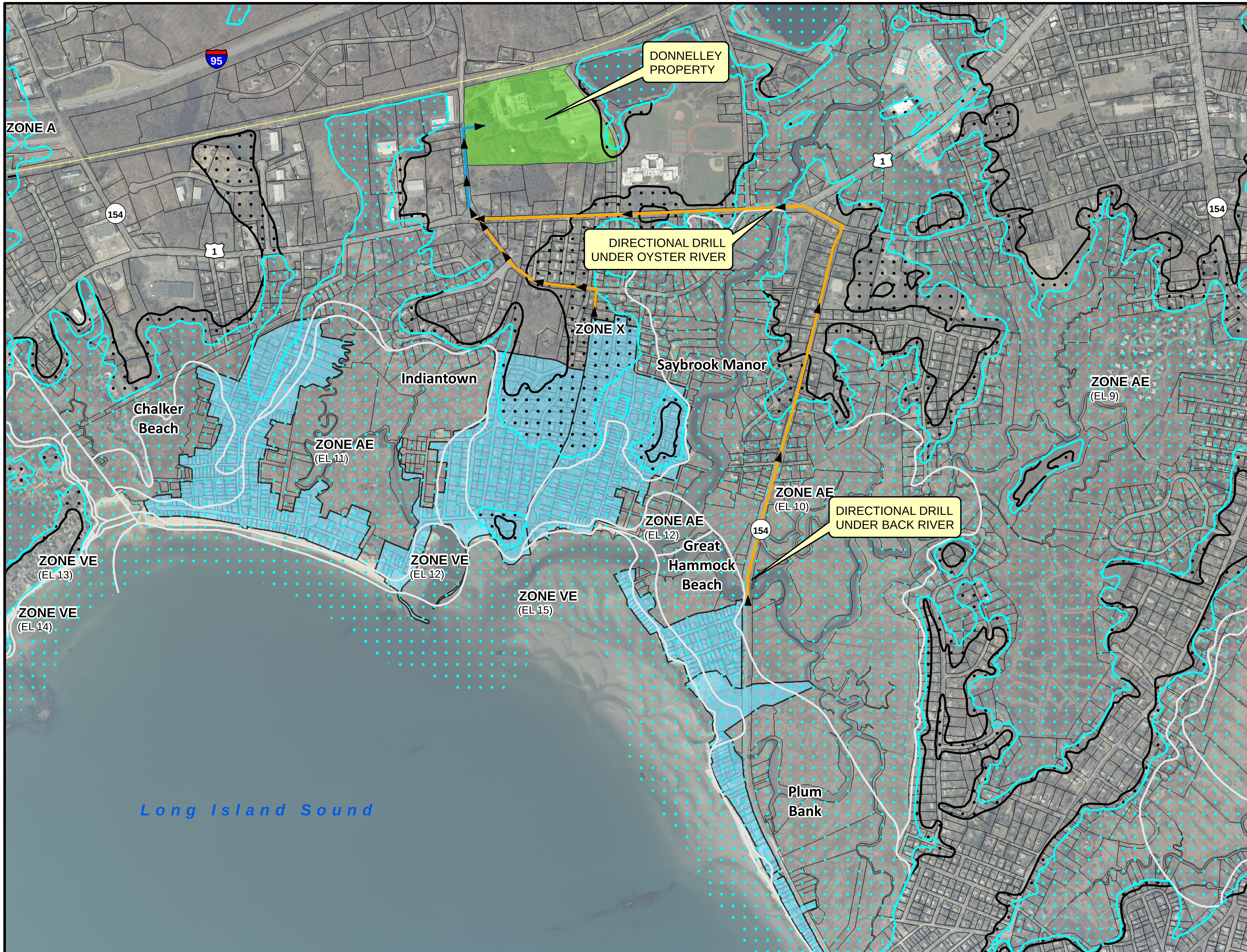
Green Site Design LLC
CONSULTING CIVIL ENGINEERS

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-7 - Chalker Beach LP Sewer Opt.mxd

5.1.3 Vacuum Sewer System

A vacuum sewer collection system consists of gravity laterals leading to vacuum valve chambers, typically one valve chamber is provided to service one to four lots. The vacuum valve chamber collects wastewater from the lot service laterals, and when a specified volume of wastewater is collected, a pneumatic valve within the chamber opens to allow the wastewater to be pulled into the sewers via the negative pressure (vacuum) applied to the sewer. The vacuum sewer mains then connect to a common pump station consisting of a vacuum system to create the negative pressure and a vacuum chamber to collect the wastewater. Conventional wastewater pumps are then used to convey the collected flow to the WPCF via force mains.

There are two municipal vacuum systems operating in the northeast, with municipal vacuum systems installed in Provincetown and Newburyport, Massachusetts. Information provided by the system suppliers indicates that vacuum systems work well for small, low-lying communities including shoreline areas, and that there are numerous systems operating successfully in other parts of the country. However, it was noted that both Provincetown and Newburyport have experienced significant system failures. In Provincetown, a break in one of the sewer lines caused loss of vacuum over a wide-ranging area, affecting numerous properties. A potential cause of this was debris that got into the sewer travelling at a high velocity impacting the pipe at a directional change. Typical pumped force mains convey sewage at a velocity in the range of 3 to 5 feet per second, yet vacuum sewers can operate at velocities greater than 15 feet per second. Therefore, non-wastewater debris in the system, traveling at high velocities can cause damage to the piping and the system needs to be designed to account for these issues. In Newburyport, the vacuum sewer system experienced failures across a wide area due to extreme winter weather. A series of significant snow events over a short period of time and corresponding below-average temperatures caused freezing of systems components and also limited access to the system for repairs due to the snow. While both of these systems have been repaired and continue to operate, there appears to be difficulties in determining the location of leaks when a loss of vacuum occurs, and additional monitoring is required throughout the system to determine the source of leaks that is not typically required with low-pressure or conventional gravity sewer/pump station systems. A preliminary vacuum sewer system layout was prepared by Green Site Design, to serve the five focus areas. This preliminary layout is presented in Figures 5-9 through 5-11.



Legend

- WWMD
- Site 02 - Donnelley Property
- 4" Sewer Force Main
- 6" Sewer Force Main

N

1,000 500 0 1,000

1 inch = 1,000 feet

TREATMENT PLANT CONVEYANCE SYSTEM
SEWER FORCE MAIN OPTION FOR VACUUM SYSTEM
TO DONNELLEY PROPERTY

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO: GSD-34	DATE: 8/1/18
Green Site Design LLC CONSULTING CIVIL ENGINEERS	FIGURE: 5-9

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-11 - Force Main to Donnelley Prop Vacuum.mxd

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-9 - Great Hammock Beach Plum Bank Sewer V System.mxd

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 5-10 - Chalker Beach Indiantown Saybrook S Vacuum Opt.mxd

5.1.4 Directional Drilling Evaluation

Many of the collection system routing alternatives (and the treated effluent conveyance alternatives discussed later in the report) include horizontal directional drilling (HDD) or other “trenchless” piping installation methods to avoid excavation of sensitive areas, such as beneath railroad tracks, river crossings, wetlands, etc. Wright-Pierce engaged Brierley Associates, an engineering firm specializing in these types of installation methods, to review the proposed crossings and determine feasible installation methods and cost implications of these specialized construction techniques. Based on Brierley Associate’s evaluation, considering on-site constraints, anticipated subsurface conditions, and pipe sizes, HDD appears to be a viable trenchless force main installation method for each crossing identified for the various sewer system alternatives. Micro tunneling is also a technically viable method but has not been considered further due to higher anticipated costs compared to HDD and because it is typically used for larger diameter pipes than anticipated in Old Saybrook.

The preliminary pipeline routing developed by Green Site Design, LLC was based on following existing streets so that access to the pipeline could be provided for maintenance. Therefore, the use of trenchless construction techniques evaluated by Brierly Associates was based on this routing. As noted previously, once a collection system technology alternative is selected, it may be possible to identify additional areas where trenchless construction techniques could shorten the proposed pipeline routes. However, this approach is only applicable for force mains operating under pressure and would not be used for gravity or vacuum sewers. Therefore, these alternatives were not investigated as part of this report.

Based on the information presented above for potential collection system layouts for various technology alternatives, and available information on existing soil and depth to bedrock information, Brierley associates developed unit cost pricing information to support development of probable construction costs for various collection system alternatives. These unit prices are presented in Table 5-1 have been used in developing our opinion of the probable construction cost of each alternative presented below.

TABLE 5-1

PRELIMINARY OPINION OF HDD INSTALLATION COST

Location	Approximate Pipe Size	Bedrock Drilling	Casing	Approximate Cost/foot
Plum Bank Creek Crossing	4-inch	No	No	$190
Oyster River at Barnes Rd.	4-inch	No	No	$190
Oyster River at Route 1	4-inch	No	No	$190
Railroad at Ford St.	10-inch	Yes	Yes (14 to 16-in.)	$900
Railroad at Rivers Ridge Rd.	10-inch	Yes	Yes (14 to 16-in.)	$900
Outfall to CT River	10-inch	Yes	Yes (14 to 18-in.)	$1,325

5.2 OPINION OF PROBABLE COSTS

The preliminary layouts described above were utilized to determine the necessary linear feet of collection piping, force mains, number of pump stations, and number of crossings requiring HDD construction techniques. These preliminary layouts were used as the basis for the preliminary opinion of capital and operational costs presented below. Detailed backup for these costs is included in Appendix C. As described in AACE International 18R-97, this is considered a Class 4 level estimate. This estimate has been prepared based on limited information and subsequently will have a wide range for accuracy. Class 4 estimates are commonly used for project/process screening, feasibility studies, and establishing preliminary project budgets. This class of cost estimate is provided at the stage in a project when engineering is less than 15% complete. The accuracy range for Class 4 estimates is -30% to +50%.

