Environmental Impact Evaluation for Coastal Wastewater Management Plan

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1. PROJECT SUMMARY

1.1 PROJECT BACKGROUND & DESCRIPTION

The Town of Old Lyme retained an independent engineering firm to perform detailed evaluations of local and regional wastewater management alternatives for the areas identified herein. The Town of Old Lyme and three chartered beach communities, including Miami Beach Association (MBA), Old Colony Beach Club Association (OCBCA) and Old Lyme Shores Beach Association (OLSBA), have expressed a desire to implement a coordinated solution to address the wastewater management needs identified in the project area. The Project Area subject of this Environmental Impact Evaluation is comprised of the beach neighborhoods known as Sound View and Miscellaneous Town Area B (MTA-B).

The Town's Environmental Impact Evaluation (EIE) is intended to address the requirements set forth in the Connecticut Environmental Policy Act (CEPA), under Section 22a-1a of the Regulations of Connecticut State Agencies and is a supporting document for the Old Lyme Coastal Wastewater Management Plan (CWMP), dated April 14, 2017 for the Town Sub-Areas, i.e. Sound View Beach and Miscellaneous Town Area B (hereafter known as the **Town Sub-Areas,** shown in Figure 1-1). Sound View Beach and Miscellaneous Town Area B are recommended to join efforts with the beach associations to install sanitary sewers in a coordinated fashion, while Hawks Nest Beach Association has been recommended for additional groundwater monitoring due to data gaps.

MBA, OCBCA, and OLSBA (hereafter called the **Beach Associations**) developed independent facility planning reports and recommendations to address identified wastewater management needs associated with the onsite wastewater disposal systems. The Beach Association's facilities planning reports concluded that the continued use of these septic systems is no longer sustainable for maintaining long term public health and environmental protection. In addition, the reports identified the construction of sanitary sewers for pumping to the existing municipal wastewater treatment plant located in the City of New London via the Towns of East Lyme and Waterford as the most cost-effective alternative for addressing wastewater management needs. The beach associations independently appropriated the funding necessary to implement the recommended solution.

This CEPA process started with the issuance of a Scoping Notice that was published in the Environmental Monitor available on the Council on Environmental Quality's website on July 22, 2014 for the Beach Associations, as well as for the Town Sub-Areas. The EIE for the Beach Associations was published on October 6, 2015 with a Record of Decision (ROD) approved on September 28, 2017. This EIE is being published for the Town Sub-Areas that were not included in the EIE and ROD for the Beach Associations.

1.2 WASTEWATER MANAGEMENT NEEDS

On-site wastewater systems in the Town Sub-Areas have been problematic for several decades because of many combinations of factors including the age and condition of these systems, soils that drain too fast and are subject to tidal influence, shallow groundwater, small lots, and excessive development density. Coupled with these conditions, the threat of intense storms and rising seasonal high ground waters are expected to further diminish the effectiveness of these systems for proper subsurface wastewater renovation.

To evaluate and prioritize wastewater management needs for the Town Sub-Areas, a wastewater management needs analysis was conducted for these Sub-Areas. Factors including lot size, soil permeability, density of development, expected nitrogen loadings, sea level rise concerns, groundwater conditions, water supply and age of septic systems were used to prioritize wastewater management needs in each Town Sub-Area. The needs analysis was performed in two phases, the first of which utilized an analytical quantitative approach and included the following criteria:

- Lot Size – More than 83% of lots throughout the Town Sub-Areas are less than 0.25 acres, while over 14% of lots are between 0.25 and 0.5 acres. The remaining less than 2% of lots are greater than 0.5 acres. Figure 1-2 illustrates the predominance of small lots (< 0.25 acres, shown in blue) within specific Sub-Areas. It is generally accepted that a lot size of at least 0.75 acres is required to site a fully compliant septic system, where an on-site well also exists. None of the lots within the Town Sub-Areas meet this recommended acreage.

- Development Density Analysis – Density of development is a surrogate for assessing the capacity of the land to properly renovate wastewater pollutant loadings such as Nitrogen and bacteria. There is an inverse correlation between density of development, and the capacity of the land to properly renovate wastewater. For this analysis, the number of equivalent dwelling units (EDU), total area per Sub-Area, and average number of people per EDU (or bedrooms per EDUs) based on census data available, were used to calculate the development density for each Sub-Area, in units of bedrooms per acre.

  The Connecticut Department of Health (CTDPH) established via circular letter No. 2000-01 (see Appendix A) a guideline of six (6) bedrooms per acre as a guideline for recommended development densities in areas with subsurface disposal systems. In high density areas such as those identified in the project area, there is a commingling effect of wastewater plumes that may migrate across property lines and pollute sensitive receptors such as onsite drinking water wells or other nearby receptors such as storm drains. Table 1-1 summarizes the development density of each Sub-Area and compares it to CT-DPH guidelines. As shown in Table 1-1, each Sub-Area within the Project Area does not satisfy CT-DPH guidelines. Table 1-1 and Figure 1-2 show a similar distribution between high development density and small lot size among the Sub-Areas. Sound View exhibits a threefold exceedance of DPH's recommended density limit of 6 bedrooms per acre.

Figure 1-2: Lot Size Distribution of Town Sub-Areas

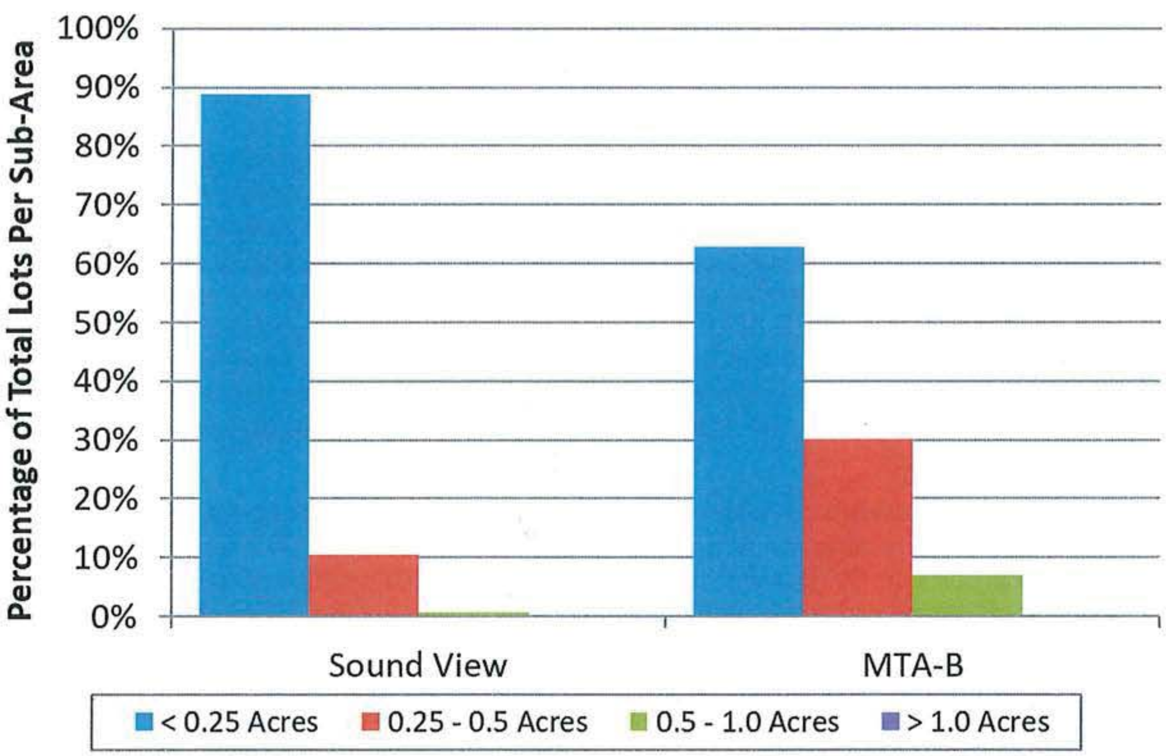

Table 1-1: Density of Development by Sub-Area

Description	EDUs	Estimated Average Number of Bedrooms per EDU[1]	Total Land Area (Acres)	Number of Bedrooms per Acre	DPH Guideline Bedrooms per Acre[2]	Guideline Exceeded
Sound View Beach	229	2.7	34.4	18.0	6.0	Yes
Miscellaneous Town Area B (MTA-B)	41	2.6	14.0	7.6	6.0	Yes

1. Average Number of Bedrooms per Residential EDU calculated based on provided Health Department data
2. From Connecticut Department of Public Health Circular Letter No. 2000-01 (Appendix A)

- Soil Drainage Classification – CT-DEEP classified soils throughout the State in terms of drainage characteristics. Soil drainage classification was used to approximate the ability of soils in each Sub-Area to accept wastewater from on-site septic systems. CT-DEEP's soil drainage classification is based on observations of the water table, soil saturation, proximity to water bodies, and soil characteristics. Figure 2-2 depicts the Project Area overlaid with CT-DEEP's soil drainage data. Soils are classified by drainage ability, including "excessively drained," "well drained," and "poorly drained." Soils considered "very poorly drained," "poorly drained," and "somewhat poorly drained" factored greatest in terms of need. The overall rating for each Sub-Area is based on percentage of each soil present in that Sub-Area. Soils classified as "excessively drained" may be considered adequate for accepting large volumes of flow but may negatively impact retention time for removal of pollutants. In terms of wastewater acceptance, excessively drained soils are rated low as negative effects on retention time are exacerbated by high development densities. As shown in Figure 2-2, most of the Town Sub-Areas are comprised of moderately well drained soil with some very poorly drained and excessively drained soils.
- Sea Level Rise & Coastal Flooding Impacts – Sub-Areas containing low-lying areas and significant coastline are most prone to coastal flooding and expected impacts associated with increases in sea levels. Severe storm events such as Storm Sandy and Hurricane Irene caused significant flooding damage in the project area. The attached Figure 2-1 was developed using the 2016 Sea Level Affecting Marshes Model (SLAMM). SLAMM predicts long term shoreline and tidal wetland habitat class changes as a function of land elevation, tide range and sea level rise (SLR). CT-DEEP calibrated the 2016 model using the State of New York 2014 planning effort for several SLR scenarios. These scenarios were reviewed and determined to be the most current and relevant available and thus applied to the Connecticut coast for several years including 2010 (initial condition year), 2025, 2040, 2055, 2070, 2085 and 2100 for years in which predicted conditions are available in the model.

  The Connecticut Institute for Resiliency and Climate Adaptation (CIRCA) at the University of Connecticut recently developed a projection of a static sea level rise of 0.5 meters (~1.8 feet) by 2050 along the Connecticut Coastline. This projection does not take into account tidal cycle, wave action or any other factors that may exacerbate storm surge. With this SLR projection, Figure 2-1 was developed using SLAMM which shows that the areal extent covered by the current base flood elevation (i.e. current 100-year FEMA flood plain) compared with the projected base flood elevation (BFE), including a 0.5 meter (or ~1.8 feet) SLR increase, will not change in areal extent due to the predominant topography of the project area. However, the SLAMM model predicts an increase in inundation frequency from a 100-year storm to 10-year storm levels by 2055.

  The increased frequency of inundation further reinforces the need to replace existing onsite wastewater disposal systems which will be increasingly subject to failure due to flooding and rising groundwater levels.

- Estimated Nitrogen Loads – According to a study by the UConn Department of Marines Sciences[1], biological uptake and reduction of nitrogen occurs within the biomat which develops on septic system leaching fields, typically providing a net removal of 40% of total nitrogen from wastewater. The remaining nitrogen is deposited into groundwater. The same study suggests cesspools, similar to septic systems but without a leaching field, would provide limited nitrogen removal of about 5%. The existing Beach Associations onsite wastewater disposal systems are expected to provide a range of total nitrogen removal between 5% and 40%, depending on the type of system and depth to groundwater.

  Nitrogen removal is dependent upon many factors including the leaching system area, number of users, water use, the condition of the onsite septic system, and the distance to the environmental receptor. Septic systems located closer to the shoreline are expected to contribute higher nitrogen loads to the sound. The New London WPCF in comparison to typical septic systems provides on average an estimated 84% removal of total nitrogen before returning treated water to the environment, based on monthly operating report data for the period of January 2013 through December 2016 assuming a typical influent wastewater nitrogen concentration.

  For the needs analysis, a total effluent flow rate for each Sub-Area was calculated assuming an average water use rate of 180 gallons per day (gpd)/EDU (2.39 people per household multiplied by 75 gallons per capita per day (gpcd)). Assuming an average septic system effluent total nitrogen concentration of 50 mg/L-N (See table 1-2 below), the average total nitrogen (TN) load can be calculated as the mass of nitrogen per volume multiplied by the volume of wastewater treated per day. It is important to note that these communities may implement water conservation measures which can contribute to higher Total Nitrogen effluent concentrations entering the ground. During the summer months increased occupancy within the Beach Communities leads to even greater total nitrogen loading.

  Table 1-2 summarizes the total nitrogen loading to environmental receptors for each Town Sub-Area, assuming a range of nitrogen removal of 5%-40% for cesspools or septic tanks and 84% for the New London WPCF. As shown in the table, the Town Sub-Areas would contribute a total daily load of approximately 12 to 19 pounds of nitrogen to the local groundwater aquifer daily. In contrast, treating all Town Sub-Area flows at the New London WPCF would contribute 3.3 pounds of nitrogen to the Thames River on a daily basis, thereby avoiding additional nitrogen deposition to the Town Sub-Areas groundwater aquifer and reducing the overall load of nitrogen to the Long Island Sound.

Table 1-2: Nitrogen Loading Discharge

Description	EDUs	Average Daily Flow (gpd)[1]	Total Land Area (Acres)	Wastewater TN Concentration (mg/L-N)[2]	Cesspool / Septic TN Removal[3]	Estimated WPCF TN Removal[4]	Cesspool / Septic TN Load Discharge (lbs/day)	WPCF TN Load Discharge (lbs/day)
Sound View Beach	229	41,220	34.4	50.0	5%-40%	84%	10.3-16.3	2.8
MTA-B	41	7,380	14.0	50.0	5%-40%	84%	1.8-2.9	0.5

1. Assuming 180 gpd/EDU.
2. Based on average TN Septic Tank Effluent - CTDEEP (Table 2). CT Department of Environmental Protection, Guidance for the Design of Large-Scale wastewater renovation systems (February 2006).
3. Based on 2016 UConn nitrogen loads study (see reference footnote 1 in page 3)

[1] "Embayment Nitrogen Loads for Long Island Sound". Jamie Vaudrey, Department of Marine Sciences, UConn. March 18, 2016.

During the second stage of the needs analysis, the following additional criteria were considered:

- Septic systems, private wells, and depth to groundwater - Table 1-3 summarizes septic system age, properties with private wells, and depth to groundwater. Overall, less than 21% of properties have septic systems that were built prior to 1980. Before this date, septic systems were not required to meet long term acceptance rates and are more likely to fail due to insufficient soil porosity or loss of acceptance over time. Over 79% of properties have onsite wells in Miscellaneous Town Area B and over 42% have on site wells in Sound View. The small lot sizes in these Sub-Areas, combined with onsite septic systems and drinking water wells, introduces a high probably that CT-DPH minimum set back requirements are not met. All three Sub-Areas show a minimum test pit depth to groundwater of 16 inches or less, which is less than the typical design minimum of 42 inches recommended by CT-DPH to facilitate proper separation from groundwater without a mounded system.

Table 1-3: Comparison of Additional Data for selected sub-areas

Description	Percent of Septic Systems Built prior to 1980	Percent of Properties on Private Wells	Minimum Test Pit Depth to Ground-water (in)	Maximum Test Pit Depth to Ground-water (in)	Percentage of Test Pits with Groundwater Observed
Sound View Beach	20.8%	42.6%	16	96	91.8%
Miscellaneous Town Area B (MTA-B)	21.4%	79.2%	38	90	81.8%

- Groundwater Quality – Groundwater quality data was provided by the Health Department for the Sound View Beach Sub-Area and included nitrogen species concentrations and bacterial counts. Figure 1-1 shows the approximate location of each groundwater monitoring well used during the groundwater monitoring campaign. Table 1-4 summarizes the groundwater monitoring results for each sample location. Table 1-5 summarizes the number of occurrences where nitrogen and bacteria limits for drinking water and wastewater effluent were exceeded. The data was collected between June 25, 1998 and June 19, 2012 from five sample stations within the Sound View Sub-Area, and was retrieved from the 2012 Nathan Jacobson (NLJ) report.

    - Nutrient Pollution

In the technical standards, CT-DPH requires minimum horizontal separating distances from septic systems to existing sensitive receptors or other points of concern including but not limited to surface waters, drinking wells, wetlands, and property lines. In coastal areas, a minimum vertical separating distance of 24" from the bottom of the leaching system to seasonal high groundwater is also required to facilitate proper wastewater renovation. These separating distances are necessary to maximize nitrogen reduction, and bacterial and viral die-off.

Table 1-4 shows that Soundview has experienced elevated and above typical background levels of total nitrogen, ammonia, and nitrate during the sampling period. As shown in Table 1-4, the guideline for total nitrogen in drinking water was exceeded three times. The data analysis shows that total nitrogen consisted mostly of ammonia and organic nitrogen, a strong indicator of the presence of raw wastewater. Sound View shows consistently high levels of Ammonia concentration which indicates raw sewage pollution.

In the evaluation of the effects of Sewering on Nitrogen Load to the Niantic River (see Appendix B), the United States Geological Service (USGS) indicated that *"Grady (1994) determined that the median nitrate plus nitrite concentration in groundwater in glacial stratified deposits beneath 21 sewered areas in Connecticut was 2.3 mg/L. This compares with a value of 1.1 mg/L of nitrate plus nitrite beneath undifferentiated urban areas in the Connecticut River, Housatonic River, and Thames River Basins (Grady and Mullaney, 1998). These* *concentrations are higher than those for undeveloped or forested areas where median values for nitrate plus nitrite ranged from 0.11 to 0.14 mg/L. ... Remaining sources of nitrogen input to the groundwater at Pine Grove include atmospheric deposition, lawn fertilizers, and pet and animal wastes."* While Nitrogen concentrations found in the environment can originate from different sources, the main source of Nitrogen loads in the project area are the septic systems. The values provided in the USGS evaluation put in perspective the groundwater quality results shown in Table 1-4 and how these numbers compare to typical background concentrations assessed elsewhere in the State.

Table 1-4 shows that Soundview exhibited elevated concentrations of multiple nitrogen species that are indicative of human waste, well above typical background concentrations. While septic systems typically provide a nominal level of nitrogen removal, high development density and inadequate spacing of septic systems may not allow for adequate reduction of nitrogen to typical background levels.

Table 1-4: Groundwater Monitoring Results - Nitrogen Species (EPA/CT Drinking Water Limit, mg/L)[1] and Bacterial Count (EPA Freshwater Limit Colonies per 100 mL)

Sample Location ID	Statistic	Nitrate (10 mg/L)	Nitrite (1 mg/L)	TKN[2]	Ammonia[2]	TN (10 mg/L)	Total Coliform (200)	Fecal Coliform (200)[3]	Fecal Strepto-coccus (200)	E Coli (126)[3]
SV-1	Average	**3.33**	0.01	0.86	0.10	4.20	13	14	18	13
	Maximum	**5.50**	0.02	2.00	0.74	6.90	80	100	100	20
SV-2	Average	0.04	0.02	6.32	**4.54**	6.82	11	23	22	13
	Maximum	0.18	0.09	9.60	**7.20**	13.10	20	250	160	20
SV-3	Average	**4.07**	0.06	1.41	0.18	5.54	23	17	21	12
	Maximum	**7.80**	0.89	12.00	**1.60**	14.70	120	100	100	20
SV-4	Average	0.05	0.03	7.87	**7.03**	7.90	16	16	65	12
	Maximum	0.28	0.08	12.00	**11.00**	12.00	100	100	600	20
SV-6	Average	0.05	0.01	2.10	0.76	2.16	64	73	71	41
	Maximum	0.23	0.05	6.00	**2.50**	6.10	300	1000	600	300
Sound View	***Average***	***1.51***	***0.03***	***3.71***	***2.52***	***5.33***	***25***	***28***	***39***	***18***
	Maximum	***7.80***	***0.89***	***12.00***	***11.00***	***14.70***	***300***	***1000***	***600***	***300***

1. EPA National Primary Drinking Water Regulations - https://www.epa.gov/ground-water-and-drinking-water/table-regulated-drinking-water-contaminants – Accessed August 26, 2016
2. No EPA or State established limits for drinking water.
3. EPA limit for drinking water is zero colonies per 100 mL and no more than 5% of samples positive per month or no more than one positive sample per month for less than 40 samples per month. No more than one sample was collected in any given month for the sampling program.

- Bacterial Pollution

Sound View has shown elevated levels of various types of bacteria, as shown in Table 1-5. The limits presented in Table 1-5 are required by EPA[2] to ensure safe public use of wastewater effluent receiving waters. However, the EPA's safe drinking water standards are much more stringent. While these standards do not apply to private systems serving less than 25 individuals, they represent a good reference for drinking water safety.

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[2] EPA Recreational Water Quality Criteria - https://www.epa.gov/sites/production/files/2015-10/documents/rwqc2012.pdf - Accessed August 26, 2016

The Total Coliform Rule in the Safe Drinking Water Act (SDWA) specifies a goal of zero for total coliforms (which includes fecal coliform and Escherichia coliform (E. coli)). Groundwater samples obtained from monitoring wells for Sound View were collected approximately biannually. Approximately 92% of samples

were positive for fecal coliform. It should be noted that fecal coliforms may be indicative of the presence of disease causing organisms. The regular occurrence of coliform bacteria in Sound View samples suggest inadequate wastewater renovation which may pose a risk of contamination of private drinking water wells in these areas.

Table 1-5: Nitrogen and Bacterial Limits Number of Exceedances[1]

Description	Total Nitrogen	Total Coliform	Fecal Coliform	Fecal Streptococcus	E. Coli
Limit (Source)	**10 mg/L (CT DPH Drinking Water Std)**	**200 #/100 mL[2]**	**200 #/100 mL (EPA)**	**200 #/100 mL[2]**	**126 #/100 mL (EPA)**
Sound View	9	2	2	5	1

1. *Based on 2012 NLJ Report*
2. *The US EPA's fecal coliform limit is used for analytical purposes.*
3. *Limits are based on the EPA 30-day geometric mean count.*

In summary, the wastewater management needs analysis shows evidence that onsite septic systems are a clear source of pollution and are no longer a sustainable solution for treatment and disposal of wastewater. Wastewater treatment alternatives are discussed and evaluated in the following section. Sound View presents consistently higher levels of ammonia concentration which indicates raw sewage pollution.

1.3 BALANCING WASTEWATER MANAGEMENT NEEDS

Subsequent to submission of the December 2014 Draft Coastal Wastewater Management Plant (CWMP) to CT-DEEP, the WPCA, Town leadership, and an independent engineering firm engaged other Town boards/commissions/residents and CT-DEEP staff in meetings and discussions related to the proposed regional alternative for the Coastal Wastewater Management Plan. To address data gaps, it was decided to perform additional monitoring within Hawks Nest. It is anticipated that a recommendation for Hawks Nest Sub-Area will be presented in a subsequent engineering report. Hawks Nest Sub-Area will be further investigated through an additional groundwater monitoring program to be performed in two phases:

1. Phase 1 – Well Network Evaluation: This phase will include well condition evaluation and groundwater flow mapping. The intent of this phase is to monitor groundwater levels and map groundwater flow direction at Hawks Nest Sub-Area. Phase 1 results will be used to determine representative locations for water quality monitoring. Phase 1 was completed in October of 2017.

2. Phase 2 – Well Installation, Sampling Program and Report: Based upon the results of Phase 1, additional wells may be installed, a well sampling program will be developed and implemented, and a separate engineering report will be developed. The results of this program will be used to generate a recommendation for Hawks Nest Sub-Area. It is anticipated that Phase 2 will begin in 2018.

The CWMP recommended that the Hawk Nest Sub-Area be monitored and further evaluated based on the results of the phase 1 and phase 2 monitoring program..

1.4 ALTERNATIVES EVALUATION

As part of the CEPA evaluation, several alternatives have been considered for this project, including a "no action" alternative and two different primary wastewater management alternatives (the local Alternative and the Regional Alternative) explained below in more detail. The primary distinction between the local and regional alternative is that Regional Alternative is predicated on the use of the existing New London Water Pollution Control Facility (WPCF) to treat wastewater from the Town Sub-Areas, and the Local Alternative relies upon the construction of a new treatment facility in Old Lyme, coupled with either local subsurface disposal and reuse, or a new surface water discharge permit for the Connecticut River.

1.4.1 Continuation of Septic System Use Alternative

Given the prevalence of the evidence provided herein, the continuation of septic system use is not a long term reliable and sustainable solution. The community pollution problem due to the high density of development would continue to be unresolved. Onsite drinking wells and groundwater in general would continue to be vulnerable to septic system pollution. Some property owners may still pursue the upgrade of onsite septic systems via conventional methods. Septic system upgrades in several project areas would likely require the use of mounded and non-traditional and/or engineered septic systems due to the limited space available and shallow groundwater conditions. Septic system upgrades in areas with limiting site conditions such as those found in the Town Sub Areas may require a variance issued by the health district due to the inability of the septic system to meet minimum required separating distances. Many septic systems located within the flood plain would remain susceptible to flooding and rising groundwater conditions due to sea level rise concerns. Continuation of septic system use would not resolve the existing 2016 notice of public health nuisance from the Town's Health Department (see appendix C).

1.4.2 Local Alternative 1 with Subsurface Disposal and Reuse

Local Alternative 1 includes multiple collection, treatment, disposal and reuse options. Following is a brief overview of each component of Local Alternative 1:

- Collection and Transmission System: A gravity collection system would collect wastewater and convey it to a common point for transmission to the treatment location. A pump station would be required to convey the wastewater from the project areas to the site where the treatment plant would be located.
- Treatment: Treatment will be accomplished with a local WPCF in Old Lyme. The level of treatment required will depend of the permit requirements associated with the permit(s) issued for disposal and/or reuse.
- Disposal and Reuse: Disposal of treated effluent will be accomplished by discharging effluent into the ground at a suitable site with adequate hydraulic capacity to receive expected peak flows from project area, commonly referred to as subsurface disposal. To supplement disposal, effluent reuse for surface irrigation is a key component of the Local Alternative 1.

Under this alternative, combined wastewater flows from the Town Subareas and Beach Associations would be conveyed to a common point for transmission to a centralized location for treatment and disposal. Several sites were evaluated by the Beach Associations and the Town for potential local subsurface disposal of treated effluent, including four undeveloped parcels along Shore Road and a vacant driving range known as "Cherrystones". However, significant limitations were identified at the Cherrystones site including potential impacts on a nearby public well field administered by the Connecticut Water Company (a.k.a. San Jose Water Company). Once evaluated, this alternative was ruled out due to its higher construction and operational costs.

1.4.3 Local Alternative 2 with Surface Disposal to the Connecticut River

Local Alternative 2 includes identical collection and treatment options as Local Alternative 1 but differs in disposal methodology. Following is a brief overview of each component of this second Local Alternative:

- Collection and Transmission System: Collection will utilize sewer infrastructure within the Town Sub-Areas to collect wastewater and convey it to a common point for transmission to the treatment location.
- Treatment: Treatment will be accomplished with a local WPCF in Old Lyme. The level of treatment required will depend of the permit requirements associated with the permit issued for disposal.
- Disposal: Disposal of treated effluent will be accomplished by discharging effluent to the Connecticut River.

Local Alternative 2 was eliminated due to higher capital and O&M costs, the need for additional land for construction of the proposed WPCF, easements, and additional permitting required for crossing of natural features.

1.4.4 Regional Alternative

Following is a brief overview of each component for the Regional Alternative:

- Collection and Transmission System: Similar to the Local Alternatives, collection for the Regional Alternative will utilize sewer infrastructure within the Town Sub-Areas. In addition to the proposed transmission main from the Town Sub-Areas to existing sanitary sewer in East Lyme, the Regional Alternative transmission system will use approximately ten miles of existing gravity sewer and force mains, and five existing pump stations in East Lyme, Waterford, and New London to convey wastewater to the New London WPCF.
- Treatment: Treatment will be accomplished at the existing WPCF in New London. New London has an existing NPDES permit dictating the level of treatment and permit criteria.
- Disposal: The New London WPCF performs surface water discharge of treated effluent to the Thames River, which is in close proximity to Long Island Sound.

The advantages and limitations of each alternative proposed are summarized in Table 1-6.

1.4.5 Cost Analysis Summary

Table 1-7 summarizes the capital and O&M costs for each of the three proposed alternatives. All capital costs are escalated to the year 2019 at an annual inflation rate of 3% to account for projects constructed in the future. Net Capital cost is the total project cost assuming a 25% grant from the CT-DEEP Clean Water Fund (CWF); however, the CWF funding does not apply to costs associated with capacity buy-in at the New London WPCF for the Regional Alternative. In order for buy-in costs to be eligible for CWF funding assistance, the buy-in fee would have to be used as a capital improvement project at the treatment plant or within the applicable wastewater conveyance infrastructure. Table 1-7 also shows the capital and O&M costs per EDU in Town owned Sub-Areas (Sound View and MTA-B).

1.5 PROPOSED ALTERNATIVE

The Regional Alternative is the proposed solution for addressing on-site wastewater disposal limitations in the Project Area due to significantly lower capital and annual O&M costs, as shown in Table 1-7. As discussed in Section 1.4, the proposed Regional Alternative will rely on a gravity sewer system to collect wastewater throughout the Town Sub-Areas. The gravity sewer system will replace the existing onsite septic systems. The estimated cost sharing for the Town's Sub-Areas for this gravity sewer system prior to any funding assistance is $9.4 M, escalated to the year of 2019. The Town has applied to the CT-DPH Drinking Water State Revolving Fund (DWSRF) to replace the aging water mains and connect existing private wells. The drinking water project upgrade was estimated at $4.5 M. This funding application is addressed further in Section 1.5.1.

Figure 1-3 shows the Project Area overlaid with the proposed gravity sewer layout. The beach associations and Town have been in discussions to build the proposed wastewater pump station in the public parking area located in Sound View at the end of Hartford Avenue near the shoreline. This location is one of the lowest topographical points in the project area and therefore it would allow all wastewater from Town Sub Areas and Beach Associations to be conveyed to a central location by gravity thus eliminating the need for intermediate conveyance facilities. The CWMP evaluated alternative methods of wastewater collection, including low pressure sewer, vacuum sewer, and septic tank sewer combination systems, and determined that gravity sewer was the most economically feasible solution. This proposal maximizes the cost effectiveness of the project by centralizing the proposed infrastructure, which allows available resources to be invested on a more cost-effective basis. The Town expects to seek the funding and local approvals necessary to build the pump station within Sound View. The common pump station will utilize new force main to transport wastewater to the existing East Lyme collection system. From there, wastewater will flow via gravity and force main to the New London WPCF for treatment through existing sewer infrastructure. Odor control measures will be implemented to reduce the presence of offensive odors and corrosion at the pump station.

The New London WPCF and existing conveyance systems have been documented to have adequate capacity to receive the projected flows from the Town Sub-Areas. The opinion of capital cost in Table 1-7 includes expected costs associated with the necessary intermunicipal agreements and capacity buy-in. Capacity buy-in is conservatively estimated to cover the costs of maintenance to downstream municipalities systems to receive the Town Sub-Area flow. A limited amount of existing wastewater infrastructure may be upgraded as part of this project, and an accompanying buy-in payment is expected.

Funding assistance for the proposed project will be provided by the CT-DEEP CWF priority list reserve for "Small Community Projects." The Town of Old Lyme would qualify for a 25% grant and a 20-year low interest loan under this funding category. Capacity buy-in costs do not qualify for CWF funding assistance unless the buy-in fee is utilized to upgrade the existing wastewater infrastructure used by wastewater flows from the Town Sub Areas and Beach Associations.

Flow projections for the Town Sub-Areas are summarized in Table 1-8, where the average sanitary flow was estimated by multiplying each Sub-Area's EDU count by the assumed average water consumption rate of 180 gpd/EDU. The collection system and pump station will be sized appropriately for the total average daily flow and peak hourly flow of the Project Area, of which the Town Sub-Areas will contribute an estimated 53,000 gpd and 199,000 gpd respectively. Initially flows are expected to be less than the projected average daily flow based on data obtained from the Point O' Woods Beach Community (POW). Between June 2013 and September 2014, the POW collection system discharged an average 20,011 gpd out of the design flow of 105,000 gpd. Peak flow from POW was recorded at 40,569 gpd in September 2014. Lower initial flows are expected to result in lower O&M costs until flows reach the projected average daily flow.

Given that the Town Sub-Areas are primarily composed of seasonally occupied residences, flows are also expected to vary significantly with the seasons. Approximately 10 to 30% of residences in the adjacent beach associations are occupied year-round. The projected average daily flow assumes full occupancy. Therefore, during off-peak seasons the average daily flow is anticipated to be significantly lower.

The CWMP identified other capital project needs within the Town Sub-Areas, such as improvements to the drinking water system within Sound View Sub-Area, upgrades to storm water infrastructure, including, where feasible, the implementation of green infrastructure enhancements to effectively manage storm water pollution concerns in the Town Sub-Areas. It should be noted that the Town applied for funding assistance from the CT-DPH DWSRF program in April of 2017 to address drinking water needs in these areas. In addition, there are likely cost savings opportunities if water, storm water, and wastewater projects are designed and constructed concurrently.

1.5.1 Drinking Water Infrastructure

The proposed alternative will also allow the Town of Old Lyme to address various public health issues within the Sound View Beach Community by connecting private wells to the drinking water system. These private wells may be subject to contamination due to soil conditions and lack of appropriate setbacks to on-site septic systems. The drinking water project will also upgrade the existing water supply system and replace the aging water infrastructure. The intent of this project is to serve existing homes that are on private wells; it is not intended for growth as infill potential is limited.

The water project would include the replacement of approximately 10,000 linear feet of 12-inch through 6-inch cement lined ductile iron water main improvements including associated service lines, gate valves, meters, and hydrants, and temporary and permanent pavement repair. Water main improvements are proposed in the Sound View Beach neighborhood in Old Lyme. The neighborhood will be served off a 12-inch transmission main in Shore Road that connects to existing Connecticut Water Company wellfield and infrastructure near Robbin Avenue. The Sound View neighborhood is currently served by Connecticut Water Company. The work will be constructed within existing roadways and service connections will be constructed to the property line. Property owners will be offered the option to connect to the new water mains upon completion of the project.

The Town is working with the CWF and DWSRF programs to fund the sanitary sewer and drinking water projects concurrently. It is likely that the sanitary sewer and water work will be performed at the same time, which will maximize cost efficiencies.

1.5.2 Storm Resiliency Considerations for the Proposed Wastewater Conveyance Infrastructure

It is also important to note that any proposed wastewater infrastructure in flood prone areas needs to be properly designed to withstand the effects of flooding impacts. Considerations regarding storm preparedness and resiliency measures for proposed wastewater infrastructure are discussed in the next paragraphs.

With SLR projections provided by CIRCA for midcentury mentioned in a previous section of this EIE, a vulnerability analysis using the SLAMM model was performed for the proposed infrastructure through the year 2055. The typical useful life of wastewater infrastructure ranges between 20 to 50 years. 2055 was chosen as the modeled SLR year because it is available in SLAMM and because it is 35 years out into the future, a reasonable life span for wastewater infrastructure.

The Base Flood Elevation (BFE) at the proposed pump station site in Sound View based on FEMA maps is elevation 12' (or elevation 13.5' with the modeled SLR increase by 2055). The current minimum elevation to protect critical equipment would be at elevation 15'. This elevation was derived from the Technical Report No. 16 "Guides for the Design of Wastewater Treatment Works" which recommends a minimum 3-foot freeboard separation between the BFE (i.e. elevation 12') and the minimum recommended elevation for the protection of critical equipment during flood conditions (i.e. elevation 15'), see Figure 2-1. Therefore, the TR-16 minimum protective elevation as documented herein is considered adequate as it would sufficiently cover the SLAMM prediction relative to SLR through the year 2055 and beyond.

Additionally, a shoreline change analysis was also assessed for this project. The attached Figure 2-4 portrays the shoreline change for the proposed project area from 1880 to 2006. This change was measured over two time periods i.e., 1880 to 2006 and 1983 to 2006 at numerous transects along the entire Connecticut (CT) shoreline. This information is derived from the 2014 "Analysis of Shoreline Change in CT, 100+ Years of Erosion and Accretion", developed cooperatively by UConn's Center for Land Use Education and Research (CLEAR), the CT Sea Grant and CT-DEEP. The goal of this analysis was to quantify shoreline change with the use of historic maps, more recent GIS datasets and a United States Geological Service software developed for this purpose.

Based on a long-term analysis developed by CT-DEEP, the University of Connecticut, and CT SeaGrant, the shoreline area near the proposed wastewater pump station and transmission line (as shown in the figure) is generally an accreting beach where shoreline change patterns have either remained constant or exhibited a positive rate (accretion) trend. Note that areas of accretion are indicated by the green and yellow dots in Figure 2-4.

The documented long-term stability of this beach combined with modern flood proofing measures for protection of the proposed wastewater infrastructure will allow the infrastructure to withstand extreme weather events.