5.2.1 Capital Costs

Cost proposals were obtained from sewer system manufacturers for the low-pressure and vacuum sewer systems to develop the capital costs in conjunction with site work, mechanical, structural, electrical, HVAC, and instrumentation requirements for pump stations. The gravity sewer system costs were derived from recent experience for New England coastal installations. Collection system costs include piping and pumping required to convey the wastewater from the parcels in the five focus areas to the each of the proposed treatment sites. The capital costs also include land acquisition, engineering and contingency. Our preliminary opinion of the order-of-magnitude capital costs for each collection system alternative is presented below.

5.2.1.1 Conventional Gravity Sewer System

Order-of-magnitude capital costs for the gravity collection system with pumping to either of the two potential WPCF locations is presented in Table 5-2 below.

TABLE 5-2

PRELIMINARY GRAVITY COLLECTION SYSTEM CAPITAL COST ESTIMATE

Item	Quantity	Unit	Avg Unit Cost	Cost
To Donnelley Site				
Lateral sewer	740	EA	$4,000	$2,960,000
Gravity sewer	32,250	LF	$200	$6,450,000
Force main	16,050	LF	$120	$1,926,000
Pump stations	4	LS	$1,000,000	$4,000,000
Pump Station Land	1	LS	$80,000	$80,000
Contingency @ 40%	1	LS		$6,166,000
Total				**$21,582,000**
Potential Range -30%/+50%			*$15,107,000 to $32,373,000*	
To Roam Tree Site				
Lateral sewer	740	EA	$4,000	$2,960,000
Gravity sewer	32,250	LF	$200	$6,450,000
Force main	32,280	LF	$135	$4,358,000
Pump stations	4	LS	$1,000,000	$4,000,000
Pump Station Land	1	LS	$80,000	$80,000
Contingency @ 40%	1	LS		$7,139,000
Total				**$24,987,000**
Potential Range -30%/+50%			*$17,491,000 to $37,481,000*	

5.2.1.2 Low Pressure Sewer System

Order-of-magnitude capital costs for the low-pressure sewer collection system with pumping to either of the two potential WPCF locations is presented in Table 5-3 below. These estimates are based on budgetary costs provided by a supplier of low-pressure sewer systems, and piping cost opinions from a local contractor. These costs were then supplemented for items not included in the vendor submittals such as pavement restoration, emergency power provisions, and other items.

TABLE 5-3

PRELIMINARY LOW-PRESSURE SEWER SYSTEM CAPITAL COST ESTIMATE

Item	Quantity	Unit	Avg Unit Cost	Cost
To Donnelley Site				
Grinder Pumps	740	EA	$7,500	$5,550,000
Low pressure sewer	51,025	LF	$95	$4,847,000
Contingency @ 40%	1	LS		$4,159,000
Total				**$14,556,000**
Potential Range -30%/+50%			*$10,189,000 to $21,834,000*	
To Roam Tree Site				
Grinder Pump	740	EA	$7,500	$5,550,000
L P Sewer	71,255	LF	$109	$7,767,000
Contingency @ 40%	1	LS		$5,327,000
Total				**$18,644,000**
Potential Range -30%/+50%			*$13,051,000 to $27,966,000*	

5.2.1.3 Vacuum Sewer System

Order-of-magnitude capital costs for the vacuum sewer collection system with pumping to either of the two potential WPCF locations is presented in Table 5-4. These costs are based on estimates provided by two vacuum sewer system manufacturers, and piping cost input from a local contractor. These costs were then supplemented for items not included in the vendor submittals such as pavement restoration, emergency power provisions, and other items.

TABLE 5-4

PRELIMINARY VACUUM SEWER SYSTEM CAPITAL COST ESTIMATE

Item	Quantity	Unit	Avg Unit Cost	Cost
To Donnelley Site				
Pump stations	2	EA	$1,100,000	$2,200,000
Pump Station Land	1	LS	$40,000	$40,000
Vacuum sewers & force mains	59,350	LF	$98	$5,816,000
Valve pits	257	EA	$5,430	$1,395,000
Contingency @ 40%	1	LS		$3,781,000
Total				**$13,232,000**
Potential Range -30%/+50%				*$9,262,000 to $19,848,000*
To Roam Tree Site				
Pump stations	2	EA	$1,100,000	$2,200,000
Pump Station Land	1	LS	$40,000	$40,000
Vacuum sewers & force mains	74,680	LF	$109	$8,140,000
Valve pits	257	EA	$5,430	$1,395,000
Contingency @ 40%	1	LS		$4,710,000
Total				**$16,485,000**
Potential Range -30%/+50%				*$11,540,000 to $24,728,000*

5.2.2 Operation and Maintenance Costs

The operation and maintenance costs for each alternative were developed considering factors such as power requirements, emergency power fuels, cleaning and equipment maintenance, as well as staffing and management costs. A breakdown for these estimated annual costs are included in Appendix C.

5.2.2.1 Conventional Gravity Sewer System

The estimated annual O&M costs for the gravity collection system are presented in Table 5-5. Refer to Appendix C for additional information and assumptions regarding the costs presented.

TABLE 5-5

GRAVITY COLLECTION SYSTEM O&M COST ESTIMATE

Item	Cost
Personnel	$156,000
Electricity	$11,000
Sewer/WW Cleaning	$18,000
Pump and Generator Maintenance	$30,000
Miscellaneous	$6,500
Total	**$221,500**

5.2.2.2 Low Pressure Sewer System

The estimated annual O&M costs for the low-pressure sewer collection system are presented in Table 5-6. These costs are anticipated to be less than for the gravity collection system due to the additional power consumption and maintenance requirements associated with the gravity sewer system. Refer to Appendix C for additional information and assumptions regarding the costs presented.

TABLE 5-6

LOW-PRESSURE SEWER SYSTEM O&M COST ESTIMATE

Item	Cost
Personnel	$62,400
Electricity	$5,000
Maintenance	$75,000
Miscellaneous	$5,000
Total	**$147,400**

5.2.2.3 Vacuum Sewer System

The estimated annual O&M costs for the vacuum sewer collection system are presented in Table 5-7. These annual costs are based on data provided by one of the vacuum sewer system manufacturers. Refer to Appendix C for additional information and assumptions regarding the costs presented.

TABLE 5-7

VACUUM SEWER SYSTEM O&M COST ESTIMATE

Item	Cost
Personnel	$62,400
Electricity	$5,500
Tank Cleaning	$4,000
Vacuum Valve Chamber Maintenance	$74,000
Pump and Generator Maintenance	$25,000
Miscellaneous	$6,500
Total	**$177,400**

5.2.3 Present Worth Analysis

To compare each of the alternatives, the present worth costs were developed utilizing the preliminary capital costs and 20-year present worth of the annual operational costs presented above. These costs are presented in Table 5-8 for each of the three collection system alternatives.

TABLE 5-8

PRESENT WORTH COST ESTIMATE

Item	Gravity	Low Pressure	Vacuum
Donnelley Site			
Capital cost	$21,582,000	$14,556,000	$13,232,000
Present Worth of Annual Costs	$3,622,000	$2,410,000	$2,901,000
Present Worth	**$25,204,000**	**$16,966,000**	**$16,133,000**
Roam Tree Site			
Capital cost	$24,987,000	$18,644,000	$16,485,000
Present Worth of Annual Costs	$3,622,000	$2,410,000	$2,901,000
Present Worth	**$28,609,000**	**$21,054,000**	**$19,386,000**

5.3 RECOMMENDED ALTERNATIVE

Based on the preliminary cost evaluation presented above, low-pressure sewers and vacuum sewers appear to have similar present worth costs. The capital costs are lower for the vacuum sewer alternative than for the low pressure sewer alternative presented above, however the annual operations and maintenance costs are anticipated to be slightly higher for the vacuum sewer alternative. One of the differences between the assumptions used in developing the capital costs is that for the low-pressure sewer, the manufacturer assumed that each parcel would be served by its own grinder pump station and that for the vacuum sewer system the manufacturer assumed that each valve chamber would serve four parcels. During preliminary design, it is likely that additional valve chambers would be required and that on average, each valve chamber would serve fewer than four parcels. This would increase the capital cost of the of the vacuum sewer system relative to the low-pressure sewer system further by increasing the number of valve chambers required. Because the present worth costs of the low-pressure sewer and vacuum sewer alternatives are similar, factors beyond capital costs and present worth costs were considered in developing the recommendation for the type of collection system. To evaluate these factors, a comparison of monetary and non-monetary criteria was developed for each type of collection system and was ranked from 1 to 3 with 3 being the most favorable and 1 being the least favorable. Based on the similarity between present worth costs, long-term reliable operating history of low-pressure sewer systems in the northeast, problems experienced by vacuum sewer systems in other municipalities in the northeast, and comparison of criteria presented below, it is recommended that the collection system associated with a community treatment system in Old Saybrook be designed around a low-pressure sewer system.

TABLE 5-9

COLLECTION SYSTEM COMPARISON CRITERIA

Parameter	Gravity	Low-Pressure	Vacuum Sewer
Number of installations	3	2	1
Winter operation	2	2	1
Space requirement	1	2	2
Ease of operation	2	3	2
Ease of construction	1	3	2
Operation & maintenance costs	1	3	2
Energy consumption	2	3	3
Cost	1	2	3
Total	**13**	**20***	**16**

Section 6

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SECTION 6

SURFACE WATER DISCHARGE EVALUATION

6.1 PROPOSED OUTFALL LOCATIONS

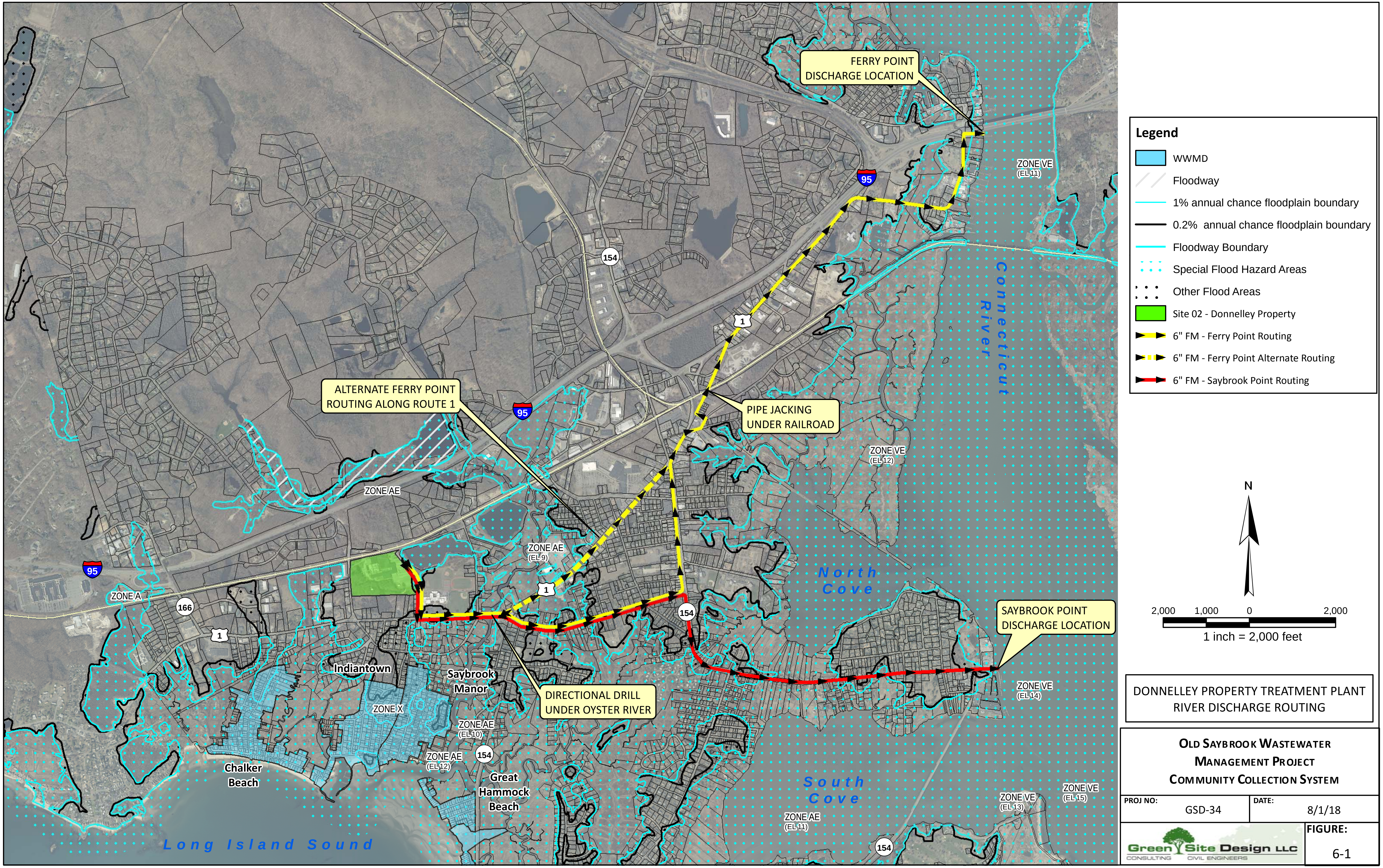
Following treatment, one of the evaluated disposal options for the wastewater effluent is a pipe discharge to the Connecticut River. Based on the DEEP's Surface Water Quality Classification, the Connecticut River is the only receiving watercourse in Old Saybrook where the treated wastewater effluent could be discharged. Three locations were selected as possible outfall locations based on their ability to provide assimilative capacity of the treated wastewater. Each of these locations has different potential cost and technical advantages depending on the location selected for the treatment facility. The outfall locations and potential routes from the WPCF are illustrated in Figures 6-1 and 6-2. Each of these discharge locations is described below.

6.1.1 Ferry Point North

The proposed Ferry Point North outfall location is adjacent to Ferry Road between the I-95 corridor and the railroad tracks. This site would be near a treatment facility located at the Roam Tree Road location. This location would utilize more conventional construction techniques and would locate the discharge piping primarily in existing roadways and public rights-of-way.

6.1.2 Ferry Point South

The proposed Ferry Point South outfall location was developed to try to shorten the length of piping required compared to the Ferry Point North location. This route would diverge from the Route 1 corridor near the Roam Tree Road properties and run parallel the metro north railroad tracks in the area of the Gardella Property. It would then cross under the railroad tracks and extend to the river through the area noted on the mapping as the Ragged Rock Creek Marsh Wildlife area. This outfall location avoids the more congested and developed areas adjacent to the river.



Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 6-1 - Donnelley Property to River.mxd

Legend

- WWMD
- Floodway
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway Boundary
- Special Flood Hazard Areas
- Other Flood Areas
- Site 38 - Roam Tree Rd
- FM from Neighborhood Collection Systems
- Combined FM to Treatment Site
- FM to Ferry Point Discharge

N

2,000 1,000 0 2,000

1 inch = 2,000 feet

FORCEMAIN ROUTING TO ROAM TREE ROAD TREATMENT PLANT & DISCHARGE TO FERRY POINT

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT COMMUNITY COLLECTION SYSTEM

PROJ NO:	DATE:
GSD-34	8/1/18

Green Site Design LLC — CONSULTING CIVIL ENGINEERS

FIGURE: 6-2

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 6-2 - Neighborhoods to Roam Tree to River.mxd

However, to reach this location, extensive private property easements or land taking may be required, as well as utilizing Horizontal Directional Drilling (HDD) pipe installation methods for crossing beneath the Metro North railroad tracks, and the marsh/wildlife area. Extensive marine construction would be required for the outfall pipe in the Connecticut River. This area would also be more difficult to access should future maintenance of the outfall piping be required.

6.1.3 Saybrook Point

The proposed Saybrook Point outfall location would be located just off the intersection of College Street and Bridge Street (both are called CT Route 154). This site would be reasonably accessible, due to existing development in the area, although there would be some disruption to these existing facilities during construction.

6.2 OPINION OF PROBABLE COSTS

The preliminary layouts presented in Figures 6-1 and 6-2 were utilized to determine the necessary linear feet of outfall piping and areas requiring HDD construction techniques. These preliminary layouts were used as the basis for the preliminary capital and operational cost estimates presented below. More detailed backup for these costs is included in Appendix C. As described in AACE International 18R-97, this is considered a Class 4 level estimate. This estimate has been prepared based on limited information and subsequently will have a wide range for accuracy. Class 4 estimates are commonly used for project/process screening, feasibility studies, and establishing preliminary project budgets. This class of cost estimate is provided at the stage in a project when engineering is less than 15% complete. The accuracy range for Class 4 estimates is -30% to +50%.

6.2.1 Capital Costs

The discharge piping costs were derived from recent relevant experience for New England coastal installations, with feedback from a local contractor on pricing. Piping lengths were taken from the layouts prepared by Green Site Design, based on the selected potential outfall and treatment facility locations.

TABLE 6-1

SURFACE WATER DISCHARGE CAPITAL COST ESTIMATES

(FROM TREATMENT PLANT TO DISCHARGE LOCATION)

Item	Quantity	Unit	Avg Unit Cost	Cost
Donnelley to Ferry Point North				
Force main	23,685	LF	$133	$3,155,000
Outfall	1	LS	$500,000	$500,000
Contingency @ 40%	1	LS		$1,462,000
Total				**$5,117,000**
Donnelly to Saybrook Point				
Force main	15,900	LF	$107	$1,701,000
Outfall	1	LS	$500,000	$500,000
Contingency @ 40%	1	LS		$880,000
Total				**$3,081,000**
Roam Tree Road to Ferry Point North				
Force main	8,000	LF	$125	$1,000,000
Outfall	1	LS	$500,000	$500,000
Contingency @ 40%	1	LS		$600,000
Total				**$2,100,000**
Roam Tree Road to Ferry Point South				
Force main	1,200	LF	$105	$126,000
Force main w/HDD & Outfall	3,350	LF	$1,325	$4,439,000
Contingency @ 40%	1	LS		$1,826,000
Total				**$6,391,000**

6.2.2 Operation and Maintenance Costs

The costs associated with pumping effluent to outfall location are included in the O&M costs for the WPCF. The long-term maintenance of the outfall and discharge piping is minimal, which includes routine inspections and occasional sewer cleaning only. This is estimated to be $9,000 per year. The breakdown for these estimated annual costs is included in Appendix C.

TABLE 6-2

SURFACE WATER DISCHARGE O&M COST ESTIMATE

Item	Cost
Sewer Cleaning	$4,000
Routine Inspection	$5,000
Total	**$9,000**

6.2.3 Present Worth Analysis

To compare each of the alternatives, the present worth costs were developed utilizing the preliminary capital costs and 20-year present worth of the annual operational costs presented above. The summary of the costs is presented in Table 6-3 for each of the three surface water discharge alternatives.

TABLE 6-3

PRESENT WORTH COST ESTIMATE

Item	Ferry Point N	Saybrook Point	Ferry Point S
Donnelley WPCF Site			
Capital cost	$5,117,000	$3,081,000	N/A
Present worth of annual costs	$147,000	$147,000	N/A
Present Worth	**$5,264,000**	**$3,228,000**	N/A
Roam Tree WPCF Site			
Capital cost	$2,100,000	N/A	$6,391,000
Present worth of annual costs	$147,000	N/A	$147,000
Present Worth	**$2,247,000**	N/A	**$6,538,000**

6.3 RECOMMENDED ALTERNATIVE

Preliminary opinions of probable costs have been developed for the effluent discharge piping from the Donnelley treatment facility site to Ferry Point North and Saybrook Point outfall locations; and for the Roam Tree treatment facility site to Ferry Point North and Ferry Point South outfall locations. The effluent discharge piping from the Donnelley site to Ferry Point South would cost more than to the Ferry Point North location due to the high cost of HDD underneath the tidal wetland area. Also, the effluent discharge piping from the Roam Tree site to the Saybrook Point location would potentially cost more since there are railroad crossings and the piping will be longer than to either of the Ferry Point locations. Therefore, the costs for these two alternatives have not been developed.