Table 1-6: Summary of Advantages & Limitations of Alternatives Proposed

Alternative	Advantages	Limitations
Local Alternative 1 Disposal/Reuse	- No intermunicipal agreements required - Higher quality effluent - More control over annual O&M costs - Possibility of water reuse opportunities	- Higher capital and O&M costs - New local WPCF and permitting required - Additional pump station required at WPCF - More substantial land requirements - Complicated permitting process
Local Alternative 2 CT River Discharge	- No intermunicipal agreements required - More control over O&M costs	- Higher capital and O&M costs - New local WPCF required - Additional pump station required at WPCF - Land requirements - Additional permitting to cross resources - Easement(s) required
Regional Alternative	- Lower capital and O&M costs - No new WPCF required - Moderate permitting requirements - Minimal property acquisitions - Less construction required - Maximizes economies of scale due to the significantly larger user base.	- One capacity and one conveyance agreement required - Future Downstream infrastructure upgrades possible - Less control over future escalations in annual O&M costs by downstream communities

Table 1-7: Alternative Cost Comparison (2019 Cost)

	Town Share of Project (Town Sub-Areas - Sound View & MTA-B)					
Wastewater Management Alternative	**Opinion of Capital Cost[1,3]**	**25% CT-DEEP Grant[2,3]**	**Net Capital Cost[1,3]**	**Estimated Annual O&M Cost[1,3]**	**Capital Cost Share Per Town EDU[1,3]**	**Annual O&M Cost Per Town EDU[1,3]**
Local Alternative 1 Disposal/Reuse	$14,860,000	$3,715,000	$11,145,000	$853,000	$41,300	$910
Local Alternative 2 CT River Discharge	$13,742,000	$3,436,000	$10,306,000	$853,000	$38,200	$910
Regional Alternative	$9,402,000	$1,959,000	$7,443,000	$410,000	$27,600	$440

1. Costs escalated to anticipated mid-point of construction (2019) at an annual inflation rate of 3%
2. 25% CT-DEEP CWF Grant does not apply to capacity buy-in at the New London WPCF for the Regional Alternative
3. Only includes fraction of total capital cost applicable to Town owned areas within the Project Area

Table 1-8: Summary of Gravity Flow Projections for Town Sub-Areas

Sub-Area ID	Description	Equivalent Dwelling Units (EDU)	Average Daily Flow (GPD)			Max Daily Flow (GPD)[3]	Peak Hourly Flow (GPD)[4]
			Sanitary Flow	I/I[2]	Total		
6[1]	Sound View Beach	229	41,220	2,818	44,038	85,258	167,698
MTA-B[1]	Miscellaneous Town Area B	41	7,380	1,697	9,077	16,457	31,217
Total		**270**	**48,600**	**4,515**	**53,115**	**101,715**	**198,915**

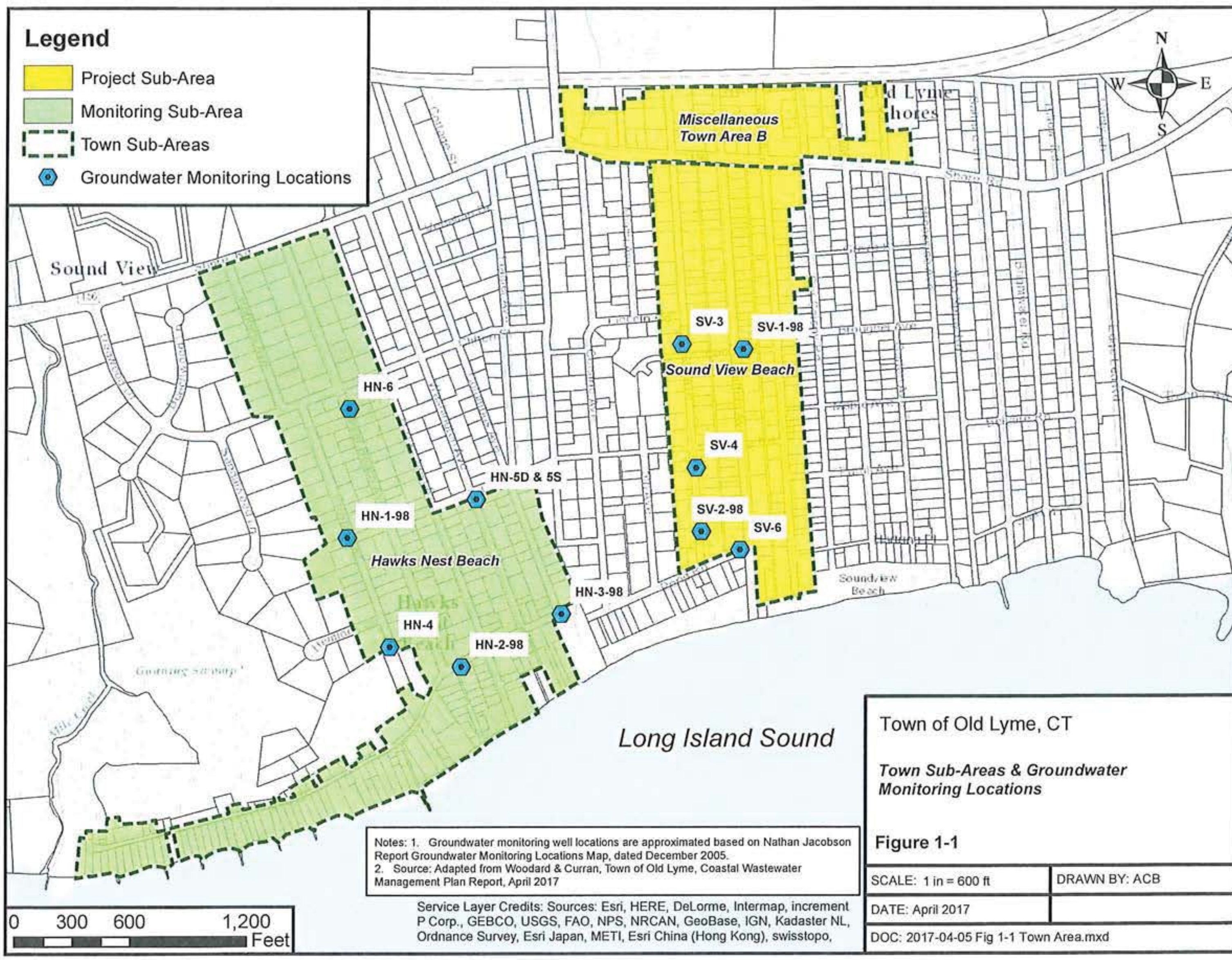
1. Existing EDU counts for Sub-Areas 6 and MTA-B are based on Town Sanitarian records and include assumed commercial contributions.

2. I/I estimate is based on a preliminary gravity sewer layout of 8-inch pipe, assuming 400 gpd/idm.

3. Maximum Daily Flow is the Sanitary Flow multiplied by a safety factor of 2, added to I/I.

4. Peak Hourly Flow is the Sanitary Flow multiplied by a peaking factor of 4, added to I/I.

As noted previously, the Regional Alternative is the proposed solution for on-site wastewater disposal limitations within the Project Area and has the advantages of significantly lower capital and annual O&M costs. This alternative includes a gravity sewer system for collection of wastewater throughout the Town Sub Areas and a regional pump station to convey wastewater to the New London WPCF, which will collectively replace the existing onsite septic systems.


Legend
Project Sub-Area
Monitoring Sub-Area
Town Sub-Areas
Groundwater Monitoring Locations
N
W
E
S
Miscellaneous Town Area B
Sound View Beach
Hawks Nest Beach
SV-3
SV-1-98
SV-4
SV-2-98
SV-6
HN-6
HN-5D & 5S
HN-1-98
HN-3-98
HN-4
HN-2-98
Sound View
Long Island Sound
Notes: 1. Groundwater monitoring well locations are approximated based on Nathan Jacobson Report Groundwater Monitoring Locations Map, dated December 2005.
2. Source: Adapted from Woodard & Curran, Town of Old Lyme, Coastal Wastewater Management Plan Report, April 2017
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo,
0 300 600 1,200
Feet
Town of Old Lyme, CT
Town Sub-Areas & Groundwater Monitoring Locations
Figure 1-1
SCALE: 1 in = 600 ft
DRAWN BY: ACB
DATE: April 2017
DOC: 2017-04-05 Fig 1-1 Town Area.mxd

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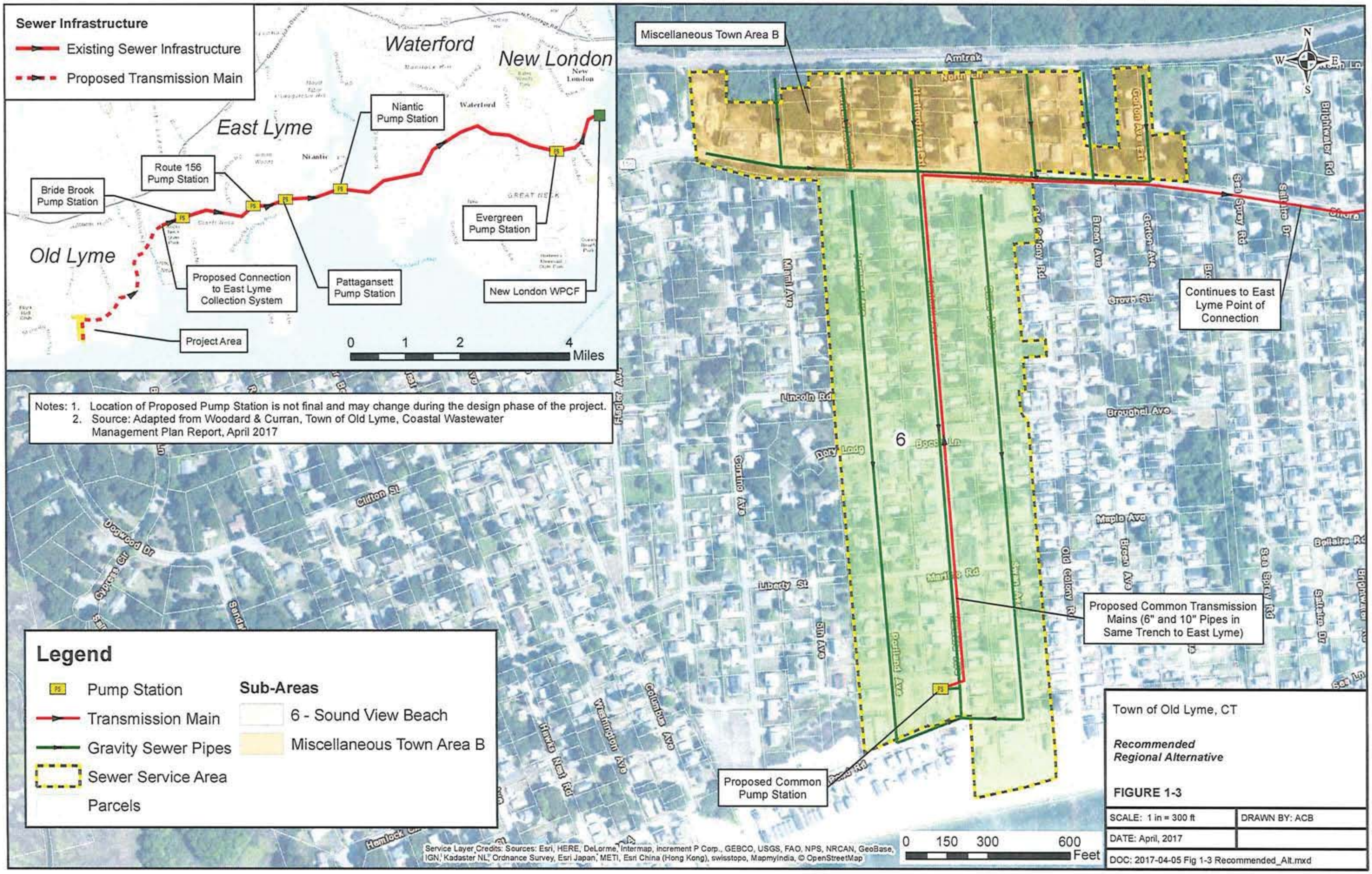
Sewer Infrastructure
Existing Sewer Infrastructure
Proposed Transmission Main
Waterford
New London
East Lyme
Old Lyme
Niantic Pump Station
Route 156 Pump Station
Bride Brook Pump Station
Evergreen Pump Station
Proposed Connection to East Lyme Collection System
Pattagansett Pump Station
New London WPCF
Project Area
0 1 2 4 Miles
Notes: 1. Location of Proposed Pump Station is not final and may change during the design phase of the project.
2. Source: Adapted from Woodard & Curran, Town of Old Lyme, Coastal Wastewater Management Plan Report, April 2017
Miscellaneous Town Area B
Amtrak
Continues to East Lyme Point of Connection
Proposed Common Transmission Mains (6" and 10" Pipes in Same Trench to East Lyme)
Proposed Common Pump Station
6
Legend
Pump Station
Transmission Main
Gravity Sewer Pipes
Sewer Service Area
Parcels
Sub-Areas
6 - Sound View Beach
Miscellaneous Town Area B
0 150 300 600 Feet
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap
Town of Old Lyme, CT
Recommended Regional Alternative
FIGURE 1-3
SCALE: 1 in = 300 ft
DRAWN BY: ACB
DATE: April, 2017
DOC: 2017-04-05 Fig 1-3 Recommended_Alt.mxd

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2. EVALUATION OF ENVIRONMENTAL IMPACTS

2.1 CEPA REQUIREMENTS

According to CEPA requirements, an EIE should discuss direct effects, indirect effects, and cumulative impact on the environment from actions associated with a project. Direct effects may result from construction activities, while indirect effects include short and long-term changes in social, economic or natural conditions. Cumulative impacts include those activities that may cause negative changes to the environment when combined with other preexisting or future environmental impacts. Public comments in response to this EIE will be reviewed as part of the environmental impact assessment process.

2.2 AIR QUALITY

No long-term change in existing air quality is anticipated as a result of the proposed plan. Construction may cause a short-term increase in total suspended particulate matter and emissions from construction equipment in the area, although the level will not be sufficient to impact ambient air quality. Prior to construction, the State air pollution program administrator responsible for enforcing the State Implementation Plan (SIP) will be contacted to determine whether construction activities must comply with the SIP. In order to minimize air quality issues, the contractor will be required to mitigate levels of excessive dust through the application of calcium chloride or water to unpaved areas subject to vehicular traffic.

CT-DEEP typically encourages the use of newer off-road construction equipment that meets the latest EPA or California Air Resources Board (CARB) standards. If that newer equipment cannot be used, equipment with the best available controls on diesel emissions including retrofitting with diesel oxidation catalysts or particulate filters in addition to the use of ultra-low sulfur fuel would be the second choice that can be effective in reducing exhaust emissions. The use of newer equipment that meets EPA standards would obviate the need for retrofits.

CT-DEEP also encourages the use of newer on-road vehicles that meet either the latest EPA or California Air Resources Board (CARB) standards for construction projects. These on-road vehicles include dump trucks, fuel delivery trucks and other vehicles typically found at construction sites. On-road vehicles older than the 2007-model year typically should be retrofitted with diesel oxidation catalysts or diesel particulate filters for projects. Again, the use of newer vehicles that meet EPA standards would eliminate the need for retrofits.

Additionally, Section 22a-174-18(b)(3)(C) of the Regulations of Connecticut State Agencies (RCSA) limits the idling of mobile sources to 3 minutes. This regulation applies to most vehicles such as trucks and other diesel engine-powered vehicles commonly used on construction sites. Adhering to the regulation will reduce unnecessary idling at truck staging zones, delivery or truck dumping areas and further reduce on-road and construction equipment emissions. Use of posted signs indicating the three-minute idling limit is recommended. It should be noted that only CT-DEEP can enforce Section 22a-174-18(b)(3)(C) of the RCSA. Therefore, it is recommended that the project sponsor include language similar to the anti-idling regulations in the contract specifications for construction in order to allow them to enforce idling restrictions at the project site without the involvement of the Department.

The operation of the proposed wastewater transmission facilities is not expected to adversely impact the existing air quality. The pump station will use electricity for power sources. However, in case of electrical outage, an emergency generator will be automatically activated to power the pump station. This diesel or natural gas fueled generator will emit a very limited amount of air pollutants. The generator is expected to run for short durations until power is restored.

2.3 WATER QUALITY

No negative impacts to surface or ground water quality are anticipated from construction of the proposed system. Erosion and sedimentation control measures will be implemented as required by Best Management Practices (BMPs) to prevent runoff into nearby surface waters. BMPs will maximize the implementation of green infrastructure measures such as pervious pavement at the pump station, rain gardens, infiltration basins, and bioretention swales adjacent to roadways.

Groundwater quality, and therefore drinking water quality, in the Town Sub-Areas is expected to improve after construction of the proposed system. Drinking water in the area is provided by local community and individual groundwater wells. Treatment of wastewater at an offsite location will ensure the protection of the local groundwater table against wastewater contamination, as the most densely populated areas become sewered and the existing septic systems are properly abandoned. Figure 2-2 shows that poorly and excessively drained soils are within the Project Area, however the proposed gravity collection system, pump station and force main will all be built within paved roadways and developed parcels.

Stormwater discharges from construction sites where one or more acres are to be disturbed, regardless of project phasing, require an NPDES permit from the Permitting & Enforcement Division. The General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities (DEEP-WPED-GP-015) will cover these discharges. The construction stormwater general permit dictates separate compliance procedures for locally approvable projects and locally exempt projects (as defined in the permit).

Locally exempt construction projects disturbing over one acre must submit a registration form and Stormwater Pollution Control Plan (SWPCP) to CT-DEEP. Locally approvable construction projects with a total disturbed area of one to five acres are not required to register with CT-DEEP provided the development plan has been approved by a municipal land use agency and adheres to local erosion and sediment control land use regulations and the CT Guidelines for Soil Erosion and Sediment Control. Locally approvable construction projects with a total disturbed area of five or more acres must submit a registration form to CT-DEEP prior to the initiation of construction. This registration shall include a certification by a Qualified Professional who designed the project and a certification by a Qualified Professional or regional Conservation District who reviewed the SWPCP and deemed it consistent with the requirements of the general permit. The SWPCP for locally approvable projects is not required to be submitted to CT-DEEP unless requested.

The SWPCP must include measures such as erosion and sediment controls and post construction stormwater management. A goal of 80 percent removal of total suspended solids from the stormwater discharge shall be used in designing and installing post-construction stormwater management measures. The general permit also requires that post-construction control measures incorporate runoff reduction practices, such as low impact development (LID) techniques, to meet performance standards specified in the permit. For further information, contact the division at 860-424-3018. A copy of the general permit as well as registration forms may be downloaded at CT-DEEP's website.

Development plans for utilities in urban areas that entail soil excavation should include a protocol for sampling and analysis of potentially contaminated soil. A soil management plan should be developed for the project to deal with soils during construction. CT-DEEP's Guidance for Utility Company Excavation should be used as a guide in developing the plan. The guidance is available on-line at CT-DEEP's website.

2.3.1 Groundwater

Minimum separation distances will be adhered to for the proposed project, ensuring that sewer infrastructure, including sewer pipes, cleanouts, manholes, and the pump station, are located at minimum prescribed distances from water supply wells and distribution lines. Regulations of Connecticut State Agencies (RCSA) section 19-13-B51 (d) prescribe these minimum separation distances to protect public health by ensuring that intermixing of drinking water and wastewater does not occur.

The United States Geological Survey (USGS) conducted a hydrogeological study of the Sound View well field in Old Lyme and produced three technical papers presenting the results. The study indicated that groundwater in the area flows predominately from north to south towards the shore. Sound View's well field is located north of Route 156 and therefore groundwater replenishment is not expected to be affected by the installation of new sewers, as the project area is downgradient of the groundwater aquifer in the area. There is no aquifer protection areas mapped in Old Lyme based on CT-DEEP GIS mapping.

Woodard & Curran performed a groundwater study in the Hawks Nest Beach Association confirming the direction of groundwater flow is north to south, and that the shallow aquifer has a close hydraulic connection with surface/subsurface infiltration, such as rainfall, snowmelt, and on-site wastewater discharge.

2.3.2 Public Water Supply

Public water supply wells are located in and nearby the Town Sub-Areas and are not anticipated to be affected by the proposed project (see groundwater section above). Many properties included within the project also rely on onsite private well systems. No change in water supply is expected from this project. Based on an annual average precipitation rate of 50 inches per year[7], the impacts on recharge potential of the aquifer are negligible. i.e. the volume of water to be moved offset for treatment is significantly less than the expected recharge from rainfall.

Pollutant discharge into the groundwater aquifer will be reduced significantly by the abandonment of onsite septic systems through the use of a sewer system to collect and treat contaminated water off site. It should be noted that the Town is working with the Connecticut Water Company (a.k.a. San Jose Water Company) to investigate upgrading the existing public drinking water supply system and expanding the service to some of the project areas to address public health concerns with private drinking water wells, but these efforts will not impact this project. Significant project cost savings can be achieved if upgrades to the water supply system can be executed concurrently with the installation of the proposed sanitary sewer system. Along with these upgrades, it is anticipated that the Town would repave affected roadways as part of this project.

2.4 FLOODPLAINS AND COASTAL ZONES

The attached FEMA Floodplain Map shown in Figure 2-1 indicates that the Town Sub-Areas are within Zone AE, Zone VE, and Zone X classified lands. Zone AE is the designation for a 100-year flood area, zone VE designates wave action areas. Zone X indicates the 500-year flood area. The remaining unshaded areas in the figure are outside of FEMA's special flood hazard zones. Properties located within special flood hazard zones require flood insurance. While the proposed pump station will be located within a floodplain, all construction will take place on currently occupied and developed property.

Proposed sewer infrastructure within the special flood hazard zones will be designed with waterproof manholes and covers, and a state of the art flood proofed pump station. All sewer infrastructure will be designed to survive major climatic events, including the 100-year flood, with the ability to restore operational capability as soon as possible afterwards. Proposed wastewater infrastructure will be designed to applicable with CTDEEP's resiliency policy and the latest revision of TR-16 to ensure operability or survivability for the 100-year and 500-year flood, respectively.

The proposed project will have a positive effect on coastal resources. A significant reduction in the amount of nitrogen discharging to coastal waters and Long Island Sound will occur with replacement of existing septic systems with sanitary sewer. The project is consistent with achieving the goals of the Long Island Sound Study.