Based on the present worth cost estimate analysis, the effluent discharge piping from a Roam Tree site WPCF to the outfall location at Ferry Point North has a lower life-cycle cost than the other alternatives. However, the recommended alternative for the surface water discharge location needs to also be considered in conjunction with the recommended collection system alternative and WPCF treatment site alternative for the final determination of the discharge location. As discussed in Section 5, a low-pressure sewer collection system is recommended to convey wastewater to the WPCF site. To determine the more cost-effective alternative, the present worth of a low-pressure sewer system to the Donnelly site with a surface water discharge to Saybrook Point was compared with a low-pressure sewer system to the Roam Tree site with a surface water discharge at Ferry Point North. This comparison is presented in Table 6-4.

TABLE 6-4

PRESENT WORTH COMPARISON COLLECTION & DISCHARGE

Item	Present Worth Cost
Donnelley WPCF Site	
Low Pressure Collection System Present Worth	$16,966,000
Discharge to Saybrook Point Present Worth	3,228,000
Present Worth	**$20,194,000**
Roam Tree WPCF Site	
Low Pressure Collection System Present Worth	$21,054,000
Discharge to Ferry Point North Present Worth	$2,247,000
Present Worth	**$23,301,000**

When considering the cost of both the collection system and the discharge piping and outfall, locating the WPCF at the Donnelley site appears to be more cost-effective, however, it is noted that the preliminary nature of these costs has an anticipated accuracy of -30% to +50% and the difference between the two present worth estimates is approximately 15%. Prior to making a final determination, consideration will need to be given to the availability of either site to the Town and other benefits to the Town that are not considered in this cost evaluation.

Section 7

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SECTION 7

SUBSURFACE EFFLUENT DISPERSAL SYSTEM EVALUATION

7.1 PROPOSED DISPERSAL SITES

Following treatment, the other evaluated disposal option for the wastewater effluent is discharge to a subsurface dispersal system. As described in Section 3, a preliminary desktop mounding analysis was conducted using available published data for multiple sites throughout Old Saybrook to determine if sufficient dispersal capacity may be available. A total of nine sites were investigated. Of these, five were identified as potentially feasible sites for subsurface dispersal. Based on the preliminary mounding analysis, it appears that if all sites were utilized, sufficient capacity may be available for the estimated flows from the 740 parcels remaining in the five focus areas. However, additional field investigations including hydraulic load testing would be required to confirm this capacity and more detailed analyses would be required to account for setback distances and travel time requirements.

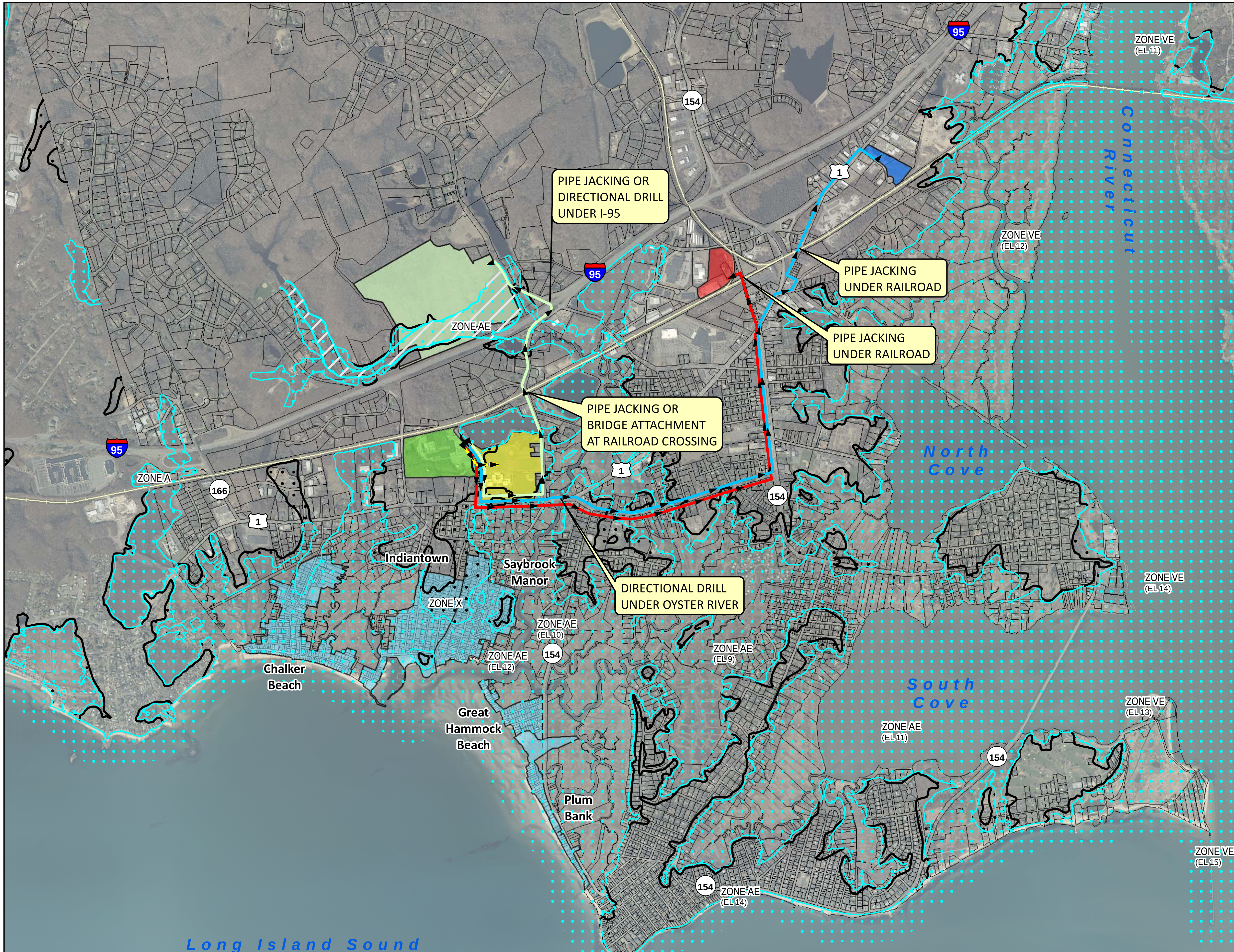
Although these preliminary desktop investigations estimated that there may be sufficient capacity through a combination of multiple dispersal sites, these sites may not provide the typically required 50% reserve capacity. Should the community system with subsurface dispersal be the recommended alternative to the current wastewater management program, significant additional field work is required to verify the treated effluent capacity at each site. In addition, we would work with the CT DEEP to identify the necessary reserve capacity. Based on subsequent ground water mounding analyses, it may be determined that these sites can provide sufficient reserve capacity, or it may be possible to increase the size of any post-equalization tankage provided at the WPCF to reduce peak flows to the dispersal sites with a resulting decrease in the reserve capacity required by CT DEEP. The CT DEEP has required that the sizing of the subsurface dispersal system be based on the CT DPH criteria of 150 gpd/bedroom but recognizes that these criteria are conservative and provides for safety factors to allow for system operation under peak flow conditions. The CT DEEP has stated that if the subsurface dispersal alternative is determined to be cost effective, they would discuss the alternative of post-equalization/treated effluent storage to reduce the required reserve capacity.

As noted in Section 3, for the purposes of developing the capital and present worth cost analysis of the subsurface effluent dispersal alternative, it was assumed that the treated effluent would only be sent to the five dispersal sites listed below.

- High School
- Donnelly Property
- Roam Tree Road Parcels
- Ingham Hill (Town-owned parcel)
- Mill Rock Road East

As described below, because two of the sites, Roam Tree Road and Ingham Hill, require large dispersal fields and provide for limited capacity, a second capital and present worth cost analysis was developed assuming that additional post-equalization/treated effluent storage capacity is provided. ***As stated in Section 3, the availability of specific parcels may have changed over this course of this evaluation and certain parcels may no longer be available to the Town.***

The conveyance systems to these sites are shown in Figure 7-1.



Legend

- Floodway
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway Boundary
- Special Flood Hazard Areas
- Other Flood Areas
- WWMD
- Site 01 - OS High School
- Site 02 - Donnelley Property
- Site 38 - Roam Tree Rd
- Site 42 - Open Land Ingham Hill Rd
- Site 43 - Mill Rock Road East
- 6" FM to Site 01
- 6" FM to Site 38
- 6" FM to Site 42
- 6" FM to Site 43

N

2,000 1,000 0 2,000

1 inch = 2,000 feet

DONNELLEY PROPERTY TREATMENT PLANT DISPERSAL SITES ROUTING

OLD SAYBROOK WASTEWATER MANAGEMENT PROJECT
COMMUNITY COLLECTION SYSTEM

PROJ NO: GSD-34	DATE: 8/1/18
Green Site Design LLC CONSULTING CIVIL ENGINEERS	FIGURE: 7-1

Y:\PROJECTS\34 - Old Saybrook Sewer Mapping\GIS\GSD Figures\Revised GIS Maps - August 2018\Figure 7-1 - Donnelley Property to Sites.mxd

7.2 PROPOSED SUBSURFACE DISPERSAL SYSTEMS

For each of the five potential dispersal sites, two different types of dispersal systems are potentially able to be installed, conventional leaching chambers and drip dispersal systems. A brief description of each alternative is presented below.

7.2.1 Conventional Leaching Chambers

Generally, it is assumed that a conventional gallery of chamber systems would be used. This is a standard method for dispersal of larger volumes of treated effluent into the ground. These systems consist of long vaults of arched chambers connected via piping for equal distribution. Based on actual designed space and loading rates, these systems are efficient at maximizing the surface area available for dispersal. A typical leaching chamber is shown in Figure 7-2.

Figure 7-2 Conventional Leaching Chambers

7.2.2 Drip Dispersal

Although conventional leaching chambers are widely used, in some of the proposed sites, drip dispersal systems may also be appropriate at some sites. Drip dispersal systems consist of a network of perforated tubes with a small diameter opening installed just below the surface to disperse the effluent. These small tubes can be installed in a much less intrusive manner, essentially cutting down into the grass and soil, peeling back the ground cover to create a small gap into which the tube is inserted, and then folding the ground cover back down, essentially leaving at most a seam where the grass was cut, and perhaps some equipment tracks. Although this type of system is less efficient than leaching chamber in terms of maximizing available surface area for dispersal, it is installed at a shallower depth, increasing the potential separating distance between the bottom of the leaching system and the top of the mound. This can result in increased capacity or provide additional reserve capacity. While a larger surface area may be required, many of the proposed sites have a potentially large available area with a low overall dispersal rate, so the drip dispersal system is feasible.

A typical drip dispersal system installation is shown in Figure 7-3.

Figure 7-3 Typical Drip Dispersal System Installation

7.3 OPINION OF PROBABLE COSTS – FIVE POTENTIAL SITES

The estimated available area for dispersal for each of the five potential sites identified in LBG's preliminary mounding analyses included in Appendix B were utilized as the basis for developing our preliminary opinion of capital costs for the subsurface dispersal systems. In addition, the layouts presented in Figure 7-1 were utilized to determine the necessary linear feet of force mains, and number of crossings requiring HDD construction techniques. These preliminary layouts were used as the basis for the preliminary opinion of capital and operational costs presented below. Detailed backup for these costs is included in Appendix C. As described in AACE International 18R-97, this is considered a Class 4 level estimate. This estimate has been prepared based on limited information and subsequently will have a wide range for accuracy. Class 4 estimates are commonly used for project/process screening, feasibility studies, and establishing preliminary project budgets. This class of cost estimate is provided at the stage in a project when engineering is less than 15% complete. The accuracy range for Class 4 estimates is -30% to +50%.

7.3.1 Capital Costs

The capital costs for the subsurface dispersal alternatives include the following cost items:

- Discharge piping from the WPCF site to the subsurface dispersal locations;
- Subsurface piping and leaching chambers;
- Site work including surface restoration; and,
- fill over the dispersal area (where necessary).

The capital costs were developed based on the use of conventional leaching chambers at each site. The estimated cost for the installation of the subsurface piping and leaching chambers was based on an installed cost of $7 per square foot of dispersal area. This estimate is based on costs obtained from a leaching chamber manufacturer. Costs for land acquisition, piping to the sites, and fill over the specific areas are in addition to this unit cost are and are also included in the capital cost estimates. A summary of the anticipated dispersal area required at each site, based on the desktop analysis conducted by LBG, is presented in Table 7-1.

TABLE 7-1

SUMMARY OF REQUIRED DISPERSAL AREA PER SITE

Site No.	Description	Dispersal Area, ft^2	Fill Required, ft
1	Old Saybrook High School	246,864	None
2	Donnelly Property	28,148	None
38	Roam Tree Road Parcels	268,900	3.5
42	Ingham Hill Road (Town-Owned Site)	1,767,491	3.5
43	Mill Rock Road East Parcels (w/fill)	126,600	3.5

The sizing of the fields was based on the approximate area required to disperse the effluent based on the site desktop analysis by LBG as well as the site constraints provided by the DEEP specifically regarding flood elevations relative to the dispersal elevations.

Because the Donnelley site is the closest treatment facility site to the potential dispersal site locations, the dispersal costs were developed assuming treated effluent would be pumped from that site to each dispersal location. Because the additional piping required to convey raw wastewater flows to the Roam Tree site for treatment, and then back to each dispersal site would add additional costs, the Roam Tree site was not considered to be cost-effective for the WPCF if a subsurface dispersal option is selected. Based on the assumptions presented above, our preliminary opinion of the capital costs to convey flows from a Donnelley site treatment facility to the five potential dispersal sites and construct the dispersal facilities in each location is approximately $41.1 million to construct. The backup for these costs is included in Appendix C.

7.3.2 Operation and Maintenance Costs

The operation and maintenance costs for the Donnelley dispersal site is estimated to be similar to, but slightly higher than the maintenance costs for the river discharge. The operation and maintenance cost includes inspections and cleaning of the effluent dosing pump station and discharge piping. The dispersal fields will also require quarterly groundwater sampling, testing and reporting. The O&M cost for the dispersal field is estimated to be approximately $11,400 per year. The breakdown for these estimated annual costs is included in Appendix C.

7.3.3 Present Worth Analysis

The present worth of the operation and maintenance costs of a dispersal system is approximately $186,000. Including the capital costs, the full present worth value of this alternative is approximately $41.3 million.

7.4 ALTERNATIVE COST ANALYSIS

The capital cost of using all five sites as presented above is significant. A breakdown of the preliminary opinion of probable cost by site is presented in Table 7-2 below. These costs are based on the information provided in Appendix C.

TABLE 7-2

OPINION OF PROBABLE CAPITAL COST PER SITE

Site No.	Description	Opinion of Probable Capital Cost, $	Estimated Capacity, gpd	Cost/gpd
1/2	High School/Donnelly Property	$3,400,000	246,600	$13.79
38	Roam Tree Road Parcels	$6,300,000	47,000	$624.39
42	Ingham Hill Road (Town-Owned Site)	$25,600,000	41,000	$134.04
43	Mill Rock Road East Parcels (w/fill)	$5,800,000	100,000	$58.00
	TOTAL	**$41,100,000**	**434,600**	**$94.57**

As seen in Table 7-2, the Roam Tree Road and Ingham Hill Road sites have a significantly greater capital cost and lower capacity than the other three sites. These cost per gallon per day for these sites is excessive and these sites are not considered to be cost-effective, although they would help provide reserve capacity. As an alternative, based on discussions with CT DEEP, it may be feasible to reduce the reserve capacity requirements through the provision of a post-equalization/treated effluent storage tank on the treatment facility site. This tank would be utilized to store peak flows in excess of a certain capacity to reduce loading to the dispersal systems.

7.4.1 Post-Equalization/Treated Effluent Storage Tank Sizing Criteria

As discussed in Section 2, the seasonal average flow anticipated at the community treatment system is approximately 77,000 gpd. Based on typical peaking factors, the maximum day flow is anticipated to be 244,000 gpd. As discussed in Section 3, the capacity of Sites 1, 2, and 43 using conventional leaching chambers is estimated to be approximately 235,700 gpd. The capacity could potentially be increased to 346,600 gpd if shallower dispersal systems, such as drip irrigation, were utilized in some areas. Therefore, if Sites 1, 2, and 43 were utilized with drip irrigation systems used in some areas, there is potentially enough capacity to accept maximum day flows based on using water consumption data and typical peaking factors and including some allowances for “pent up demand” and infiltration and inflow.

To estimate the required sizing for a post-equalization/treated effluent storage tank, it was assumed that on days when the maximum day flow exceeded the treatment system design maximum day flows, excess flow would be diverted to the storage tank. The difference between the dispersal system sizing using CT DPH criteria (318,200 gpd) and the anticipated maximum day flows (244,000 gpd) is 74,200 gpd. Based on the seasonal nature of the community, it is likely that if the anticipated maximum day flows are exceeded, it would occur over a long holiday weekend during the summer.

As a preliminary basis for sizing the storage tank capacity and developing a preliminary opinion of the probable construction cost, it was assumed that a ten-day storage capacity would provide enough storage for high flows over an extended holiday weekend. Therefore, a storage tank with a capacity of approximately 750,000 gallons was assumed for developing preliminary costs.

7.4.2 Preliminary Opinion of Capital Costs

To provide the required operating volume, it was assumed that a square tank approximately 82 ft. x 82 ft. x 15 ft. water depth would be required. An additional two feet of freeboard above the maximum water surface would also be provided. It was assumed that the tank would have the following features:

- Constructed of cast-in-place concrete,
- Covered and ventilated to an activated carbon odor control system,
- Mixed with floating mechanical mixers, and
- Provided with duplex pumps to divert flows into the storage tank.

A preliminary opinion of the probable costs for the construction of a post-equalization/treated effluent storage tank was developed as a Class 4 estimate as described above. Detailed backup for these costs is included in Appendix C.

The revised opinion of probable costs for the subsurface dispersal facilities using three sites plus a post-equalization/treated effluent storage tank is presented in Table 7-3.

TABLE 7-3

OPINION OF PROBABLE COSTS – ALTERNATIVE COST ANALYSIS

Site No.	Description	Opinion of Probable Capital Cost, $
1/2	High School/Donnelly Property	$3,400,000
43	Mill Rock Road East Parcels (w/fill)	$5,800,000
--	Post-Equalization/Treated Effluent Storage Tank	$3,520,000
	TOTAL	**$12,720,000**

7.4.3 Operation and Maintenance Costs

The operation and maintenance costs for the dispersal sites includes inspections and cleaning of the effluent dosing pump station and discharge piping. The dispersal fields will also require quarterly groundwater sampling, testing and reporting. In addition, the operating costs for the post equalization tank includes power costs for the mixers, diversion pumps and odor control fan. For developing these costs, it was assumed that the diversion pumps would operate approximately 10 days per year, the mixers would operate 30 days per year and the odor control fan would operate year-round. In addition, maintenance costs were assumed to include two staff for a full day to clean the storage tank at the end of the summer season and replacement of the activated carbon (assuming $25,000 to replace the carbon once every ten years or $2,500/yr.). The O&M cost for the dispersal field and post-equalization/treated effluent storage tank is estimated to be approximately $39,400 per year. The breakdown for these estimated annual costs is included in Appendix C.