The Town Sub-Areas are located within a state designated coastal zone, and therefore a coastal consistency review with the CT-DEEP office of Long Island Sound programs may be required for the project. However, given that the area is already densely developed and construction will take place exclusively within previously disturbed areas, no significant impacts to coastal resources are anticipated.

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[7] Average annual precipitation in the State of Connecticut, source:
http://www.weather.com/weather/wxclimatology/monthly/graph/06371

2.5 WETLANDS

The proposed work will take place on currently developed and previously disturbed areas. No work is to be conducted on wetlands or natural resource areas. Proper erosion control and dewatering measures will be implemented to prevent sedimentation of nearby wetlands. The State of Connecticut "Guidelines for Soil Erosion and Sediment Control" (CT-DEEP Bulletin 34) will be used as a basis for all soil erosion control. The risk to impact inland wetland areas (if any) accidentally during the construction operations will be mitigated by the construction of fencing delineating areas that are not to be disturbed. The contractor will not be able to store equipment, materials or otherwise disturb these areas. Wetland soil types are identified in the Soil Survey Geographic (SSURGO) database for the state of Connecticut. While there is no construction planned in inland wetlands, an Old Lyme Wetlands Permit may be required for construction activities located within 100 feet of any wetlands or watercourse, or 400 feet from a vernal pool.

The proposed force main that will convey flow to East Lyme, will cross two rivers considered tidal wetlands, including 3-Mile River and 4-Mile River. Crossing of the 3-Mile River is expected to be accomplished using trenchless pipe techniques to minimize any impacts on the tidal substrate or vegetation. The 4-Mile River crossing will utilize a suspended pipe from the existing bridge, thereby avoiding disturbing existing wetland resources. These jurisdictional crossings will require a permit from CT-DEEP Office of Long Island Sound programs.

2.6 FARMLAND

The proposed project is not expected to affect any designated farmland within the Town of Old Lyme. No existing farmland is located on or near the Town Sub-Areas, which are currently zoned as residential and densely built out. The recommended plan is not anticipated to encourage expansion of the sewer system or development of any existing farmland.

2.7 AQUIFER PROTECTION AREAS

According to CT-DEEP GIS data, the Town Sub-Areas contain no aquifer protection areas. No construction activities required by the recommended plan are anticipated to negatively affect groundwater quality. As discussed previously, the impacts on recharge potential of the aquifer are negligible as the volume of water to be moved offset for treatment is significantly less than the expected recharge from rainfall.

2.8 HISTORICAL AND ARCHEOLOGICAL RESOURCES

The National Park Service's online National Register of Historic Places was reviewed and no historic places were determined to be located within or near the Town Sub-Areas. Ten historic properties were found in Old Lyme, including the Peck Tavern, Old Lyme Historic District, and the Florence Griswold Museum, none of which would be affected by the proposed project. The National Register was accessed on September 1, 2015 at the following web address:

http://www.cr.nps.gov/nr/research/

A Phase I archeological survey may be required prior to starting construction given that the Town Sub-Areas are located adjacent to the shoreline. The survey will be initiated by submitting a project review request to the State Historic Preservation Office (SHPO).

2.9 ENDANGERED SPECIES AND NATURAL RESOURCE AREAS

Information on threatened or endangered species or habitats was requested from the CT-DEEP through the Department's Natural Diversity Data Base (NDDB) review process. Preliminary screening map data (obtained from the CT-DEEP GIS database) were reviewed as shown in Figure 2-3 and it was determined that a request for NDDB review by the CT-DEEP was necessary as the Project Area intersects with natural diversity areas. A request for review was submitted to the CT-DEEP Wild Life Division via email on August 27, 2015 and an acknowledgement of receipt was received on August 28. CT-DEEP replied with an NDDB determination letter (shown in Appendix D) on November 5, 2015, stating that there are no anticipated negative impacts to state listed species resultant from proposed activities within the Project Area. This letter expired in November 2016 and a new NDDB request was resubmitted to CT-DEEP. The preliminary screening map data was obtained from the following web address:

http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323466&deepNav_GID=1628%20 (accessed April 06, 2017)

Direct correspondence with the United States Fish and Wildlife Service (USFWS) was not required as detailed in the federal agency's "Endangered Species Consultation" web site of the New England field office:

http://www.fws.gov/newengland/endangeredspec-consultation.htm (accessed April 7, 2017)

According to the "Federally Listed Endangered and Threatened Species in Connecticut" document shown in Appendix D and accessed from the above web link, there are three species that are potentially present within the Town Sub-Areas, including the threatened Piping Plover, threatened Red Knot, and threatened Final 4(d) Rule Northern Long-eared Bat. Habitats for the Northern Long-eared Bat include mines, caves and a variety of forested areas. It is highly unlikely that the project will affect the bat's habitat given that there are no mines or caves within the Town Sub-Areas, and that construction will only occur on existing developed land. It is also expected that the Piping Plover and Red Knot habitats, coastal beaches, rocky shores, and sand and mud flats, will not be impacted by this project given the density of existing development in the Town Sub-Areas. However, a proposed gravity sewer crossing Swan Brook, adjacent to a public beach, could potentially affect the Piping Plover's habitat. The attached letter (shown in Appendix D) obtained from the USFWS states that no further consultation with the USFWS is required.

2.10 CONSISTENCY WITH CONSERVATION AND DEVELOPMENT

The Office of Policy and Management has developed a Plan of Conservation and Development (POCD) for the State of Connecticut outlining six growth management principles for guiding intelligent community development. The POCD is intended for comparison to community and municipal plans where development will make use of state funding. Growth management principles 4, 5 and 6 apply specifically to this project.

Growth management principles 4 and 5 are primarily concerned with protecting the environment and natural resources that contribute to public health and safety, including aquifers for public and private water supply. Collection and treatment of wastewater will reduce nitrogen and bacterial loading to Long Island sound and protect local groundwater quality. The recommended alternative will also protect the quality of groundwater supplying public and private water systems by removing non-compliant septic systems. Use of resilient wastewater infrastructure will further protect the environment and public health but minimizing the potential for wastewater collection or transmission system failure.

Utilizing a combination of green infrastructure and state of the art flood proofing measures within regional project area will minimize potential adverse impacts on nearby environmental resources and at the same time increase resiliency of proposed wastewater infrastructure during large storm events. Increased resiliency in this flood-prone area is also critical to avoid health hazards such as the documented risk for flooding septic systems throughout the area. Implementation of adequate flood proofing measures will allow proposed wastewater infrastructure to restore operational capability as soon as possible after large storm events.

Green infrastructure improvements proposed to be incorporated (where technically feasible) in the project area may include: rain gardens, bio-swales, stormwater, retention basins, infiltration basins, pervious pavement, rain barrels, and/or flow-through planters.

The Regional Alternative is consistent with growth management principle 6 in that it requires inter-municipal agreements between the Town of Old Lyme, East Lyme, Waterford, and New London, and encourages sharing of existing and potentially under-utilized infrastructure. Wastewater collection systems typically facilitate growth and development within the sewer service area; however, the Town of Old Lyme is concerned with overdevelopment within the Town Sub-Areas. Maintaining appropriate zoning regulations is the single best measure to avoid induced growth. Existing lots within the proposed Town Sub-Areas are mostly quarter acre residential, with some quarter acre commercial lots in MTA-B, and a strip of mixed development along Hartford Avenue in Sound View Beach. The preponderance of existing high-density residential development on highly desirable lots near beachfront reduces the possibility of undesirable additional development. There are also very few undeveloped parcels within the proposed project area, lessening the potential for urban sprawl.

The recommended plan is based solely on existing development in the proposed Town Sub-Areas. There are no allowances for future development or growth, which will otherwise have to be supported by on-site systems. The Town of Old Lyme has a sewer avoidance policy, and the WPCA has made exception only to facilitate a solution to on-going existing on-site problems for those lots included in the proposed project.

2.11 INDUCED GROWTH

This project is not expected to induce further growth as the majority of land in the Town Sub-Areas is already densely built out with residential housing units.

However secondary impacts due to the availability of sewers in flood prone areas will be, in addition, subject to FEMA National Flood Insurance Program (NFIP) regulations if the proposed building improvements are located within a special flood hazard area and are considered Substantial Improvements (i.e. "substantial improvement" pursuant to the Substantial Improvement/Substantial Damage Desk Reference FEMA P-758 May 2010). A "substantial improvement" is any reconstruction rehabilitation, addition or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure (or smaller percentage if established by the community) before the "start of construction" of the improvement. This term includes structures that have incurred "substantial damage," regardless of the actual repair work performed. The Town of Old Lyme is currently listed as a community participating in the National Flood Program (see https://www.fema.gov/cis/CT.html).

In addition to existing zoning regulations, the funding agency plans on including conditions in the funding agreement that would supplement those regulations (i.e. square footage increases) for properties located in flood hazard areas (i.e. 100-year flood zone as identified in FEMA maps). CT-DEEP can require these restrictions employing the regulatory authority under the Coastal Management Act pursuant to Connecticut General Statutes Section 22a-92. These restrictions will be incorporated and enforced via a Sewer Use Ordinance to be adopted by the Town. Section 4 of the Town zoning requirements also has policies to minimize hazards to life and property in flood prone areas.

It could be reasonably argued that winterization of homes could be pursued by way of upgrading existing septic systems employing the use of systems or methods approved by the public health code. Mounded drain fields with optimized effective leaching areas and/or installation of pump chambers could help overcome challenging site conditions within the Study Area. Therefore, the availability of public sewers does not necessarily encourage seasonal to year-round use of homes in the Study Area. It can also be argued that, due to the long lead time to develop a functional biomat, a seasonally occupied home may cause greater pollution than an identical structure occupied year-round.

In summary, the proposed project will be subject to the following conditions pursuant to local zoning restrictions, CWF funding agreement conditions and FEMA regulations:

1. Restrictions on the development of unapproved vacant lots.
2. Incorporation of Low Impact Development measures to mitigate flooding impacts in viable upland areas.
3. Conditions to limit the addition of square footage to existing homes within flood hazard areas.

2.12 CLIMATE CHANGE IMPACTS

Figure 2-1 shows the project area overlaid with CIRCA static sea level rise data from the SLAMM (see Section 1.2). As shown in the figure, much of the Town Sub-Areas lie within the inundation zones. The proposed project will reinforce coastal infrastructure by eliminating flood-prone septic systems in the Town Sub-Areas. In addition, washouts by rising tides will no longer compromise the septic systems. Gravity sewers with deeper infrastructure and flood-proof manhole covers will protect the wastewater infrastructure.

With sea level rise, due to climate change, infrastructure resiliency becomes an increasingly important goal. The proposed sewers will allow homeowners to upgrade their properties, and better use parts of the lots currently occupied by septic systems, to set up storm ready reinforcements to protect their homes. The proposed pump station will be sited at elevations above flood levels, constructed of concrete and reinforced materials, and equipped with an emergency generator, independent fuel sources, and a remote monitoring system with back-up, allowing continuous sewer service during extreme weather events. Electrical components inside the proposed pump station will be placed in elevated platforms and inside watertight compartments. Flood proofing design elements associated with the proposed pump station will be compliant with requirements included in the federal executive order No. 13690 of January of 2015, and other applicable state regulations.

2.13 NOISE

The proposed transmission station will be designed to control noise levels from operation of the pumps and generator. Noise generating operations will be mitigated by acoustical enclosures, use of sound attenuating construction materials such as acoustic block and insulation, and equipment specifications that will dictate allowable noise levels emanating from the equipment.

The construction of the wastewater collection facilities will involve the use of various trucks and construction equipment. New construction may temporarily elevate noise levels above current background levels.

The impact of construction and demolition noise can be mitigated by enforcing a weekday work schedule and normal daytime working hours. Equipment and construction noise, while noticeable, is not expected to raise noise levels above that considered deleterious.

2.14 TRAFFIC

Disruption to normal traffic patterns is expected during construction but will cease upon completion of construction. During the estimated 12-month construction period of the collection system, work will be scheduled between 7:00 AM to 4:00 PM. Traffic will likely need to be rerouted around construction as gravity sewer lines and force mains are installed. Disruption will only affect specific areas as construction proceeds. Work crews will coordinate with local authorities to minimize the impact on traffic flow. Upon completion of the daily work routine and during weekends and holidays, existing traffic patterns will prevail. Access to the site is from Route 156 only. No significant long term increases in traffic congestion are expected due to this project since the Town Sub-Areas are nearly fully built out already.

2.15 SOCIOECONOMIC IMPACTS

The proposed project will help improve water quality and therefore, environmental quality, as described in Section 2.3 above. No adverse human or environmental health issues are anticipated from this project work. The proposed project will not change the area's socio-economic make-up. The character of the neighborhoods should not change, as the wastewater collection system will be constructed in existing roadways. No population growth is expected given that the site is already densely developed and much of the population is seasonal.

The proposed pump station will be constructed with a visual style characteristic of the surrounding neighborhood. The pump station will be designed with state of the art technology to achieve maximum energy efficiency and operational reliability.

According to the U.S. Environmental Protection Agency's (USEPA) EJView mapping tool, the Town Sub-Areas consist of primarily high density, high income, and low minority households. A significant number of properties are rented seasonally, 30 to 40% according to USEPA. The output maps are shown in Appendix E. The EJView mapping tool was accessed on September 1, 2015 at the following web address:

http://epamap14.epa.gov/ejmap/entry.html

The proposed project will not pose any disproportionately high, adverse human health or environmental effects to minority and low-income populations. The residents that make up the Project Area will pay for the costs associated with this project. These costs will not affect any populations outside the Project Area. The improvements are proposed in this area due to aging infrastructure, excessive development density, shallow groundwater, and significant on-site septic systems challenges, and are unrelated to the economic or ethnic make-up of the area. The proposed sewer system will benefit the users in the proposed Project Area.

2.16 MITIGATION OF ADVERSE IMPACTS

No impacts to wetlands or other resource areas are anticipated given that the proposed project will be constructed entirely on previously developed and disturbed sites. Mitigation measures to prevent erosion and sedimentation will be implemented whenever excavation work will take place. Excavations will occur throughout the Town Sub-Areas to install gravity sewer mains, force main, and the pump station. Erosion control measures such as hay bales, silt fence, and composite socks will be placed on the downhill side of excavations to prevent sediment from reaching nearby water bodies and/or wetlands. In addition, silt sacks will be placed in nearby catch basins, if such exist, that may receive run off from site work.

In the event dewatering is required, the contractor will be required to properly discharge the water to either a hay bale sedimentation capturing device, silt bag, or other qualified device. This will prevent sediment from reaching nearby water bodies and/or wetlands.

Where bypass pumping is required, sewage flow will be pumped from the suction manhole and be discharged to the discharge manhole, which will vary depending on the particular site. The contractor will be required to submit a bypass plan, stamped by a certified Professional Engineer in the State of Connecticut, and will be required to inspect the bypass system and hoses/pipes for leaks. Any leaks discovered will be repaired before further work continues.

The direct effects of the proposed project will be temporary effects on air quality, transportation, and noise due to construction activities. The proposed project does not pose any adverse long-term indirect effects to the area. The proposed project work will remain within existing developed and previously disturbed land. The proposed facilities are consistent with the current and historical land use. There are no known adverse cumulative effects to the area as a result of the proposed project. The proposed wastewater collection system is expected to improve groundwater quality in the area through reduction of nutrient and organic loadings.

No significant impact on the environment is anticipated from the use of toxic or hazardous materials. Such materials will be limited to diesel fuel used by the emergency power generator and chemical dosing for odor control at the proposed pump station. Use and storage of these materials will be performed in accordance with State and Federal flood protection standards to maintain operation during severe climatic events and protect the environment from spills.

Substantial aesthetic or visual impacts will be minimized in the Town Sub-Areas by designing the proposed pump station inside a building that would blend-in within the architectural character of the surrounding area. The remaining sewer infrastructure will be buried and out of sight.

2.17 RESPONSE TO CEPA SCOPING NOTICE

This CEPA process started with the issuance of a Scoping Notice that was published in the Environmental Monitor available on the Council on Environmental Quality's website on July 22, 2014 for the Beach Associations, as well as for the Town Sub-Areas. The EIE for the Beach Associations was published on October 6, 2015 with a Record of

Decision (ROD) approved on September 28, 2017. This EIE is being published for the Town Sub-Areas that were not included in the EIE and ROD for the Beach Associations.

The July 22, 2014 Scoping Notice included a project description, a map of the proposed project area, a conceptual layout of the proposed sewer system, as well as a figure illustrating the alignment of the existing downstream receiving sewers in East Lyme and Waterford. During the public comment period, State agencies, members of the public and other interest groups were afforded the opportunity to provide comment letters to CT-DEEP. Received comment letters are appended to the CWMP. Following is a summary of five comment letters that were received by CT-DEEP, as well as a statement for each summarizing how these comments were considered and incorporated into the updated CWMP:

- *Eric Thomas of CT-DEEP submitted an email, dated August 20, 2014, inquiring as to whether the Niantic Pump Station and/or force main in East Lyme were going to be upgraded as part of the proposed project. Mr. Thomas inquired as to the current condition of the Niantic force main below the Niantic River.* There are no proposed upgrades to the Niantic Pump Station as part of this project, and the design pumping rate of the Niantic Pump Station is not expected to change as a result of the proposed Old Lyme project. Woodard & Curran did mention this comment to East Lyme Water & Sewer staff at a Fall 2014 meeting. East Lyme is in the process of considering future needs at the Niantic Pump Station and should coordinate any potential force main evaluation tasks with CT-DEEP as part of their independent project work.
- *Marcy Balint of the State of Connecticut submitted an email on August 20, 2014, via David Fox (also of the State), to CT-DEEP. The email summarizes comments regarding the project's consistency with the State's Water Quality policies, coastal resiliency, and climate change considerations.* As a result of these comments, Woodard & Curran and CT-DEEP met in November 2014 to update the wastewater management needs analysis to ensure that it considered sea level rise, coastal resiliency, and other measures to improve coastal management and water quality goals. The proposed project is only serving existing development, and there are no allowances for future flows associated with in-fill development as part of the proposed project. CT-DEEP has stated that the future loan/grant agreement, through Connecticut Clean Water Fund funding, will include a provision stating that only existing wastewater needs from previously developed parcels can be served through the proposed wastewater infrastructure to be constructed, and funded by CT-DEEP. A condition limiting the addition of square footage to existing homes located within flood hazard areas as mapped by FEMA will also be incorporated in the funding agreement. Additional control measures will include the implementation of an inter-municipal agreement with the "tri-town" municipalities, which will limit the amount of flow that can be discharged into the system from the Project Area. Sanitary sewers will ultimately be limited to the confines of the Beach Association boundaries and proposed Town Sub-Areas as identified in the sewer service maps for the project. Lastly, the project will incorporate where technically feasible, Low Impact Development (LID) elements to maximize stormwater infiltration into the ground throughout the proposed sewer project area (e.g., rain gardens). This will be done with due consideration of the required setbacks prescribed within the Regulations of Connecticut State Agencies in Section 19-13-B51d for the protection of drinking water resources.
- *Ellen Blaschinski of the Department of Public Health submitted a letter to CT-DEEP on August 22, 2014. The letter included questions relating to the sewers supporting future growth in the proposed service area. As well as statements related to confirming that existing septic systems will be properly abandoned and other sensitive environmental and public health considerations be included in the proposed project.* In response to these comments, the proposed sewer service area has been updated to eliminate undeveloped lots, include only existing development, and does not include any flow allowances for future development. Vacant lots would have to be compliant with existing local zoning regulations and demonstrate that they can sustain a fully code compliant septic system in order to be allowed to tie into the sewer system. This is consistent with the Town of Old Lyme's long-standing goal to avoid sewers, except in this case where it is the only viable and cost-effective alternative to solve existing on-site wastewater management challenges and pollution problems.