7.4.4 Present Worth Analysis

The present worth of the operation and maintenance costs of a dispersal system is approximately $643,000. Including the capital costs, the full present worth value of this alternative is approximately $13,363,000.

Because this alternative is more cost-effective than the use of five separate dispersal sites, these costs will be utilized for the comparison of alternatives. However, it is noted that the CT DEEP has not confirmed that this approach will be acceptable and has not provided any requirements for sizing the equalization tank. Based on the required capacity of the post-equalization tank, need for redundancy (two separate tanks) and other regulatory requirements, the cost of this alternative may increase.

Section 8

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SECTION 8

REVIEW OF ON-GOING PROGRAM

8.1 OVERVIEW OF EXISTING PROGRAM

The WPCA has been implementing the terms of the second modified Stipulated Judgement since January 2011 to upgrade the existing septic systems in 15 focus areas. Significant progress has been made in bringing septic tanks and leaching field systems into compliance with Old Saybrook's Wastewater Upgrade Program Standards (Standards), and the latest State of Connecticut Public Health Code in 10 of the 15 focus areas. One component of the Stipulated Judgment is the requirement to install nitrogen-removing advanced treatment (AT) system components on 233 waterfront parcels. Due to uncertainty on the specific aspects of the AT program, no action has yet been taken to implement those AT components. One of the objectives of this study is to estimate the cost of completing the decentralized program, including the installation of AT components on the waterfront parcels, as well as discuss the technical feasibility of continuing this program given the most recent sea level rise and increased storm activity projections developed by GZA GeoEnvironmental, Inc., that will impact waterfront lots in low lying areas of Old Saybrook.

8.2 NUMBER OF PARCELS STILL TO BE ADDRESSED

As discussed in Section 1, it is estimated that through the end of 2018, the WPCA will have completed 732 conventional upgrades and that 355 are either upgrade compliant (U/C) or the homeowner opted out of the program. Therefore, 1,087 of the 1,688 non-AT parcels should be addressed by the end of 2018. A total of 602 non-AT parcels and 233 AT parcels remain to be completed under the next phase (Phase 3) of the current program. For the purposes of this evaluation, we have rounded these numbers up to a total of 840 parcels remaining to be completed in the 15 focus areas through the end of 2018. Those parcels are categorized as follows:

- Conventional upgrading of septic tank and leaching fields on 600 parcels (570 parcels in the five focus areas where no other work has been completed and 30 parcels in the first ten focus areas)
- Conventional upgrading on 240 waterfront parcels where AT components are also required (160 in the five focus areas and 80 in 10 other focus areas).

8.3 NATURE OF REMAINING WORK

Conventional upgrades of septic tank and leaching field systems will entail the installation of a septic tank, an effluent pump and a dispersal system, along with associated site work. For those designated waterfront parcels, the additional work items include the installation of a second pump to convey septic tank effluent to the AT component, the AT component itself, associated site work, and the installation of equipment necessary to monitor certain system functions and relay that information to a central location. The site work includes flood-protection provisions for the AT components.

8.4 ASSUMPTIONS ON AT PROGRAM

Discussions have occurred between DEEP and the WPCA over the specific requirements that will pertain to the AT components. Those discussions were not concluded, necessitating that many assumptions be made to estimate the likely costs. Both parties have agreed that the AT components would be owned privately with oversight and funding assistance by the WPCA. Each AT component would be governed by a WPCA-issued permit that would require regular maintenance of the system and periodic monitoring to confirm 50% nitrogen removal or to trigger corrective action.

The homeowner would be responsible for:

- Meeting the terms of the WPCA permit
- Paying for and maintaining the tanks and equipment
- Upgrading the home’s electrical service if required
- Paying a licensed operator to inspect the system and to obtain and analyze effluent samples.

The WPCA would:

- Pre-select one or several treatment systems
- Hire a consultant to prepare design plans
- Issue a permit for the system
- Implement a remote monitoring system
- Obtain grants and loans on behalf of the homeowner
- Prepare record ("As-built") drawings of the completed system
- Take appropriate actions to ensure compliance with the permit
- Report annually to DEEP

8.5 AVERAGE COSTS PER PARCEL

Table 8-1 summarizes the estimated capital and O&M costs for a typical parcel within the Old Saybrook Wastewater Management District (WWMD). Estimates have been prepared for those parcels requiring only a conventional upgrade and for parcels requiring both a conventional upgrade of their septic tank and leaching fields and AT components. The WPCA staff indicated that all of the waterfront parcels would require upgrading of the leaching system in addition to the AT components. In all cases the costs will include the homeowner's pro-rata share of the "program costs" incurred by the WPCA for common system elements and for engineering and administration.

These per-parcel unit costs were developed primarily from information provided by the WPCA staff regarding installations performed to date, together with Wright-Pierce's experience with on-site treatment systems in other New England areas. The conventional upgrades in the 5 remaining focus areas are expected to cost on average approximately $25,400 to construct, and approximately $200 per year to operate and maintain. These construction costs are higher than have been incurred previously in the program, due to the WPCA staff's judgement that the earlier upgrades have been performed in areas that have more favorable site conditions such as a deeper seasonal groundwater table. More recently, there have been at least eight projects that cost between $30,000 and $40,000 per parcel to construction and four additional projects that cost between $40,000 and $74,000 per parcel for conventional upgrades on difficult sites. For those parcels requiring both a conventional upgrade and AT components, the construction cost is estimated to be approximately $54,500 per parcel, with an annual O&M cost of approximately $5,000.

When these costs are compared to those for a municipally-owned community treatment system, some consideration must be given to the service life of individual treatment systems. The waterfront locations of these systems in Old Saybrook will result in periodic inundation and damage from storm surges. Considering these factors, a 15-year service life has been assumed for the AT components, compared to the traditional 20-year life of the community system. To account for that early replacement expense, the expected replacement cost at year 15 has been converted to a present worth and added to the initial capital cost. The assumptions utilized and supporting information for developing these costs is described in more detail in the memorandum on Estimates of AT Component Costs – Summary Analysis, included in Appendix A.

TABLE 8-1

AVERAGE PER-PARCEL COSTS FOR ON-SITE UPGRADES ALTERNATIVE

Item	Conventional ST/LF Upgrade	New AT Component and Conventional Upgrade
Capital Costs, $		
Septic tank	3,000	3,000
Pump	4,100	9,100
Treatment component	0	12,000
House electric service upgrade	0	1.000
Dispersal component	14,200	14,200
Site work	1,800	2,200
Remote monitoring component	0	4,000
Program costs	2,300	9,000
Total	**25,400**	**54,500**
Operation & Maintenance, $/year		
Power	0	450
Septage pumping	75	125
Inspection—routine	0	1,080
Inspection—non-compliance	0	580
Chemicals	0	30
Repairs	0	390
Effluent monitoring	0	570
Remote monitoring	0	200
Program costs	125	1,575
Total	**200**	**5,000**
PW of Early Replacement Cost, $	**0**	**11,500**
PW of O&M Costs, $	**3,270**	**81,760**
Total Present Worth, $	**28,670**	**147,760**

8.6 OVERALL COSTS

As discussed above, at the end of 2018, it is anticipated that there will still be 600 parcels remaining that require conventional upgrades and 240 parcels that require conventional upgrades with AT components. Using the per-parcel costs presented in Table 8-1, Wright-Pierce developed a preliminary opinion of the probable construction costs, annual operations and maintenance costs and present worth costs for continuing the current wastewater management program. The results are presented in Table 8-2.

TABLE 8-2

COST ESTIMATE FOR ON-SITE UPGRADES ALTERNATIVE

Item	No. of Parcels	Capital Cost	PW of Replacement Cost	PW of Annual O&M Cost	Total Present Worth
Conventional Upgrading Only					
Overall	600	$15,240,000	$0	$1,962,000	$17,202,000
Conventional Upgrading and AT Components					
Overall	240	$13,080,000	$2,760,000	$19,622,000	$35,462,000
Total-overall	840	$28,320,000	$2,760,000	$21,584,000	$52,664,000

8.7 RECOMMENDATIONS FOR THE CURRENT ON ONSITE PROGRAM

The very high annual cost to operate and maintain the AT components results in the present worth for the 240 waterfront parcels to be 70% higher than the present worth for the 600 parcels requiring only conventional upgrading.

The current program involves installation of AT components requiring significant long-term operation, maintenance, capital replacement, and logistical issues which have not yet been finalized with the regulatory agencies. The high estimated present worth of the annual O&M costs associated with the AT components is intended to include the significant program costs associated with requirements that are likely to be included in any Delegation Agreement by the CT DEEP. A discussion of the elements that are incorporated into these costs is included in Appendix A. Additionally, the 240 waterfront lots are located in areas which are potentially vulnerable to rising sea levels and increased frequency of storm surges as projected in the most recent Coastal Resiliency and Adaptation Study performed for the Town by GZA-GeoEnvironmental, Inc. The increased storm surge conditions will make these systems vulnerable to severe damage due to flooding and erosion. Rising sea levels could also result in higher groundwater tables thereby decreasing separating distances between the bottom of the leaching systems and seasonal groundwater tables. The decreased separation will particularly impact conventional septic systems, as it will diminish the capacity of the leach field and receiving soil to properly renovate wastewater. These non-monetary considerations should also be considered, in addition to a comparison of capital and present worth costs, when comparing the current program with the two community system alternatives.