The Connecticut Coastal Management Act ("CCMA") and State Flood Management program contain regulatory tools codified in Connecticut General Statutes Sections 22a-92(b)(1)(B) and 25-68 respectively, for evaluating and restricting potential collateral impacts associated with these concerns. Based on these regulatory powers coupled with the induced-growth control measures discussed above, the state funding agreement will include restrictive language to minimize these concerns. While it is expected that environmental and public health benefits that will be achieved through the implementation of the proposed sanitary sewers will significantly offset any other collateral concerns, it is also the state's priority to minimize the exposure of lives and property to flood hazards, reduce non-point source pollution impacts and avoid potential overloading of other infrastructure in the Project Area. The Town of Old Lyme, with CT-DEEP oversight, will be responsible for implementing tools for developing a methodology for implementation of mitigation measures to address these concerns.

Construction of the proposed sewer system will be conducted in a manner that is protective of water supply infrastructure. Existing septic system will be abandoned in accordance with Public Health Code requirements once the sanitary sewer system is constructed.

- *David Potts of Killingworth, Connecticut submitted a letter to CT-DEEP on August 8, 2014. The letter advocates for solutions relying on the continued use of on-site wastewater (i.e. septic systems) with local sub-surface disposal systems.* As part of this project and updated Report, on-site systems were eliminated as a viable cost-effective alternative in the proposed project area. The wastewater management needs analysis in Section 2 of the CWMP summarizes these considerations as well as reasons why on-site systems are not the most appropriate alternative in the proposed Project Area. Implementation of decentralized alternatives were evaluated within the facilities plan reports for the chartered beach associations and ruled out due to the unavailability of suitable land and high density of development. In addition, more centralized on-site "Local" alternatives were considered, but the costs are higher than that of a regional alternative, and there are more significant permitting requirements for the centralized/local alternatives.

  Monitoring data clearly indicates elevated concentrations significantly above background levels of not only parameters such as ammonia, but also pathogens, both of which are strong indicators of wastewater pollution. Nitrogen and pathogenic contamination is a significant concern during the summer months when people use, very actively, the shoreline for swimming or fishing. Summer months is when people are most likely to come into contact with contaminants. Sampling results are further corroborated by monitoring records maintained by the Town Health Department which show a prevalence of shallow groundwater conditions and ammonia pollution, especially, within the Sound View beach community.

  The proposed project is to address existing pollution concerns associated with excessive densities of development coupled with aging systems, poor soil conditions, small lots, and shallow groundwater; while minimizing to the maximum extent possible any additional development pressures that may arise associated with the project.

  Proposed infrastructure will be kept to a minimum with one pump station and force main shared by all the beach associations. Wastewater will be collected via gravity pipes, which will further reduce the need for additional pumping equipment within the flood zone. The project will also include, where feasible, the implementation of green infrastructure enhancements to effectively manage storm water pollution concerns.

  With effective implementation of low impact development, green infrastructure measures and other growth control measures discussed above, secondary effects associated with the proposed project will be minimized substantially.

- *Bruce Wittchen, Connecticut Office of Policy & Management submitted a letter to CT-DEEP on August 22, 2014. The letter is requesting clarification on the rationale for the alternative selection (comparing them to historic Town committee meeting minutes), expectations for expansion of sewer service area, and how climate* *change considerations are being incorporated.* The CWMP clearly details the options and alternatives in Section 1-7 and explains the rational for recommendations in Section 8. The CWMP represents a culmination of numerous meetings and introduces new data; therefore, it builds upon and likely supersedes historic meeting minute items. The regional alternative has a significantly lower capital and Operation and Maintenance costs associated therewith and for this reason was selected to address the identified wastewater management needs in the Town Sub-Areas.

Regarding expansion of the sewer area, Section 2.7 of the CWMP reviews the sewer need areas consistency with the State Plan of Conservation and Development. The proposed sewer system will serve existing developed properties with the potential of serving additional vacant lots if the conditions discussed in the preceding paragraphs are met. It is envisioned that upgrades to other infrastructure within the Town Sub-Areas such as stormwater and drinking water systems will be conducted concurrently with the sewer system to maximize project cost efficiency, and to increase storm resiliency and preparedness.

As noted in previous section of this EIE, climate change (SLR and Shoreline Change) is a major consideration within the Needs Assessment in Section 2 of the CWMP. SLR and Shoreline Change considerations will be an integral part in the design of the collection system and shared pump station. Proposed wastewater infrastructure will be designed and constructed to meet resiliency and preparedness requirements in flood prone areas. The proposed conceptual layout optimizes the cost effectiveness of the project by way of centralizing the proposed infrastructure which allows available resources to be utilized on a more optimal basis to build a fully resilient pump station, force main and gravity sewers. The proposed wastewater pump station will be one of the most resilient and state-of-the-art pump stations built to date in Connecticut. The topography of this area is mostly sloped in a north to south direction which allows the entire collection system to flow by gravity minimizing the amount of mechanical systems needed for conveyance.

Substandard septic systems, which are prone to flooding will be eliminated, which may facilitate the retrofitting of existing properties to better withstand the effects of flooding events and improve community recovery times after severe climatic events.

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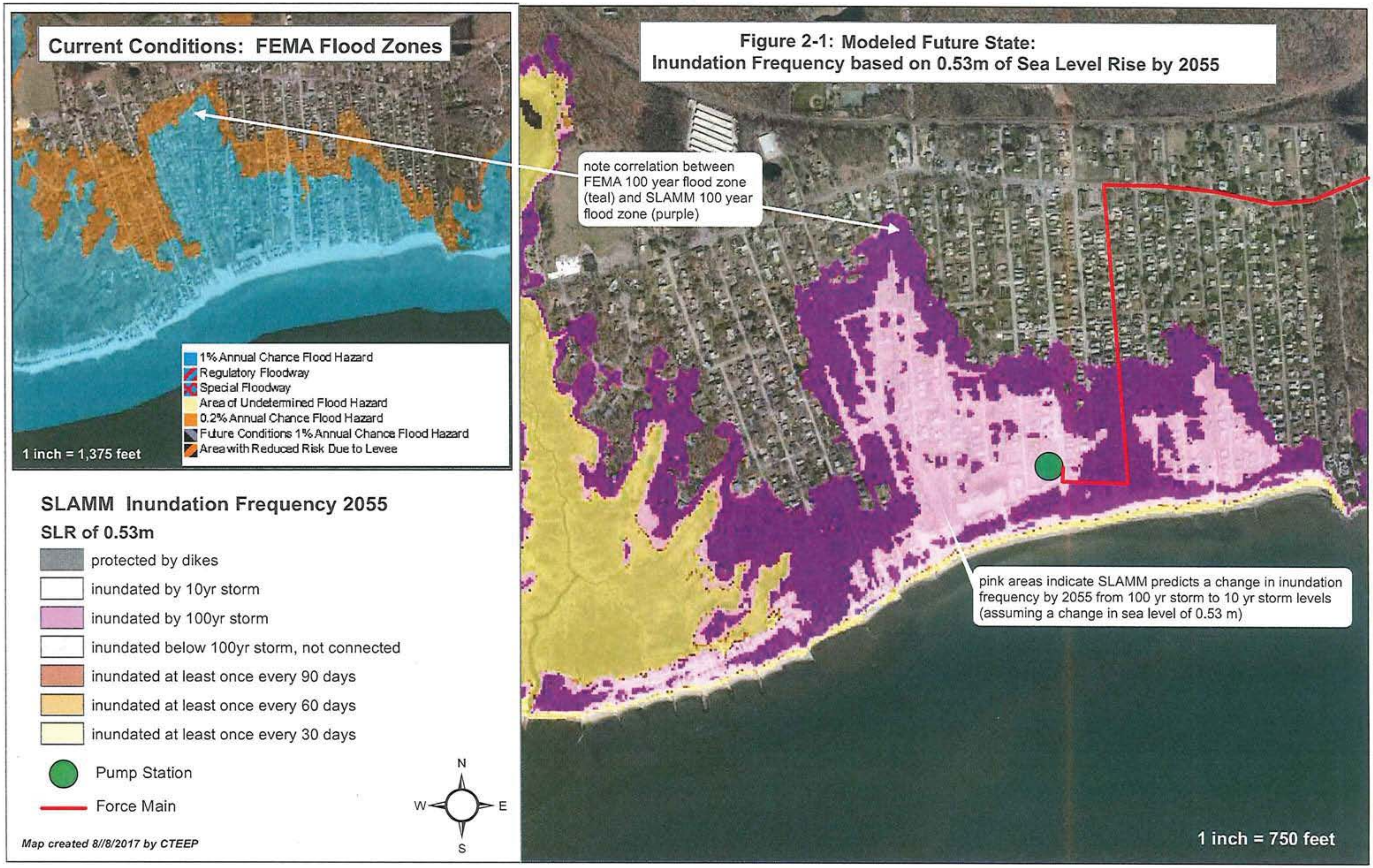
Current Conditions: FEMA Flood Zones
1% Annual Chance Flood Hazard
Regulatory Floodway
Special Floodway
Area of Undetermined Flood Hazard
0.2% Annual Chance Flood Hazard
Future Conditions 1% Annual Chance Flood Hazard
Area with Reduced Risk Due to Levee
1 inch = 1,375 feet
Figure 2-1: Modeled Future State:
Inundation Frequency based on 0.53m of Sea Level Rise by 2055
note correlation between FEMA 100 year flood zone (teal) and SLAMM 100 year flood zone (purple)
pink areas indicate SLAMM predicts a change in inundation frequency by 2055 from 100 yr storm to 10 yr storm levels (assuming a change in sea level of 0.53 m)
SLAMM Inundation Frequency 2055
SLR of 0.53m
protected by dikes
inundated by 10yr storm
inundated by 100yr storm
inundated below 100yr storm, not connected
inundated at least once every 90 days
inundated at least once every 60 days
inundated at least once every 30 days
Pump Station
Force Main
N
W
E
S
Map created 8//8/2017 by CTEEP
1 inch = 750 feet

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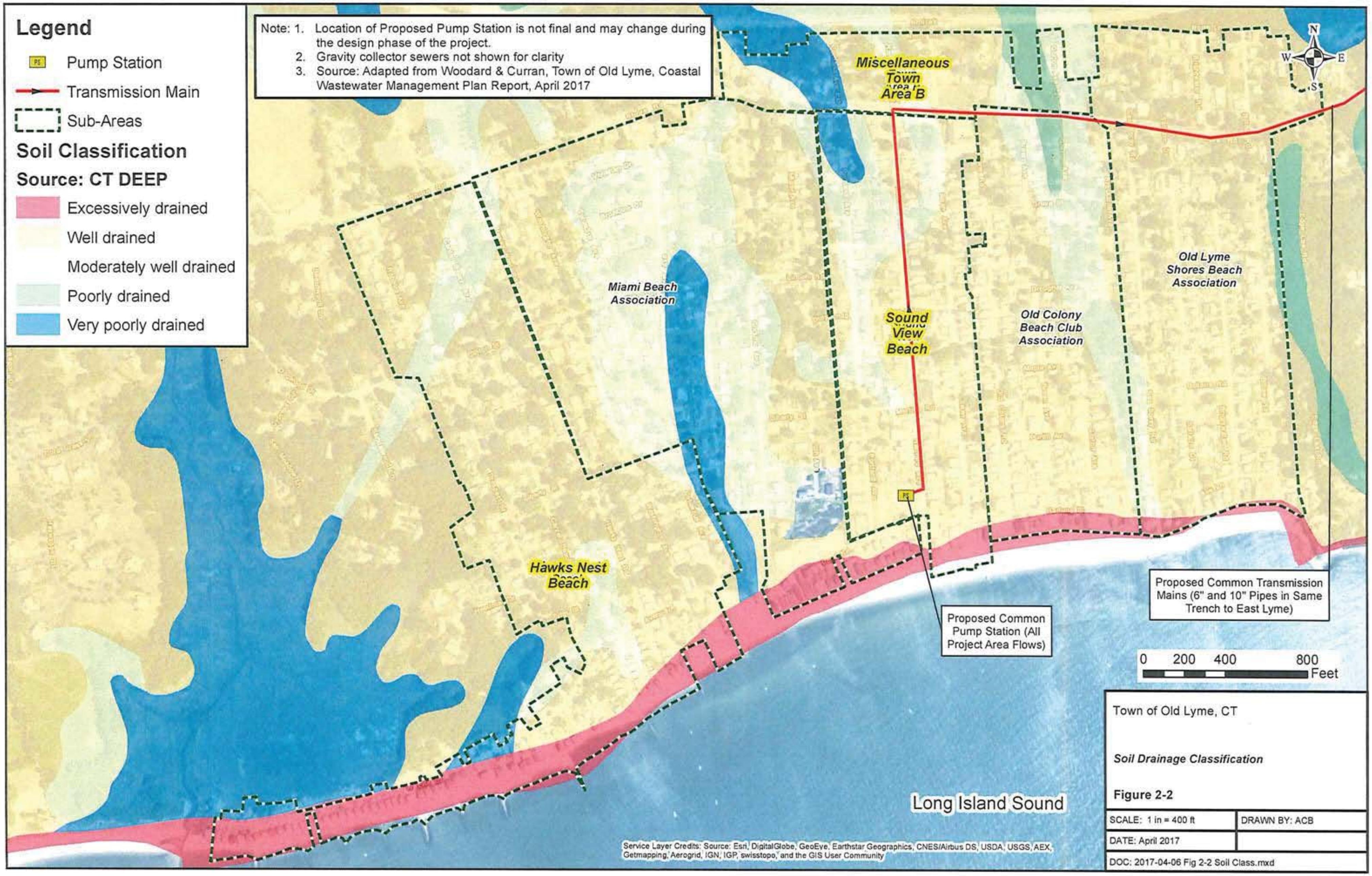
Legend
Pump Station
Transmission Main
Sub-Areas
Soil Classification
Source: CT DEEP
Excessively drained
Well drained
Moderately well drained
Poorly drained
Very poorly drained
Note: 1. Location of Proposed Pump Station is not final and may change during the design phase of the project.
2. Gravity collector sewers not shown for clarity
3. Source: Adapted from Woodard & Curran, Town of Old Lyme, Coastal Wastewater Management Plan Report, April 2017
Miscellaneous Town Area B
Miami Beach Association
Sound View Beach
Old Colony Beach Club Association
Old Lyme Shores Beach Association
Hawks Nest Beach
Proposed Common Pump Station (All Project Area Flows)
Proposed Common Transmission Mains (6" and 10" Pipes in Same Trench to East Lyme)
Long Island Sound
0 200 400 800 Feet
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Town of Old Lyme, CT
Soil Drainage Classification
Figure 2-2
SCALE: 1 in = 400 ft
DRAWN BY: ACB
DATE: April 2017
DOC: 2017-04-06 Fig 2-2 Soil Class.mxd

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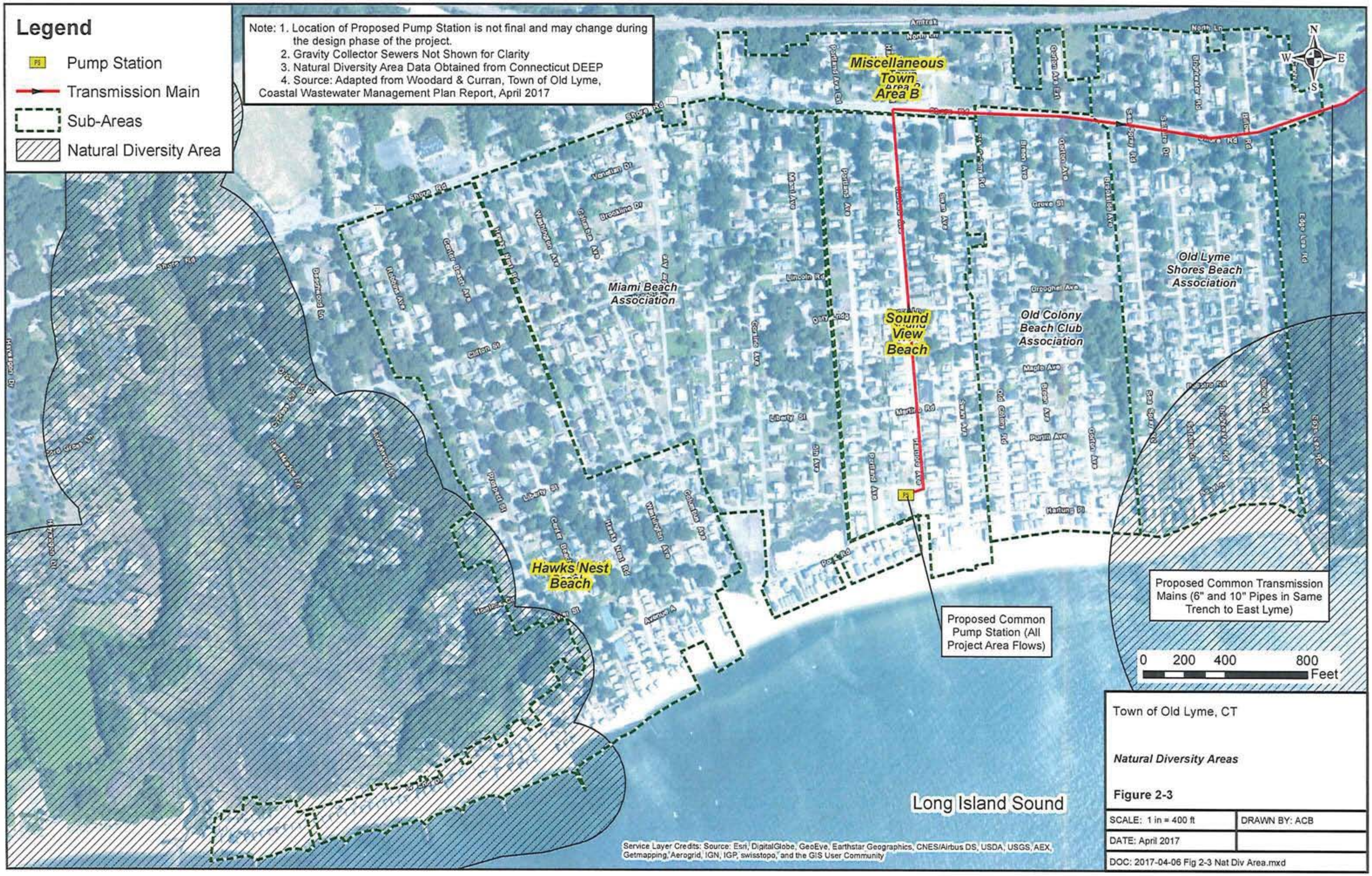

Town of Old Lyme, CT	
Natural Diversity Areas	
Figure 2-3	
SCALE: 1 in = 400 ft	DRAWN BY: ACB
DATE: April 2017	
DOC: 2017-04-06 Fig 2-3 Nat Div Area.mxd	