Section 9

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SECTION 9

COST COMPARISON OF ALTERNATIVES

9.1 APPROACH

There are two fundamental types of costs associated with both the proposed community system and the upgrading of on-site subsurface wastewater dispersal systems:

- Capital costs—the initial construction cost of new facilities including providing and installing piping, equipment and tanks; purchase of land; engineering fees for design and construction services; and program costs expended by the WPCA to oversee the program, obtain grants, etc. The Town would levy a benefit assessment on properties connected to the community system to cover the debt service financed at 20 years. The debt service would be for the capital cost of the project minus any grants or subsidies received. This project qualifies for a 25% Small Community Grant from the Connecticut Department of Energy and Environmental Protection with the balance financed at 20 years at an interest rate of 2% per year.
- Operation and Maintenance (O&M) costs—ongoing annual expenses for labor, power, chemicals, parts, etc., as well as the costs for monitoring effluent quality.

These costs were utilized to calculate 20-year present worth costs for all three alternatives for comparison to use as a basis to recommend an alternative for the WPCA's consideration.

To provide a uniform basis of analysis for comparison, costs were computed for all remaining 840 parcels that are anticipated to be remaining after December 2018. For the community system alternatives, the cost of completing conventional upgrades to 100 parcels, in addition to the community system serving 740 parcels, we included in the cost comparison. The cost to complete the current program is based on completing conventional upgrades on 600 parcels and conventional upgrades with AT components on 240 parcels.

9.2 BASIS FOR COMMUNITY SYSTEM COSTS

The costs for each of the community system alternatives were estimated based on the costs for various system components including:

- collection system to convey wastewater to the treatment facility,
- the water pollution control facility,
- a treated effluent transport system to the dispersal/discharge site, and
- the dispersal/discharge systems.

A discussion of the specific costs included in the comparison of each community system is presented separately below. Specific parcels are identified for the location of the water pollution control facility and for subsurface dispersal sites. These specific parcels were utilized for the purpose of developing preliminary costs to compare different alternatives. ***The parcels were considered to be potentially available to the Town at the beginning of the study, however, the status of some parcels may have changed over the course of the evaluation.***

9.2.1 Community System Costs with River Discharge

The costs included in the evaluation of the community system with river discharge include:

- A low-pressure sewer collection system with individual grinder pumps at each of the 740 parcels to be served and force main piping to a treatment facility located at the Roam Tree Road site.
- A water pollution control facility consisting of influent screening, sequencing batch reactor (SBR) advanced secondary treatment, post-equalization, tertiary denitrification with a denitrification filter, UV disinfection, and a treated effluent pump station.
- Discharge piping from the WPCF site to a discharge into the Connecticut River at the Ferry Point North site as described in Section 6
- Installation of a new outfall into the Connecticut River.

These costs also include the costs of completing conventional upgrades to 100 parcels outside the five focus areas that are anticipated to remain at the end of 2018.

Our preliminary opinion of the probable capital costs and present worth costs for the community system with river discharge is summarized in Table 9-1.

TABLE 9-1

COST SUMMARY OF RIVER DISCHARGE ALTERNATIVE

Item	Capital	Present Worth of Annual O&M	Present Worth
Low-Pressure System to Roam Tree Site	$18,644,000	$2,410,000	$21,054,000
SBR WPCF	$9,314,000	$5,690,000	$15,004,000
Effluent Force Main to Ferry Point North	$2,100,000	$147,000	$2,247,000
On-Site Upgrades (100 Parcels)	$2,540,000	$327,000	$2,867,000
Total	**$32,598,000**	**$8,574,000**	**$41,172,000**

9.2.2 Community System with Subsurface Dispersal

The costs included in the evaluation of the community system with subsurface dispersal include:

- A low-pressure sewer collection system with individual grinder pumps at each of the 740 parcels to be served and force main piping to a treatment facility located at the Donnelly site.
- A water pollution control facility consisting of influent screening, sequencing batch reactor (SBR) advanced secondary treatment, post-equalization, tertiary denitrification with a denitrification filter, UV disinfection, and a treated effluent pump station.
- Discharge piping from the WPCF site to five subsurface dispersal locations at the Donnelly, High School, Roam Tree Road, Ingham Hill (town-owned) and Mill Rock Road East sites.
- Installation of the subsurface piping and chamber leaching system.
- Site work including surface restoration, and, in some areas, additional fill to provide the necessary separation distance between the bottom of the leaching chambers and the top of the groundwater mound.

These costs also include the costs of completing conventional upgrades to 100 parcels outside the five focus areas that are anticipated to remain at the end of 2018.

Our preliminary opinion of the probable capital costs and present worth costs for the community system with subsurface dispersal is summarized in Table 9-2.

TABLE 9-2

COST SUMMARY OF SUBSURFACE DISPERSAL ALTERNATIVE

Item	Capital	Present Worth of Annual O&M	Present Worth
Low-Pressure System to Donnelley Site	$14,556,000	$2,410,000	$16,966,000
SBR WPCF	$9,314,000	$5,690,000	$15,004,000
Subsurface Dispersal	$12,720,000	$643,000	$13,363,000
On-Site Upgrades (100 Parcels)	$2,540,000	$327,000	$2,867,000
Total	**$39,130,000**	**$9,070,000**	**$48,200,000**

9.3 BASIS FOR CURRENT PROGRAM COMPLETION COSTS

The opinion of probable costs to complete the current wastewater management program was developed based on costs to complete 600 conventional upgrades and an additional 240 upgrades with AT components as described in Section 8. A more detailed discussion of the development of these costs is presented in Appendix A. A summary of the costs for on-site upgrades is included in Table 9-3.

TABLE 9-3

COST SUMMARY FOR CURRENT PROGRAM COMPLETION

Item	Capital Cost	PW of Replacement Cost	Present Worth of Annual O&M	Total Present Worth
Conventional Upgrades Only	$15,240,000	$0	$1,962,000	$17,202,000
Conventional Upgrades and AT Components	$13,080,000	$2,760,000	$19,622,000	$35,462,000
Total	**$28,320,000**	**$2,760,000**	**$21,584,000**	**$52,664,000**

9.4 RESULTS / CONCLUSIONS

A summary of the present worth comparison of the three wastewater management alternatives is presented in Table 9-4 and Figure 9-1 below. These preliminary costs do not take into account any grant funding that may be available through the CT DEEP's Clean Water Fund or any local funding that may be available from the Town.

TABLE 9-4

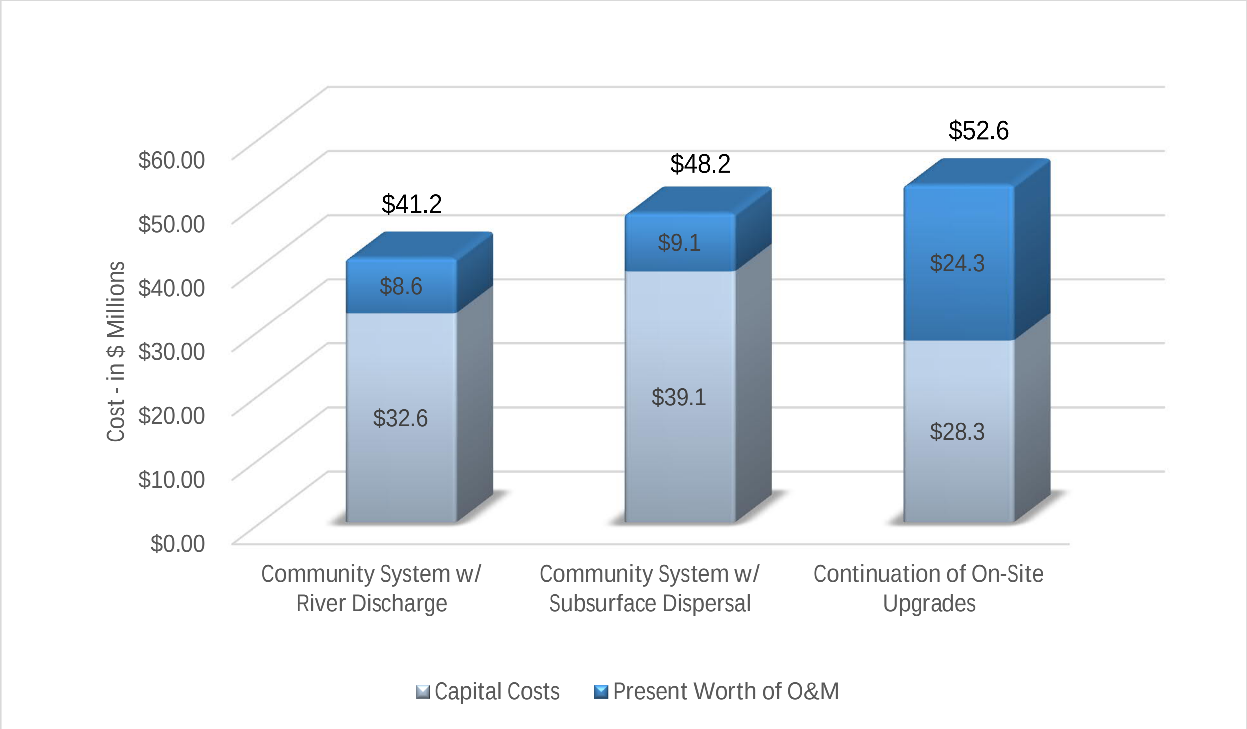
COST SUMMARY OF THREE ALTERNATIVES

Item	Community System/River Discharge	Community System/Subsurface Dispersal	Remaining Current Program
Capital Cost	$32,598,000	$39,130,000	$28,320,000
Present worth of annual O&M Cost	$8,574,000	$9,070,000	$24,344,000[A]
Present Worth Cost	**$41,172,000**	**$48,200,000**	**$52,664,000**

A. Includes present worth of AT component replacement cost for current program costs

FIGURE 9-1

COST SUMMARY OF THREE ALTERNATIVES



Based on the comparison of costs between each of the three alternatives, a community wastewater treatment system serving 740 parcels in the five remaining focus areas, with a river discharge and conventional on-site upgrades to the 100 remaining lots within the 10 focus areas appears to be the most cost-effective and feasible alternative. This alternative would be less costly to implement than either the current program or the community system with subsurface dispersal.