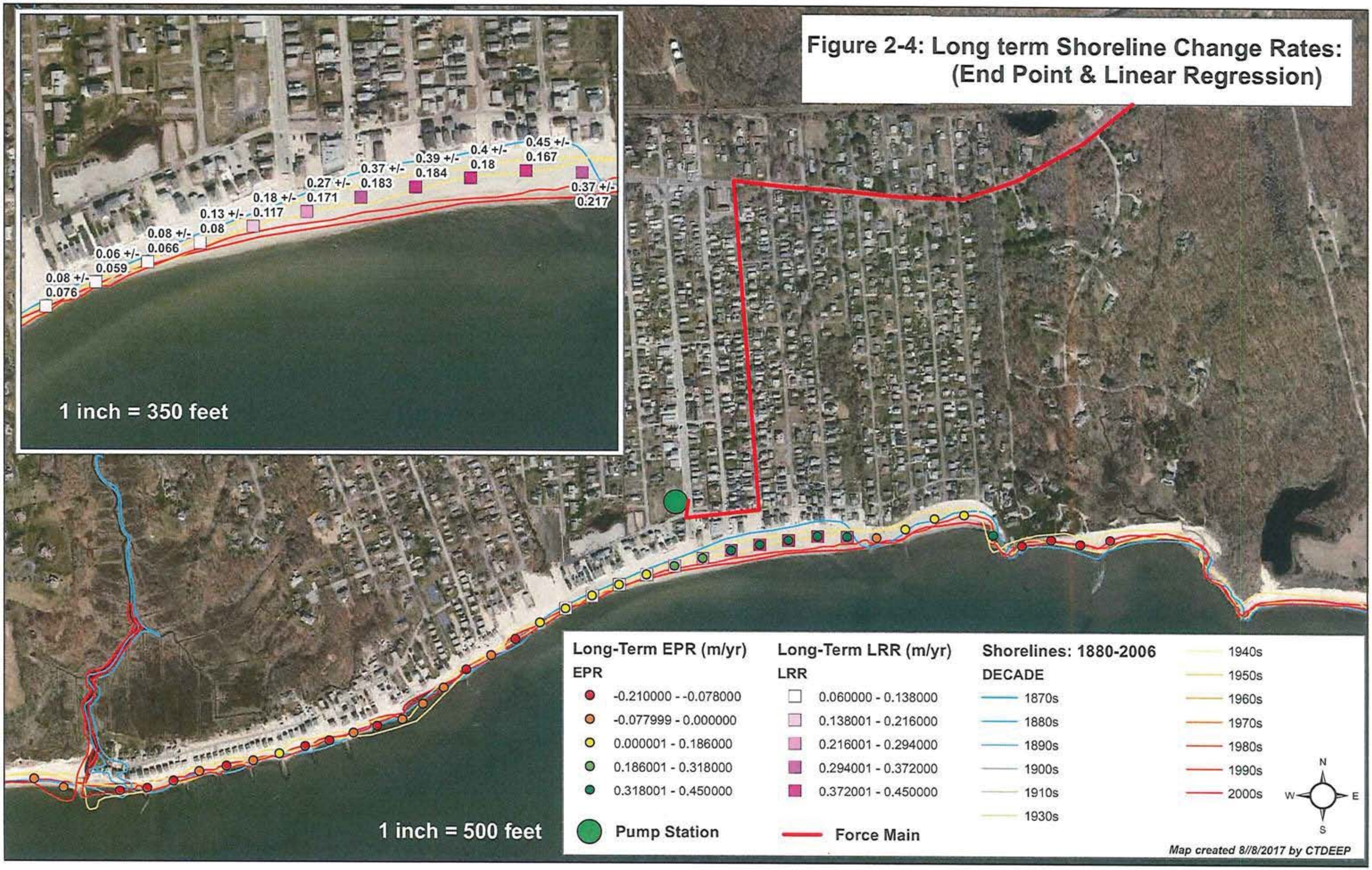
Figure 2-4: Long term Shoreline Change Rates:
(End Point & Linear Regression)
0.08 +/- 0.076
0.06 +/- 0.059
0.08 +/- 0.066
0.13 +/- 0.08
0.18 +/- 0.117
0.27 +/- 0.171
0.37 +/- 0.183
0.39 +/- 0.184
0.4 +/- 0.18
0.45 +/- 0.167
0.37 +/- 0.217
1 inch = 350 feet
1 inch = 500 feet
Long-Term EPR (m/yr)
EPR
-0.210000 - -0.078000
-0.077999 - 0.000000
0.000001 - 0.186000
0.186001 - 0.318000
0.318001 - 0.450000
Pump Station
Long-Term LRR (m/yr)
LRR
0.060000 - 0.138000
0.138001 - 0.216000
0.216001 - 0.294000
0.294001 - 0.372000
0.372001 - 0.450000
Force Main
Shorelines: 1880-2006
DECADE
1870s
1880s
1890s
1900s
1910s
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s
N
W
E
S
Map created 8//8/2017 by CTDEEP

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APPENDIX A: CT DPH CIRCULAR LETTER 2000-01

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

DEH Circular Letter 2000-01

TO: Directors of Health
Chief Sanitarians
Professional Engineers
Licensed Installers/Cleaners

FM: Frank A. Schaub *FAS*
Supervising Sanitary Engineer
Environmental Engineering Section

DATE: January 13, 2000

RE: Sewage Updates

1. Year 2000 Revisions to Technical Standards
2. Code Training and Discussions
3. Installation of Pump Vaults in Septic Tanks
4. The Density of Developments
5. Septic Tank Outlet Filter Letter

1. **Revision to Technical Standards:** Our section has completed revisions to the Technical Standands and the publications are now available to health departments and the public. *Although the changes made to the Technical Standards become effective January 1, 2000, new requirements in Section V, Septic Tanks will not be required until July 1, 2000.* Septic tank changes include compliance with ASTM C1227, installation of outlet filters, and installation of manhole extensions on existing deep tanks. Even though all of our state septic tank manufacturers have been aware of these forthcoming changes, they still have many tanks in stock and the next six months will give them an opportunity to eliminate that stock and comply with the new requirements for septic tank construction. We have delivered many of the Technical Standards to local health departments already and will be mailing a few more in the near future. Engineers and installers may purchase the document for $3.00 by mailing a check made out to Treasurer, State of Connecticut, and mailing it to the address below. Please mark the envelope "Attention – Joseph Mitchell" so that your document can be quickly mailed.

2. **Code Training and Discussions:** As with past changes to regulations or Technical Standards, our staff will be assisting local health departments in conducting meetings locally to review the changes and discuss other items of concern to health departments, engineers installers, and cleaners. Several of these meetings have already been scheduled and a few have been successfully completed. In addition to reviewing the new changes, we have various samples of septic tank effluent filters so all can review and inspect first hand. We are requesting health departments locate suitable sites for training of their area engineers,

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installers and cleaners. We would prefer a minimum of 40 individuals at each session and further suggest small health departments contact adjacent health agencies to coordinate training and the selection of the best site. We would like to do the training during normal working hours but are also willing to conduct evening sessions if the demand is there. A three-hour minimum is necessary to review all the changes, discuss filter inspections and respond to questions from the attendees. The format which brings regulators, engineers, installers and cleaners to the same meeting has been preferred by the local health departments. The months of January and February are preferable for conducting these training sessions. Please contact us so we can lock in the dates and make preparations for your area. We can bring copies of the new regulation for sale at these meetings.

3. **In-Tank Pump Vaults:** Attached please find a copy of a letter which was recently written to address installation of pump vaults within a septic tank. We believe the letter is self-explanatory and provides the names of three companies that have requested approval for use of these vaults. You will note that each company utilizes a screened (filter like) pump vault in the second chamber of the tank that allows effluent at mid depth to enter the vault. These screened vaults would meet the requirements for installation of an outlet filter in a septic tank.

4. **Density of Development:** Over the past two years, we have been working with our sister agency, the Department of Environmental Protection (DEP) to address groundwater pollution in several densely developed residential areas in our state. Some of these involve inland watercourses and others are coastal developments with both year round and seasonal use homes. We are all familiar with densely developed residential subdivisions and the typical problems of small system failures, pollution of storm drainage systems and tidal flush systems which may have been constructed in or close to the seasonal high ground water levels.

   Some municipalities and DEP have identified groundwater pollution problems involving high ammonia, nitrogen and bacteria/viruses on properties with lots as small as 1/8th or 1/10th of an acre. Even lots with "good soils" that do not suffer from hydraulic limitations can create pollution problems in dense developments. High-density developments with these soils will not pollute storm drainage systems, cause surface breakouts, or backup into the houses. They will however, adversely affect groundwater quality due to increased nitrogen loading. One can easily imagine the impact of eight three-bedroom homes constructed on a single 1-acre parcel.

   Section 19-13-B103e (a)(4) states that no permits shall be issued "for any new subsurface sewage disposal system where the naturally surrounding soil cannot adequately absorb or disperse expected volume of sewage effluent without overflow, breakout or detrimental effect on ground or surface water". Several years ago, we addressed the absorption and dispersal of effluent by naturally occurring soils with Minimum Leaching System Spread

(MLSS). We would now like to bring forth our concerns with respect to high-density development. Recent modifications to our Technical Standards include a system, that compresses a large amount of leaching area into a small area. Due to its compact size, previously non-buildable parcels underlain by well-drained sand and gravel soils may now be reconsidered for development in light of this change. With that in mind, we are recommending that any reconsideration for lot development also include scruitinization with respect to nitrogen pollution. Use of DEP's 1982 pollution renovation criteria could be utilized for this calculation. If any existing or proposed lots were being considered for new construction, we would recommend local health departments require nitrogen analysis for all parcels where the density of development exceeds one bedroom per 0.167 acre. If more than a two-bedroom house was proposed on a third acre parcel or less, we would recommend the analysis be performed. If more than a three-bedroom home were proposed on a one half-acre parcel, we would recommend nitrogen analysis be performed. Please note that these guidelines are consistent with the existing Public Health Code, which is intended to protect both public health and the environment. They should be applied to all new construction (and not include repairs) no matter what kind of leaching system is being proposed.

5. **Septic Tank Effluent Letter:** Enclosed please find a five page informational letter on tank outlet filters. This document should provide answers to many frequently asked questions. Please feel free to reproduce this document for local distribution as needed.

Enclosure (1) Pump Vault Letter
(2) Septic Tank Filter Letter
(3) Technical Standards Training Sessions - Listing

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STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

TO: **Directors of Health**
Chief Sanitarians
Professional Engineers
Licensed Installers

FROM: **Frank A. Schaub**
Supervising Sanitary Engineer
Environmental Engineering Section

DATE: **January 13, 2000**

RE: **APPROVAL OF IN-TANK FILTER/PUMP UNITS**

Over the past several years, several manufacturers of filtered pump vaults have requested approval of their products for installation in a septic tank where pumping to the leach field was required. Typically, the vault is installed in the second compartment of a specially modified septic tank with an opening large enough to facilitate the circular filter/pump vault unit that normally extends above the top of the tank. The extensions come with an access manhole that is extended to grade. The filtered units draw effluent from the mid-section of the tank and the filter not only provides a better quality effluent for discharge to the system but also protects the pump.

In our Technical Standards under Section VI, Distribution of Sewage Effluent, the second paragraph of subsection A clearly requires 24 hour emergency storage capacity above the alarm when a single pump is used, or dual alternating pumps with no required emergency storage. The most common design typically incorporates a septic tank followed by a pump chamber that ranges from 1,000 to 1,500 gallons in size. The pump is installed in the pump chamber with controls set low to maintain adequate storage capacity above the alarm. This criterion could also be achieved with a single tank if the designer specified a somewhat oversized septic tank. For example, assume a three-bedroom home is to be built requiring a minimum 1,000-gallon capacity septic tank. The designer seeks approval for installation of a 2,000 - gallon capacity septic tank with an oversized access manhole on the second compartment to facilitate the pump vault. Controls on the pump unit are set such that the pump on float occurs at the 1,400- gallon capacity level. The pump off float could perhaps be set at the 1,250- gallon mark thereby providing a 150- gallon per cycle dose. If the alarm were set at 1,500 gallons, the difference in elevation between the 1,500-gallon mark and the 2,000- gallon sewer inlet pipe would provide a 500 gallon, 24 hour emergency storage above the alarm float.

What is critical about this example is that the liquid level within the tank must always be maintained above the opening in the 1/3-2/3 tank compartment wall to prevent floating scum in the first chamber from getting into the second chamber. The filtered pump vault would most likely not allow scum to be discharged to the system but we would still prefer the second chamber effluent to remain relatively clear of solids or floating material.

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The single unit septic tank/pump chamber option maybe beneficial for use on repairs where little room is available for both septic tank and separate pump chamber installations. In addition, the pump unit within the tank may address concerns for flotation of empty chambers in wet areas and would reduce the potential for groundwater infiltration when essentially large empty tanks are installed on wet parcels. If dual alternating pumps are installed in a single pump vault, the emergency storage capacity is not required and septic tank sizing would most likely increase only 250 gallons to facilitate the expected pump dose.

If you desire additional information on these in-tank filter/pump units, you may contact the manufacturers directly. The companies, which have submitted requests and have received approvals, include Orenco Systems, Inc. (OSI), (800) 718-4699, Zabel Environmental Technology, (800) 221-5742 and the Zoeller Pump Company, (800) 928-7867. Please feel free to contact these manufacturers directly for more information.

Please note that use of any in-tank filter pump vault manufactured by the companies above does not constitute an endorsement of any of their products and this information is being provided to you at this time as an option to the standard separate septic tank/pump chamber installations. Regulators, engineers and installers must carefully review the Technical Standards to assure pump settings and emergency storage capacities are provided in compliance with the regulations. Prior to specifying use of any in-tank filter/pump, you should check with your local precast concrete tank manufacturer to confirm tank manhole openings suitable for vault installations.

If you have any questions or would like to further discuss these units, please contact our staff at 860-509-7296.

n/sewage/memos/in-tank

SEPTIC TANK OUTLET FILTERS

JANUARY 13, 2000

Frank A. Schaub

Supervising Sanitary Engineer

The installation of septic tank outlet filters is not a new concept but will be new to Connecticut starting July 1, 2000 when Connecticut regulations will require installation of an outlet filter for every new tank installed in our state. Some septic tank manufacturers will elect to provide the filter as part of the tank sales. Other septic tank manufacturers may provide an outlet filter for installation by a license installer, or licensed installers may elect to purchase and install the filters on their own. The Department of Public Health (DPH) first approved installation of tank outlet filters back in 1983. Over the years, several filter manufacturers have applied for and received approval for installation of their filter products in septic tanks. Unfortunately, relatively few installers or property owners elected to use tank outlet filters. The year 2000 changes made to our Technical Standards (TS) will now make installation a requirement after July 1st.

Other states, counties, and local municipalities have required installation of tank outlet filters increasingly over the past 5 years. Florida, a state that installs 30 to 40 thousand septic systems each year, has gained much information concerning the installation and benefit of septic tank filters over the past five years. Initially, filters were installed as an option to construction of a two-compartment septic tank. Current regulations require filter installation on all septic tanks, one and two compartment. North Carolina was the latest state to recently require installation of tank outlet filters for all new construction. Reports from these regulators have been positive.

What is an outlet filter? - A septic outlet filter is a device which is installed in place of an outlet baffle and is designed to reduce the amount of suspended solids which are discharged into the leaching system. Organic pollutants from our toilets, sinks, tubs and washing machines discharge large quantities of water together with these organic chemicals for primary treatment by a septic tank. Some heavier pollutants settle to the bottom of the tank in the first compartment and form a stable biological sludge after time. Some lighter pollutants such as soap scum and grease rise up to the top of the tank forming a scum layer. The septic tank contains large quantities of bacteria, which help digest some of the organic pollutants in an environment devoid of oxygen. The dynamic processes of settlement organic digestion by bacteria and hydraulic flow through the tank tend to carry suspended solids through the tank and out the outlet piping. This organic matter combined with other organic pollutants with specific gravities close to that of water and inorganic pollutants such as fibers from washing machines might pass through the septic tank without achieving the benefit of settlement or digestion by bacteria. The purpose of the tank outlet filter is to reduce some of the suspended solids discharged to the leaching system.

Most outlet filters achieve this goal by providing a grid or mesh type interface were floating particles may be temporarily trapped, digested in place or sloughed off to the bottom of the tank. A second method of providing quiet settlement zones within a plate type filter can also reduce suspended solid discharge by providing large flat surface areas for particles to settle on and still rely upon narrow slots for effluent passage. The screen and settlement type filters are normally made of plastic and range from 4 to 18 inches in diameter, 12" to 3 feet in length. They allow septic tank effluent to enter into the filter from below the scum line and above the sludge layer.

What is happening to the suspended solids in tanks with no filters? - A large percentage of all septic systems that exist in Connecticut will continue to operate without the benefit of a septic tank outlet filter. The particles that are discharged into the leaching system will be trapped along the perimeter of the leaching system where the sewage meets the soil. An organic slime layer builds up at this point and further effluent treatment is achieved by the slime layer as liquid effluent slowly percolates through the slime into the surrounding soils. Unfortunately, many systems which are subjected to high loads of biological pollutants or which have received continual loading of suspended solids over many years tend to build up a thick biological layer that ultimately becomes very slowly permeable. This restrictive barrier prevents effluent from getting into the soil and may cause a backup or overflow at the weakest link in the sewage disposal system. It is conceivable that on sites where the sewage flows generated do not exceed the hydraulic capacity of the soil, the reduction in suspended solids resulting from filter installation could reduce the cause of the majority of infiltrative clogging within septic systems.

Why are tank outlet filters beneficial? - By reducing the quantity of suspended solids discharged to any leaching system, the probability of clogging at the soils/stone interface is reduced. If the biological mat does not thicken to a point of becoming excessively restrictive, treatment via passing through the biological mat infiltration/detention by the aerated soils found beyond the leaching system can provide for excellent effluent treatment. In addition, tank outlet filters can help prevent major leaching system failure by property owners who abuse a sewage disposal system or discharge too many pollutants to the septic tank. Like all operating systems, septic tanks require regular service to provide long term effective effluent treatment. In general, the range of pumping frequency is from two to five years depending upon the size of the tank and the occupant loading. Failure to pump a septic tank on a routine basis will result in an accumulation of sludge and scum which, in turn, reduces the efficiency of tank function. This reduction in efficiency will result in a higher percentage of suspended solids passing to the leaching system. Installation of a tank outlet filter will most likely result in plugging of the filter if the tank is not serviced on a regular interval.

In addition, tank outlet filters will also help detect the excessive buildup of organic pollutants caused by over use of household garbage grinders which unnecessarily increase the septic tank loading by grinding up kitchen wastes. Excessive use of a garbage grinder combined with failure to pump the tank on a regular interval could result in premature filter clogging. When this occurs, it provides an educational opportunity for regulatory officials, installers and cleaners to review household water practices and discuss options with the homeowner to reduce the frequency of filter servicing. Over the past several years, we have advised local municipalities of the dangers related to installation of central vacuum systems or portable vacuum systems that use water as a means of eliminating or reducing dust while vacuuming. These small quantities of water are discharged to the septic tank and contain large amounts of organic and inorganic fiber that can quickly pass through a septic tank and plug a leaching system. It is likely that fibrous material will be trapped in the tank effluent filters before doing excessive damage to the leaching system once again providing an opportunity to educate the system user as to the perils of continued water vacuum discharge.

Do tank outlet filters have to be cleaned frequently? - The ideal situation would result in the tank outlet filter remaining functional until the required time for tank servicing. For that reason, it would be desirable for filters not to plug more frequently than every two to five years. The variability of sewage generation and organic loading by the user combined with improper selection of tank outlet filter may result in filters being cleaned more frequently. For example, if a tank manufacturer or installer elects to use a filter product with minimal infiltrate surface area, it is probable that that filter will plug sooner than a filter with a larger infiltrate surface area. If a homeowner elects to grind up all kitchen waste, that household will obviously generate a stronger sewage discharge with more suspended solids as compared to a household without a garbage grinder. It would be preferable for providers of tank outlet filters to make a careful selection and choose an outlet filter with flow capacity and projected time between servicing suitable for the intended client.

Who can clean filters? - Reports from other states indicate licensed installers and septic tank cleaners typically provide servicing of tank outlet filters. We anticipate similar results and remind all that only individuals licensed to install and/or clean subsurface sewage disposal systems can offer these services to the public. Homeowners may elect to clean their own filter. However, we do not recommend this unless the homeowner is educated on the proper procedures and on safety/health concerns. Changes made to the technical standards which become effective July 1, 2000 will require a standard septic tank top configuration with service access holes in only three choices. All tanks will have a single outlet access hole over the outlet filter. There are two choices for inlet manholes to facilitate inlet piping from the building to the tank. For this reason, servicing septic tanks after July 1, 2000 will require cleaners and installers to open both the inlet and outlet access covers to clean and inspect both the inlet baffle and outlet filter. Previously, some tanks were manufactured to provide cleaning from a central hole with inspection of inlet and outlet baffles performed via use of mirrors and flashlights. Cleaning of the outlet filter is required each time the tank is serviced. Failure to provide this service by a licensed individual during cleaning could result in disciplinary action against that individual.

Property owners could elect to clean septic tank outlet filters but, precautions must be taken to assure the protection of their and adjacent residents health. Effluent discharged from a tank contains high numbers of harmful bacteria and potentially harmful viruses. For this reason, all water used to rinse filters must be discharged back into the tank. The ground must also be disinfected with chlorinated lime if a spill does occur. Licensed individuals are familiar with the hazards involved with coming into contact with domestic sewage and take necessary precautions using gloves and disinfectants when required. For example, hoses used by the property owner or licensed cleaner should not come into contact with septic tank effluent. If such an event does occur, rinsing and disinfecting of the nozzle and all associated contaminating surfaces would be required. Servicing of filter elements during the winter months may result in a licensed installer or cleaner removing the element and installing a replacement element of same kind. The removed unit could be taken back to the place of business and cleaned in a sanitary manner. Where a hose or water supply is not available during cleaning, licensed individuals may elect to use a hand type garden spray pump to flush trapped particles off the filter back into the tank.

What should a homeowner or licensed individual do if a filter plugs prematurely? - It is possible that some filters may plug more frequently than every two to five years and these occurrences should be used by regulatory and licensed individuals as an opportunity to review water use habits in the house or make changes to the filter in order to provide extended service intervals. The licensed installer or cleaner should interview the property owner to determine if a garbage grinder is actively used. Are vacuum cleaners that use water being used in the residence? Is water softening equipment discharging to the sewage disposal system? Are the occupants disposing unused medication (that may adversely effect the biological activity inside the tank) into the septic tank? Does the clothes washing machine have a self cleaning lint filter which in turn could be discharging all the lint to the septic tank? Has the occupancy of the house recently changed in any way that would result in a greater loading on the septic tank? Is there a home business or are day care services for children being provided? Adult homes for the handicapped have a history of premature system failures due to large quantities of water used and high sewage strengths. These and other questions can be helpful in determining whether more frequent servicing of the septic tank and outlet filter are necessary or whether an outlet filter with increased capacity should be provided.

Some manufacturers of septic tank filters provide several different models of filter units to increase filtering capacity. Other manufacturers provide for easy addition of filter units in series or by multiple installation of units at the same outlet piping. If property owners are reluctant or unwilling to change habits inside the house, installers and cleaners can respond by providing a product that meets their needs for extending service intervals.

What are the drawbacks with respect to installing tank outlet filters? - For the vast majority of property owners utilizing on-site sewage disposal systems, the drawbacks to tank outlet filter installation should be minimal. It will be necessary to uncover two manholes each time a tank is serviced. By providing two access manholes, property owners can be assured of effective and efficient cleaning of both chambers within the septic tank. Currently, servicing some tanks with a central cleaning manhole does not promote complete cleaning of both chamber compartments. There may be drawbacks for some individuals who generate large quantities of organic and inorganic pollutants that discharge to a septic tank. The initial clogging of the outlet filter could result in an artificially high liquid level in the tank that would first be identified by a property owner as gurgling in the household plumbing at the lowest water fixtures being used. Tank outlet filters approved for use in Connecticut must continue to function even when the liquid level in the tank is artificially high or overflows the top of the filtering element. In our regulation, we refer to this as a non- bypass outlet filter. Continued rising of the liquid level in the tank could result in a plugging of the inlet piping or a surface discharge at the septic tank itself. If the septic tank was installed on a relatively level grade with minimal pitch back to the building served, it is possible that effluent could continue to back up in the piping and discharge at the lowest fixture inside the structure. The typical warning signs of slow draining fixtures or gurgling in the piping are apt to alert the property owner long before discharge occurs in the lowest plumbing fixture.

If concern for prevention of sewage discharge at the lowest fixture is a primary item, installation of a high liquid alarm within the septic tank can be made. One filter manufacturer offers an alarm as in intricate accessory to the filter installation. Standard high-level alarm floats similar to those installed in an effluent pump chamber could also be installed in a septic tank.

Does the effluent filter have to be installed inside the septic tank? - The answer is no. Several products are available on the market for installation of separate filter units that are housed in vaults installed on the outlet side of the septic tank. Access to these separate filter vaults must be the same as that to a septic tank and location of the vault must be clearly identified on the as-built plans so that installers, cleaners and regulators can be made aware vault location. It would be beneficial if the septic tank outlet cover was provided with a permanent tag noting the location and existence of the separate filter vault.

Are there any National Standards governing septic tank outlet filters? - At the present time, the National Sanitation Foundation (NSF) is developing Standard 46, Section 10 to address a class of products referred to as septic tank effluent filters. This standard will test filters for flow capacity when clean, flow when partially plugged solids reduction, by-pass protection and general structural suitability. While not a true test of each product's ability to effectively trap organic and inorganic pollutants, the standard is a good start to provide comparison for different products.

What would happen if a property owner, installer, or cleaner removed the filter element from its housing? – Removal of a filter element by a licensed installer or cleaner would be a violation of our Code and Technical Standards. For those filter elements installed in a standard 4 inch. Diameter sanitary tee, septic tank function would essentially revert back to the pre year 2000 regulation and an increased suspended solid loading would be placed back on the leaching system. One product manufacturer has a built in shut off feature that prevents unfiltered effluent from escaping to the leaching system when the element is removed from the housing. The shut off feature would remain functional until the liquid level raises above that of the filter housing, approximately 6 inches above the normal tank operating level. At that point, any liquid build up above the top of the filter housing would discharge to the leaching system.

Can you install a tank outlet filter in both single and two compartment septic tanks? - The likelihood of tank outlet filter clogging in a two-compartment tank is less than for one installed in a single compartment tank. The benefits in providing filtered effluent would remain equal for both situations. For that reason, installers, cleaners and property owners should consider the possibility of more frequent servicing if installed in a single compartment tank and the benefits to providing added filtration interface to extend the interval between pumping. One other consideration for retrofitting existing tanks is access to the filter element itself. The manhole over the tank outlet piping must be adequate in size to facilitate retrofitting for filter installation and removing the filter element during cleaning.

Conclusion - Installation of septic tank outlet filters should provide a long-term benefit to the health and protection of the residents in the State of Connecticut. The filters will obviously promote servicing of septic tanks on routine intervals. By reducing the pollutant loading to leaching systems, effluent filters should prolong the effective life of those leaching systems. Many systems, which receive consistent qualities and quantities of sewage effluent over many years, fail due to bio-mat build-up. This clogging failure is observed occasionally with new and recently repaired systems constructed in excellent quality sand fill. When evaluating these premature failures, the breaching of the organic layer along the side wall of the leaching system frequently results in the entire leaching system being drained into the unsaturated adjacent sandy soils. This observation is of a clogged system constructed in highly permeable soils. Reduction of pollutant loading to the leaching system can help reduce this occurrence. Reduction of suspended solids discharged to the leaching system can help extend the function of septic systems constructed in naturally occurring fine sandy soils that tend to build up a biological crust at a faster rate than other course sandy soils.

One Connecticut septic tank manufacturer has elected to provide outlet filters with each new tank installed since August of 1998. Other tank manufacturers who sell tanks beyond our borders have also provided outlet filters with their tanks for some of these out of state deliveries. The reports have been very favorable with respect to minimal problems from servicing or creation of nuisance conditions. This next year will be a learning period for our licensed installers and cleaners, regulators and engineers, as well as property owners as we adjust to the installation and maintenance of septic tank outlet filters.

APPENDIX B: USGS NIANTIC BAY NITROGEN EVALUATION

USGS
science for a changing world

Prepared in cooperation with the Connecticut Department of Energy and Environmental Protection

Evaluation of the Effects of Sewering on Nitrogen Loads to the Niantic River, Southeastern Connecticut, 2005–11

Scientific Investigations Report 2015–5011

U.S. Department of the Interior
U.S. Geological Survey

Cover. Photograph of the Niantic River, southeastern Connecticut; Smith Cove is in the foreground. Saunders Point and Pine Grove are in the middle of the photograph. Courtesy of the Office of Long Island Sound Programs, Bureau of Water Protection and Land Reuse, Connecticut Department of Energy and Environmental Protection.

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2015

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
inch (in.)	2.54	centimeter (cm)
	Area	
acre	0.4047	hectare (ha)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
	Flow rate	
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram (kg)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Supplemental Information

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Abbreviations

CTDEEP	Connecticut Department of Energy and Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
PVC	polyvinyl chloride
TDN	total dissolved nitrogen
USGS	U.S. Geological Survey

Evaluation of the Effects of Sewering on Nitrogen Loads to the Niantic River, Southeastern Connecticut, 2005–11

By John R. Mullaney

Abstract

Nitrogen concentration data were collected from 20 wells near the Niantic River Estuary, during 18 sampling periods from 2005 through 2011, as part of a study to determine changes in nitrogen concentrations and loads as a result of sewering on the Pine Grove peninsula in Niantic, Connecticut. The Pine Grove peninsula area is a neighborhood of 35 acres containing 172 residences with onsite wastewater treatment systems at the beginning of the study in 2005. From 2008 through 2009, the residences were connected to a newly installed sewer system. Water-quality data collection continued from 2010 through 2011, after the sewers were installed.

The peninsula is underlain by glacial stratified deposits. The freshwater in this aquifer ranges from 10 to 45 feet (ft) in thickness and overlies saline groundwater. The mean water-table altitude was from 0.09 to 0.97 ft above the North American Vertical Datum of 1988, with a horizontal hydraulic gradient of 0.0004 to 0.0005.

Initial sampling of the wells included analysis for nutrients, major ions, boron, bromide, and dissolved gases. Concentrations of nitrate plus nitrite nitrogen from the initial sampling ranged from 0.94 to 20 milligrams per liter (mg/L) in samples collected spatially and with depth in the aquifer. The mean concentration of total dissolved nitrogen before the sewers were installed was 7.5 mg/L, and dissolved gas analyses indicated little or no denitrification in the aquifer. Chloride to bromide ratios and boron analysis of the initial water samples confirmed that wastewater was a source of groundwater recharge to most of the wells. Annual recharge from onsite wastewater-disposal systems in 2006 was 4.98 inches, based on analysis of water-use data.

Concentrations of total dissolved nitrogen decreased following sewering in samples from most of the wells that were identified as having nitrogen related to wastewater discharge. Concentrations of total dissolved nitrogen in individual wells decreased by as much as 11.7 mg/L between the periods before and after the sewers were installed, and the mean concentration of total dissolved nitrogen in all wells decreased by 2.3 mg/L to a mean concentration of 5.2 mg/L.

Nitrogen loads from groundwater in the Pine Grove peninsula area were estimated for three time periods by using the measured mean concentrations of total dissolved nitrogen and estimated recharge rates. The estimated nitrogen load before sewering was 1,675 pounds per year (lb/yr) and following sewering was 963 lb/yr. Mean concentrations of total dissolved nitrogen were assumed to have been reduced to 1.1 to 2.3 mg/L after the aquifer had stabilized and sewage-related nitrogen had been completely discharged from the system, with an estimated future load of 202 to 423 lb/yr.

Nitrogen loads from groundwater discharge to the Niantic River Estuary from the lower part of the Niantic River watershed, including Pine Grove, were estimated to be 18,800 pounds (lb) in 2011. This compares with an additional 51,000 lb from the surface-water tributaries to the estuary and an unknown quantity of nitrogen load from stormwater runoff in the lower Niantic watershed.

Introduction

Septic systems have been long recognized as a source of excess nitrogen to estuaries, although the contribution as part of the overall nitrogen budget to embayments and the ocean is poorly understood. Estimates of the contribution of nitrogen from septic systems in the lower part of the Long Island Sound watershed are as high as 17 percent of the annual nonpoint source load (Georgas and others, 2009). These contributions may be locally important as a source of nitrogen to some embayments and their associated ecosystems (Valiela and others, 1990). Information is currently lacking on the importance of the contribution of nitrogen loads from groundwater, and specifically septic systems, to Long Island Sound (Latimer and others, 2014).

The Niantic River is an estuary at the mouth of a developed 30.2-square mile (mi^2) coastal basin in southeastern Connecticut on Long Island Sound (fig. 1). The eelgrass beds of the Niantic River function as a nursery and feeding ground for a number of recreationally and commercially important bird, shellfish, and finfish species. Many people enjoy the recreational opportunities afforded by the river, including boating, kayaking, sailing, swimming, fishing, and shellfishing. Although the Niantic River continues to serve all these functions, it has experienced fluctuations in water quality during the past few decades. The river once supported a major recreational scallop fishery that has declined drastically (Marshall, 1994). Episodic summertime hypoxia events in bottom waters of the upper estuary have occurred.

The presence of so-called nuisance macroalgae in the Niantic River indicates that nitrogen loads are relatively high, though currently low enough to provide a suitable environment for eelgrass (Jamie Vaudrey, University of Connecticut, written commun., April 2012). Excessive nitrogen loading to the Niantic River is considered to be a major cause of the decline and variability in the density of eelgrass populations (Connecticut Department of Environmental Protection, 2006b). Currently, the Niantic River one of the first areas in Long Island Sound where eelgrass is present when moving from west (New York City area) to east along a gradient of improving water quality (Latimer and others, 2014). Therefore, the Niantic River is currently thought to have marginal water quality with respect to eelgrass habitat.

The Connecticut Department of Energy and Environmental Protection (CTDEEP) has listed the Niantic River on the impaired waters list of the State of Connecticut (Clean Water Act, 33 U.S.C. §§1313 and 1315); the river is impaired as a habitat for marine fish, other aquatic life, and wildlife. The listed potential causes for this impairment include eutrophication resulting from nutrients, with sources such as industrial point-source discharges, illicit discharges, remediation sites, groundwater contamination, and insufficient septic systems (Connecticut Department of Energy and Environmental Protection, 2012, table 3–4). Other more general sources of elevated nutrients include atmospheric deposition, stormwater runoff, and groundwater discharge from developed areas, including discharge from septic systems adjacent to the Niantic River. During the past two decades, point-source nutrient loads associated with failing, privately maintained, onsite septic systems have been reduced along most of the developed shoreline of the Niantic River through the installation of municipal sewer systems (Connecticut Department of Environmental Protection, 2006b).

The Pine Grove neighborhood, a residential area on a peninsula in the Niantic River (fig. 1), contains 172 homes on an area of about 35 acres. In 2004, the town of East Lyme, Connecticut, approved sanitary sewers for the Pine Grove neighborhood. Sewer installation began in 2006, and the majority of residences were connected from 2007 through 2009. The sewering project presented an opportunity to document changes in nitrogen concentrations and loads to improve the understanding of management alternatives for reducing nitrogen loads in similar unsewered areas, which are common in the coastal areas of Long Island Sound.

In 2005, the U.S. Geological Survey (USGS) entered into a cooperative agreement with the CTDEEP to document groundwater-quality conditions and loading of nitrogen from groundwater in Pine Grove in 2005 and subsequent to sewering until at least 2010.

Purpose and Scope

This report provides information on the concentrations of nitrogen and major ions in the groundwater of the Pine Grove neighborhood in Niantic, Conn., and the process of denitrification in the groundwater during the early part of the study. The report also provides information on the concentrations of nutrients in the groundwater at this study area from 2005 through 2011 and estimates of the groundwater discharge of nitrogen leaving the Pine Grove area before and after sewers were installed. The report also provides estimates of the load of nitrogen from groundwater discharge in other regions of the Niantic River watershed that are adjacent to the Niantic River as part of the overall nitrogen budget.

Description of the Study Area

The Niantic River Basin in coastal southeastern Connecticut drains an area of 30.2 mi^2 and lies between the Connecticut River Basin on the west and the Thames River Basin on the east (fig. 1). The Niantic River Estuary is primarily a saltwater environment that covers an area of 1.25 mi^2 at the mouth of the basin. The lower part of the Niantic River basin has a 4.1 mi^2 area downstream from streamgages established by the USGS on the three major tributaries from 2007 through 2012 (Mullaney, 2013). The altitude of this lower watershed area ranges from sea level to about 270 feet (ft) above the North American Vertical Datum of 1988 (NAVD 88). Mean annual precipitation at nearby New London, Conn., is 48.7 inches per year (in/yr; Brown and others, 2011).

The surficial geology of the Niantic River Basin includes deposits of glacial till of varying thickness that underlie 63 percent of the lower watershed and coarse-grained glacial stratified deposits that underlie 37 percent of the watershed in areas next to the Niantic River (Stone and others, 1992). The surficial geology controls whether groundwater discharge or overland runoff is the dominant source of water and nutrients to surface waters in different regions of the basin. Areas with coarse-grained glacial stratified deposits have higher groundwater recharge rates than areas with glacial till and consequently provide an important source of groundwater discharge to estuaries or other surface-water bodies (Thomas, 1966).

As of 2005, the only areas with municipal sewer systems were in the town of Waterford, Conn., on the eastern side of the Niantic River and at Camp Niantic, a Connecticut National Guard training site on the western side of the Niantic River. Sewering of the Pine Grove neighborhood began in 2006 and was completed in 2009. Most of the lower Niantic River watershed is also served by public water supplied from outside the watershed. The newly installed sewers flow to the New London wastewater treatment facility where the treated wastewater is discharged to the Thames River.

The Pine Grove neighborhood is on a peninsula in the Niantic River on an area of about 35 acres. The entire peninsula is underlain by coarse-grained glacial stratified deposits. All the 172 residences in the area were served by septic

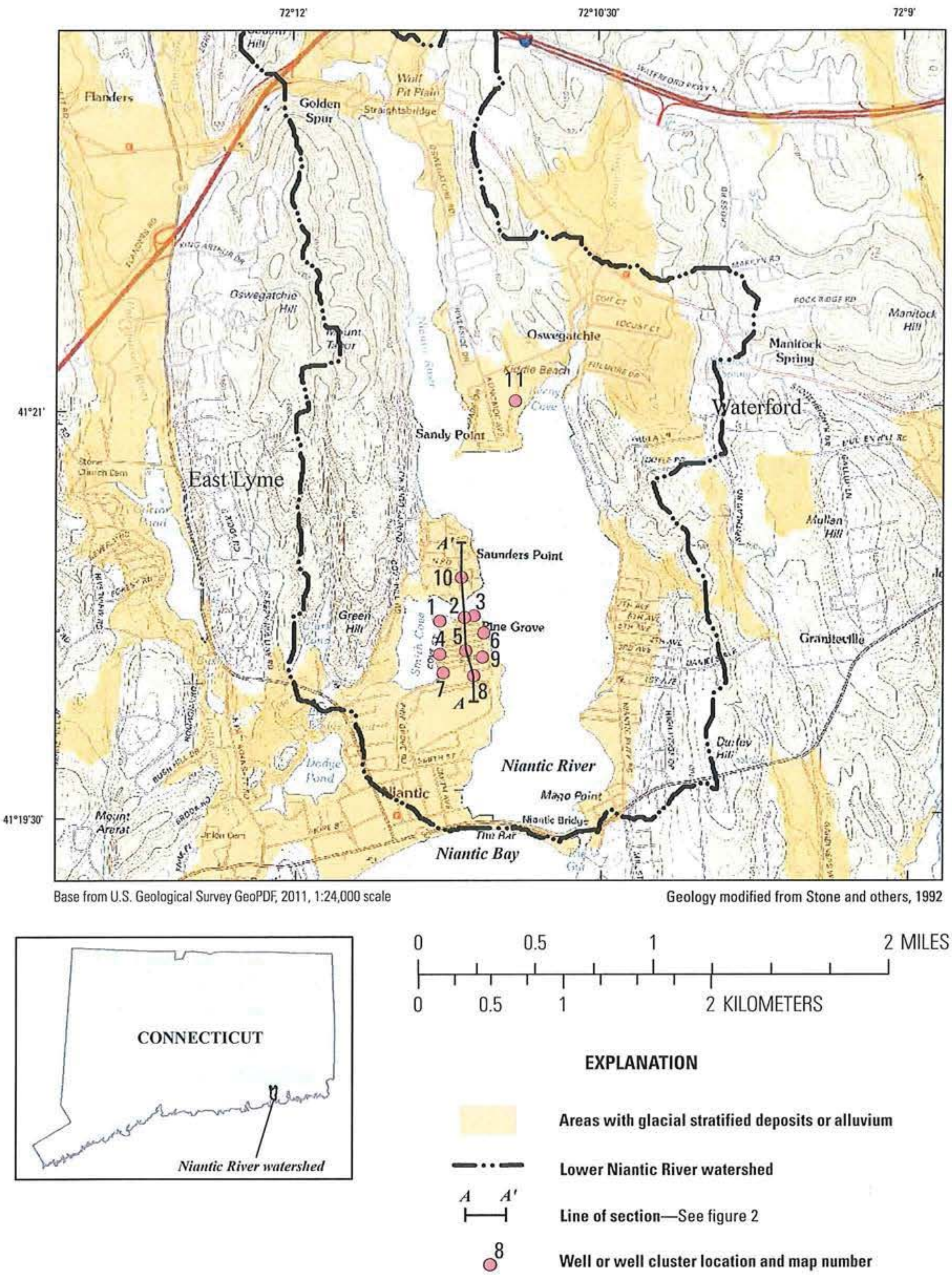


Figure 1. The Pine Grove area of the Niantic River Estuary, southeastern Connecticut, and the locations of U.S. Geological Survey (USGS) groundwater-quality monitoring sites and generalized surficial geology. Ave, avenue; Cem, cemetery; Ct, court; Dr, drive; N, north; Pkwy, parkway; Rd, road; S, south; St, street.

systems and public water supply at the beginning of this study. The study area was originally developed from the late 1800s to the 1930s; homes were initially served by onsite shallow wells but were connected to the public water supply from outside of the watershed in about 1970; many of these residences are only used seasonally in this coastal community. The area is bordered on the south by Camp Niantic.