The community system with a river discharge also offers additional advantages over completion of the current program including:

- CT DEEP will likely require that each individual AT system achieve a 50% reduction in nitrogen. Because of the seasonal nature of many of these properties, it will be difficult to consistently achieve these removal rates with a biological treatment process. If the flow is introduced into the AT system after periods of no flow, it can take several weeks for the biology to grow sufficiently to achieve a 50% nitrogen reduction. With a single community treatment facility, it will be possible to bring individual treatment trains on-line or take them off-line to account for seasonal flow variations without completely stopping the biological process.

- The AT components would be installed at waterfront lots which are vulnerable to sea level rise, storm impacts, and flooding. The community system treatment facility would be built more inland and protected against these impacts. The collection system components would be buried and protected from flood impacts as well.
- The annual operations and maintenance costs of the AT components are significantly greater than for a community wastewater system.

9.5 SMALLER COMMUNITY SYSTEM WITH SUBSURFACE DISPERSAL

During a workshop meeting with the WPCA board, a board member asked about the potential merits of a smaller-scale community system to limit subsurface dispersal to the Donnelley/High School sites only. As shown in Section 3, the estimated capacity for these two sites, assuming that a shallower dispersal system such as drip irrigation is used, is approximately 246,600 gpd. If a 50% reserve capacity is allowed for, the capacity of this site is limited to 164,400 gpd. At 150 gpd/bedroom and an average of 2.84 bedrooms per parcel, the subsurface dispersal area could accommodate approximately 386 parcels. Based on this, the WPCA would still need to address 454 remaining parcels, many of them on difficult-to-upgrade parcels. Because these lots are considered difficult to upgrade, based on recent WPCA experience, it was assumed that conventional upgrades could be on the order of $40,000 per parcel.

To determine if this alternative could be more cost-effective that the three alternatives considered above, an order-of-magnitude estimate was developed assuming that the conveyance costs would be about 90% of the costs for a full community system and that the treatment system costs would be about 75% of the costs for a full community system. The O&M costs were assumed to be 60% of the costs for the system serving 740 parcels. These costs are presented in Table 9-5.

TABLE 9-5

COST SUMMARY OF SUBSURFACE DISPERSAL ALTERNATIVE

FOR COMMUNITY SYSTEM SERVING 386 PARCELS

Item	Capital	Present Worth of Annual O&M	Present Worth
Low-Pressure System to Donnelley Site	$13,100,000	$1,446,000	$14,546,000
SBR WPCF	$6,986,000	$3,414,000	$10,400,000
Subsurface Dispersal	$3,400,000	$186,000	$3,586,000
On-Site Upgrades (454 Parcels)	$18,160,000	$1,485,000	$19,645,000
Total	**$41,646,000**	**$6,531,000**	**$48,177,000**

Based on these order of magnitude assumptions, the cost for this alternative is similar to a community system with subsurface dispersal serving all 740 parcels. It is also noted that this alternative has not been reviewed with the CT DEEP and it is unclear if the 233 “W” lots would still need to be upgraded with AT components. If AT components would still be required, the cost of this alternative would become significantly higher. In addition, the DEEP has indicated their concern with proceeding with both conventional and AT upgrades in the five remaining focus areas due to their proximity to the shoreline and susceptibility to storm damage and potential sea level rise, and because many of these lots are small and some past upgrades in these focus areas have been very costly compared with the average cost of conventional upgrades.

9.6 VALUE OF NITROGEN REMOVAL

During meetings with the DEEP and WPCA, the nitrogen removal capabilities of each alternative were discussed. As described in Section 1, the WWMD program requires the installation of AT components for 240 near water parcels to reduce nitrogen loading to Long Island Sound (LIS). As part of this study, a community wastewater treatment system has been evaluated which would reduce the nitrogen loading to LIS even further.

It is noted that with the community treatment facility, a significant amount of nitrogen load would be removed from the wastewater. A community system will provide a higher degree of nitrogen removal than on-site advanced treatment (AT) components because the community system would employ a more robust and sustainable processes for nitrogen reduction. This cannot be practically expected from on-site systems installed on individual properties, because many of them are occupied only seasonally. By addressing 740 parcels as part of the community system, if it is assumed that the nitrogen concentration is reduced from 36 mg/L to 4 mg/L at a flow rate of 104 gpd/parcel, a total of 7,500 pounds of nitrogen would be removed annually at the treatment facility. By comparison, if 240 parcels provided with AT components reduce the nitrogen concentration from 36 mg/L to 18 mg/L (50% reduction) at a flow rate of 104 gpd/parcel, a total of 1,400 pounds of nitrogen would be removed annually.

While the principal goal of the current WWMD program is to achieve compliance with the Public Health Code, nitrogen removal is a secondary but important goal. In addition to being a more cost-effective alternative, the implementation of a community treatment system provides significant additional environmental benefits when compared with the current program with respect to total nitrogen removal.

Section 10

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SECTION 10

CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

The current scope of work for the evaluation of community wastewater system consists of three stages: 1) Desktop Evaluation; 2) Additional Investigations for Subsurface Dispersal; 3) Additional Evaluations.

The objective of stage 1 - Community Wastewater System Desktop Evaluation is to perform a preliminary cost-effective analysis comparison between the following three alternatives:

- Community wastewater system with subsurface effluent dispersal system,
- Community wastewater system with surface water (river) effluent discharge, and
- Continuation of the existing on-site wastewater management program.

This report presents the results of this Desktop Evaluation.

Stage 2 – Additional Investigation work is required only if the community wastewater system with subsurface dispersal is the recommended alternative to confirm the capacity of each of the sites.

Following these evaluations, a Phase Stage 3 effort would be necessary to address any proposed modifications to the existing wastewater management program including:

- Conducting workshops with Town staff to discuss programmatic elements of the recommended solution such as responsibilities for capital costs, ownership of facilities, development of user fees, etc.
- Developing a Sewer Service Area (SSA) map to identify parcels to be served by the community system and to identify parcels considered to be in Sewer Avoidance Areas.
- Presenting this information to the citizens of Old Saybrook. Modifications to the existing WWMD program requires public acceptance and regulatory approval, including modifications to the Stipulated Judgement.

Based on the Stage 1 Desktop Evaluation, we have developed the following conclusions:

1. A community wastewater system serving the 740 parcels within the five remaining focus areas with river discharge is the most cost-effective alternative.
2. Approximately 100 parcels within the other 10 focus areas, including the designated waterfront parcels would receive conventional on-site upgrades. No AT components would be included in the remaining on-site upgrades.
3. The use of subsurface dispersal for the disposal of treated effluent from the community system is not considered feasible for the following reasons:
   a. No one site has adequate capacity to accommodate the treated effluent from the community wastewater treatment facility.
   b. The use of multiple sites results in significantly higher capital costs.
   c. The CT DEEP may allow the use of a post-equalization/treated effluent storage tank to reduce the reserve capacity requirements and minimize the number of sites required but this does not result in this alternative being more cost-effective.
   d. The dispersal capacities of some sites are not assured and would require field investigation for capacity verification.
   e. Some sites considered for subsurface dispersal may not ultimately be available to the Town for use as dispersal sites.
4. The current program involves completing on-site conventional upgrades at approximately 600 parcels and the installation of AT components on up to 240 waterfront parcels. The continuation of the current program is not cost-effective and may also not be feasible for the following reasons:
   a. The AT components have a significant long-term annual operation and maintenance cost which results in this alternative having the highest life cycle cost.
   b. No specific AT components have been identified by DEEP as being acceptable for installation at this time.
   c. The AT components will be required to reduce nitrogen by 50% at each parcel where they are installed. Because this is a biological process, and because many of these parcels are seasonal, it is unlikely that the AT components will meet the 50% reduction requirements at all times. With seasonal properties, if the home is vacant and no wastewater is added to the biological system, it will not develop a steady,

consistent nitrogen reduction process for several weeks after wastewater flows are reintroduced.

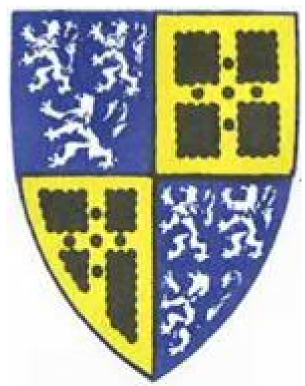
d. The 600 parcels in the five remaining focus areas that are to receive conventional on-site upgrades under the current program may not be feasible. The WPCA has completed some emergency upgrades in these areas on sites that have been significantly more costly than other sites. Some upgrades may require significant fill and retaining walls to install which is in conflict with regulations for filling within flood plain areas. The DEEP has also indicated that they may not continue to fund conventional upgrades in the five remaining focus areas.

5. The proposed AT components would be installed on designated waterfront lots that are potentially subject to storm damage and flooding impacts associated with sea level rise.

10.2 RECOMMENDATIONS

Based on our desktop evaluation and the conclusions presented above, we have developed the following recommendations:

1. The Stage 2 Field Investigation work should not be completed.
2. The Stage 3 Additional Evaluations should be conducted to refine the programmatic elements of a community wastewater system with a surface water discharge.
3. The WPCA should develop a proposed financial program for implementation of any recommended changes to the current wastewater management program, including the specific anticipated financial impacts to individual property owners.
4. The WPCA should conduct public hearings to present recommended modifications to the current wastewater management program and gain public acceptance.



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