Methods of Data Collection and Analysis

Data collection for this project included drilling and well installation to obtain groundwater samples from the Pine Grove area as well as Saunders Point and Sandy Point. Groundwater-quality data were collected during 18 different sampling periods between August 2005 and December 2011. During the first sampling of the wells, the samples were analyzed for nutrients, major anions and cations, bromide, boron, and dissolved gases. During the remaining 17 sampling periods, samples were analyzed only for nutrients.

Nitrogen concentration data were analyzed to determine if concentrations had changed as a result of the completion of the sewering project. Nitrogen loads from the study area from groundwater were estimated by multiplying estimated recharge rates and mean concentrations of total dissolved nitrogen (TDN) both before and after the sewering project was completed. Recharge rates before the installation of sewers included the discharge of water from septic systems at residences served by public water supply. Water-use data were analyzed to determine additional recharge inputs from septic systems.

Nitrogen loads to the Niantic River from other parts of the lower Niantic River Basin were estimated by using available nitrogen concentration data from this study and other studies, along with estimated recharge rates and estimated water use in areas with septic systems.

Drilling and Well Installation

Drilling sites were selected in order to characterize groundwater quality in the middle of the Pine Grove peninsula, along the coastline, and with depth in the aquifer (table 1). Test holes were drilled with the use of a truck-mounted auger drilling rig and hollow-stem augers for geologic sampling and well installation. Drilling proceeded in a sequential manner at each location. At selected depths, the geologic materials were sampled by use of a split-spoon sampler. After each geologic sample was recovered, the specific conductance was measured inside the hollow stem of the auger with a downhole conductivity probe. The conductance data were used qualitatively to determine the depth at which the water in the aquifer was becoming brackish, indicating the transition from fresh to saline groundwater. Wells were set at one to three depths in the aquifer. The deepest well at each location was set by using schedule 40 polyvinyl chloride (PVC) casing and 2 feet of number 10 slotted PVC well screen. At four locations, a second sampling point was set at a shallower depth (ranging from 7 to 25 feet above the well screen; table 1) by using 0.25-inch (in.) inside diameter polyethylene tubing. The tubing was attached to the outside of the deepest well, and the tip of the tubing was covered with a nylon mesh to screen out the aquifer materials. These sampling ports were designed to be sampled with a peristaltic suction pump. At two locations, a third well was installed just below the water table. Wells were finished with a bentonite seal above any screened sections or sampling ports (near the water table) and with concrete and a flush-mounted well box at the land surface.

Water-Quality Field Measurement and Sampling Procedures

Groundwater samples were collected from all wells during 18 different sampling periods between September 2005 and December 2011. Field sampling procedures were based on the methods described in U.S. Geological Survey (undated b). The general water sampling methods are described below.

At each site, the water level in the well was measured before sampling. The volume of water in the casing and screen of each well was determined, and the well was sampled by using a positive displacement gear-drive pump. The sampling points constructed with 0.25-in.-diameter tubing were sampled by using a peristaltic pump that was connected directly to the top of the tubing. Before sample collection, wells were purged at a low-flow pumping rate until three to five casing volumes had been removed from the well and the field measurements for specific conductance, temperature, and dissolved oxygen concentration had stabilized. Similarly, the sampling points were purged at a low-flow rate until approximately 2 to 3 gallons of water had been pumped and the field water-quality characteristics had stabilized. Samples for nutrients and major ions were filtered with use of a 0.45-micrometer capsule filter.

Methods used to collect water samples during one sampling event in 2005 for analysis of dissolved gases are described in U.S. Geological Survey (undated a).

Laboratory Measurements

The analytical methods used to analyze groundwater samples for nutrients and major anions and cations at the USGS National Water Quality Laboratory are summarized in table 2. Analytical results were entered into the National Water Information System database by laboratory personnel. Major anions and cations and dissolved gases were analyzed only for the first round of sampling that occurred in August and September 2005. TDN was determined from the sum of nitrite plus nitrate nitrogen and dissolved ammonia plus organic nitrogen. If dissolved ammonia plus organic nitrogen was less than the reporting limit, then only nitrite plus nitrate values were used.

Table 1. Site data for wells in Pine Grove, Sandy Point, and Saunders Point on the Niantic River, Connecticut.

[Latitude and longitude are in degrees, minutes, and seconds. fig., figure; USGS, U.S. Geological Survey; ID, identification number; NAVD 88, North American Vertical Datum of 1988; --, no data; pt, no well screen, point interval]

Site number (fig. 1)	USGS local ID	Station ID	Date of construction	Latitude (° ′ ″)	Longitude (° ′ ″)	Altitude of land surface, in feet above NAVD 88	Depth of well, in feet below land surface	Screened interval, in feet below land surface	Geologic materials in contact with the well screen
11	CT–WT 62	412101072105501	8/24/2005	41 21 01.7	72 10 54.8	22.8	57.9	55.9–57.9	Coarse to very coarse sand
11	CT–WT 63	412101072105502	8/24/2005	41 21 01.7	72 10 54.8	22.8	29.75	27.75–29.75	Coarse to very coarse sand, granule gravel
9	CT–ELY 63	412005072110501	7/19/2005	41 20 05.2	72 11 04.8	13.40	36.77	34.77–36.77	Coarse to very coarse sand
9	CT–ELY 65	412005072110503	7/19/2005	41 20 05.2	72 11 04.8	13.70	22.82	20.82–22.82	Medium to coarse sand, little pebble gravel, little fine to medium sand
3	CT–ELY 66	412014072110701	7/20/2005	41 20 14.3	72 11 07.2	17.31	22.86	20.86–22.86	Coarse to very coarse sand
2	CT–ELY 67	412014072111001	7/20/2005	41 20 13.9	72 11 10	19.85	28.08	26.08–28.08	Medium to coarse sand, some fine sand
6	CT–ELY 68	412010072110401	7/21/2005	41 20 10.5	72 11 04.4	13.68	25.59	23.59–25.59	Very fine to fine sand
1	CT–ELY 69	412013072111701	7/21/2005	41 20 13.2	72 11 17.4	20.20	32.75	30.75–32.75	Very coarse sand, gravel
1	CT–ELY 70	412013072111702	7/21/2005	41 20 13.2	72 11 17.4	6.00	23	pt	Very coarse sand, pebble gravel
4	CT–ELY 71	412006072111801	7/22/2005	41 20 05.8	72 11 17.5	6.00	28.3	26.3–28.3	Coarse to very coarse sand, medium sorted
4	CT–ELY 72	412006072111802	7/22/2005	41 20 05.8	72 11 17.5	--	10	pt	Coarse to very coarse sand
5	CT–ELY 73	412007072111001	7/25/2005	41 20 06.6	72 11 09.7	20.49	62.21	60.21–62.21	Fine to medium sand
5	CT–ELY 74	412007072111002	7/25/2005	41 20 06.6	72 11 09.7	--	45	pt	Coarse to very coarse sand
5	CT–ELY 75	412007072111003	7/25/2005	41 20 06.6	72 11 09.7	20.47	28.63	26.63–28.63	Coarse to very coarse sand
7	CT–ELY 76	412002072111601	7/27/2005	41 20 01.7	72 11 16.4	12.58	51.25	49.25–51.25	Medium to coarse sand, some gravel to 1 inch
7	CT–ELY 77	412002072111602	7/27/2005	41 20 01.7	72 11 16.4	12.58	22.87	20.87–22.87	Coarse to very coarse sand
8	CT–ELY 78	412001072110701	8/23/2005	41 20 01.1	72 11 07.3	16.93	54.27	52.27–54.27	Fine to medium sand
8	CT–ELY 79	412001072110702	8/23/2005	41 20 01.1	72 11 07.3	16.93	41	pt	Coarse to very coarse sand, some pebble gravel
8	CT–ELY 80	412001072110703	8/23/2005	41 20 01.1	72 11 07.3	16.89	28.45	26.45–28.45	Fine to medium sand
10	CT–ELY 81	412023072111101	7/28/2005	41 20 22.7	72 11 10.9	14	23.2	21.2–23.2	Fine to coarse sand, pebble gravel

Table 2. Analytes for groundwater samples and analytical methods, Niantic River, Connecticut.

Analyte	Reporting limit, in milligrams per liter	Reference to methodology
Nitrogen, ammonia, filtered	0.01	Fishman (1993)
Nitrogen, ammonia and organic, filtered	0.07	Patton and Truitt (2000)
Nitrogen, nitrite, filtered	0.001	Fishman (1993)
Nitrogen, nitrite and nitrate, filtered	0.04	Patton and Kryskalla (2011), Fishman (1993)
Phosphorus, filtered	0.003	U.S. Environmental Protection Agency (1993)
Phosphorus, phosphate, ortho, filtered	0.004	Fishman (1993)
Bromide	0.01	Fishman and Friedman (1989)
Boron	2	Struzeski and others (1996)
Calcium	0.022	Fishman (1993)
Chloride	0.06	Fishman and Friedman (1989)
Fluoride	0.04	Fishman and Friedman (1989)
Iron	4	Fishman (1993)
Magnesium	0.011	Fishman (1993)
Manganese	0.16	Fishman (1993)
Potassium	0.03	Clesceri and others (1998)
Residue, 180 degrees Celsius (total dissolved solids)	20	Fishman and Friedman (1989)
Silica	0.018	Fishman (1993)
Sodium	0.06	Fishman (1993)
Sulfate	0.09	Fishman and Friedman (1989)

Dissolved gas measurements (nitrogen, argon, oxygen, carbon dioxide, and methane) were used to determine excess air and recharge temperature of the groundwater and whether excess nitrogen gas, which is an indicator of denitrification in the groundwater-flow system (Lindsey and others, 2003), was present. Samples were analyzed by using methods described by Busenberg and others (1998). Excess nitrogen gas was estimated by using the procedure outlined in Lindsey and others (2003, p. 14). Dissolved gas measurements are shown in appendix 1.

Water-Level Measurements

Water-level measurements were made at all wells before water-sample collection. Continuous water-level data were collected with the use of submersible pressure transducers in five wells for different periods of time. Water levels were measured in two wells (CT–ELY 67 and CT–ELY 81) intermittently from 2006 through 2011 in order to understand the long-term trends in fluctuation at Pine Grove and in an area that was not undergoing sewering (Saunders Point; fig. 1). Additional manual water-level measurements were made at the wells where pressure transducers were installed as part of the overall data collection and as a check to determine if the transducers were reading accurately. The altitudes of the measuring points of the wells in Pine Grove were surveyed and referenced to a benchmark on the newly constructed sewer pumping station.

Water-Use Estimation

Water-use data were analyzed to estimate the amount of recharge from onsite wastewater treatment systems before the installation of sewers. This information was used as an input for the estimation of recharge associated with wastewater and nitrogen loads discharged to the groundwater at the study site. The water-use data were compiled for the period from 2006 through 2010 from meter readings for individual properties in the study area (Brad Kargl, East Lyme Water and Sewer Department, written commun., 2011). It was assumed, based on information from the USGS water-use program (U.S. Geological Survey, 1995), that consumptive water use was 14 percent and that 86 percent of the water used was returned to the aquifer via septic systems.

Estimation of Nitrogen Loads From Pine Grove

Nitrogen loads from Pine Grove to surrounding surface-water discharge areas were estimated from rates of natural recharge from precipitation, artificial recharge from septic systems, and the mean nitrogen concentrations in the groundwater with time. It was assumed that nitrogen loads can be represented by the following equation:

$$N_t = \frac{(R_n + R_s) \times N_{avg}}{10^6}, \quad (1)$$

where

N_t = estimated nitrogen load from the Pine Grove area at time t,

R_n = the mean annual effective recharge from precipitation,

R_s = the combined rate of recharge from onsite wastewater treatment systems, and

N_{avg} = the mean concentration of nitrogen in the aquifer at time t.

N_t was converted from kilograms to pounds for consistency with previous reports (Mullaney, 2013).

Natural recharge was estimated by using a relation between recharge rate and mean annual runoff that was developed by Mazzaferro and others (1979). The relation as applied to the Pine Grove study area, which is completely underlain by glacial stratified deposits, indicates that the recharge rate is about 95 percent of the mean annual runoff. The mean annual runoff for this area was previously calculated to be 24.4 in/yr (Weiss, 1983), yielding a recharge rate of 23.2 in/yr based on the 95 percent figure. During October 2008 through September 2011, the runoff from Stony Brook, a tributary of the Niantic River that is unaffected by water diversions, ranged from 27.3 to 40.7 in/yr (Mullaney, 2013), indicating that runoff conditions were higher than normal for that period.

Recharge rates to the Pine Grove area can be reduced by impervious cover that diverts water to storm drains and reduces the infiltration of the water through the unsaturated zone. It was estimated that about 23 percent of the study area is covered with impervious surfaces, potentially reducing natural rates of recharge by as much 23 percent. The impervious area was estimated by use of an impervious surface analysis tool developed by Chabaeva and others (2004), with impervious surface coefficients for Connecticut developed by Prisloe and others (2003). In reality, not all precipitation that falls on impervious surfaces is discharged to storm drains; much of it runs off of these surfaces and infiltrates the well-drained soils in the study area.

Estimates of Nitrogen Loads From Groundwater Discharge From Other Regions of the Lower Niantic River

Estimates of nitrogen load from groundwater discharge were similarly calculated for other regions of the lower Niantic River (fig. 1) by multiplying estimated recharge rates by measured or estimated nitrogen concentrations in groundwater or stream base flow. Nitrogen concentration data from three sources were used to make these estimates: (1) groundwater samples that were collected on Sandy Point and Saunders Point and analyzed for TDN as part of this study, (2) stream base flow samples that were collected by Mullaney (2013) in two small subbasins of the lower Niantic River, and (3) shallow groundwater samples that were collected by the University of Connecticut from shallow wells temporarily installed at 60 locations around the perimeter of the Niantic River in 2003 (Jamie Vaudrey, University of Connecticut, Department of Marine Sciences, written commun., April 2012). In a case where there were no nitrogen concentration data corresponding to an area, concentrations of TDN were estimated by extrapolation of data from the above sources on the basis of a qualitative comparison of land-use characteristics and whether or not the area was sewered.

The lower basin of the Niantic River (downstream from the streamgages installed for another study; Mullaney, 2013) was divided into basin segments based on surficial geology (glacial till or stratified deposits). Two of the segments were existing surface-water sampling sites where nitrogen and flow data were reported in Mullaney (2013).

Estimates of nitrogen loads from each segment were calculated by multiplying the estimated recharge rates (23.2 in. for glacial stratified deposits, 8.6 in. for glacial till) by the estimated TDN concentration; these values were confirmed by using the method described in Mazzaferro and others (1979). Recharge rates were adjusted for areas served by septic systems because the water for domestic use is imported from outside the drainage basin of the Niantic River. Estimates of water use in these areas were based on the number of residences (assuming two persons per household) and per capita water-use data from U.S. Geological Survey (1995).

Hydrogeology and Direction of Groundwater Flow

The logs from the well drilling indicate that the Pine Grove area is underlain by generally coarse-grained sand and gravel with a maximum thickness of 64 ft at well CT–ELY 73 (fig. 1, site 5). At this location, glacial till was encountered from 64 to 68 ft below land surface. The change in electrical conductivity in the water in the bottom of the hollow-stem auger during drilling indicated a gradual transition from freshwater to saltwater (fig. 2).

In July and August 2005, the thickness of the freshwater layer (difference between the altitude of the water table and top of the transition zone to saltwater) at Pine Grove ranged from about 10 ft at the northern end of the study area (well CT–ELY 66; fig. 1, site 3) to about 45 ft at the southwestern side of the study area (well CT–ELY 76; fig. 1, site 7) and averaged 27 ft. On Saunders Point (fig. 1, site 10), saltwater was not encountered during drilling. On Sandy Point, the freshwater thickness was about 43 ft (fig. 1, site 11). The top of the transition zone was identified by a change in specific conductance to greater than 1,000 microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

The mean depth to the water table (for manual water-level measurements made from 2005 through 2011) in wells at Pine Grove ranged from 5.26 to 19.92 ft below land surface; the differences in mean depth to the water table were related primarily to differences in the land-surface altitude, which ranged from 6.00 to 20.49 ft above NAVD 88. The mean altitude of the water level in individual wells, (for measurements made from 2005 through 2011) ranged from 0.09 ft (CT–ELY 66; fig. 1, site 3) to 0.97 ft (CT–ELY 78; fig. 1, site 8). Mean sea level for the Niantic River was estimated from the published values for the nearby National Oceanic and Atmospheric Administration (NOAA) tidal station at New London, Conn. (National Oceanic and Atmospheric Administration, undated). Mean sea level in the Niantic River at Pine Grove is estimated to be –0.30 ft below NAVD 88.

The annual fluctuations in the water table during the study period were typically less than 0.5 ft, as determined by the interquartile range of water levels (table 3). The maximum change in water level in the wells was about 2 ft during early spring 2010, in response to recharge from a large precipitation event of 9.2 in. on March 30, 2010 (Mullaney, 2013).

The water-level altitude data were mapped for 2007 and 2010 coincidentally with the sampling activities in order to determine groundwater flow directions and the horizontal hydraulic gradient of the water table (fig. 3A, B). Fluctuations in water levels owing to variations in recharge from precipitation and tides may affect these maps because the measurements were made when water samples were being collected over a 2-week period. The time periods selected were those with little precipitation in order to minimize the fluctuations. Water levels in the wells at Pine Grove fluctuate in response to the tides, making it difficult to get an accurate snapshot in time. Continuous water-level data from selected wells indicate the daily tidal response. Typical daily fluctuations in well CT–ELY 67, which is in the northern end of the study area and adjacent to the Niantic River (fig. 1, site 2) were in the range of 0.3 to 0.5 ft (fig. 4A). In the middle of the Pine Grove study area at well CT–ELY 73 (fig. 1, site 5), water-level fluctuations owing to tidal influence were apparent, but only on the order of 0.01 ft (hydrograph not shown). The water levels in the wells at Pine Grove also responded to a storm surge on August 28, 2011, during tropical storm Irene. Water levels rose by about 1.5 ft in well CT–ELY 67 and 0.5 ft in well CT–ELY 81 (fig. 4A, B) in response to a storm surge that reached a maximum altitude of 5.07 ft above NAVD 88 at nearby New London (McCallum and others, 2012).

The configurations of the water table in July 2007 and November 2010 indicate groundwater-flow directions predominantly toward the north, with components toward the Niantic River and Smith Cove. The horizontal gradient is shallow during these two time periods, ranging from about 0.0004 to 0.0005, likely indicative of the high hydraulic conductivity of the coarse-grained sand and gravel deposits at Pine Grove.

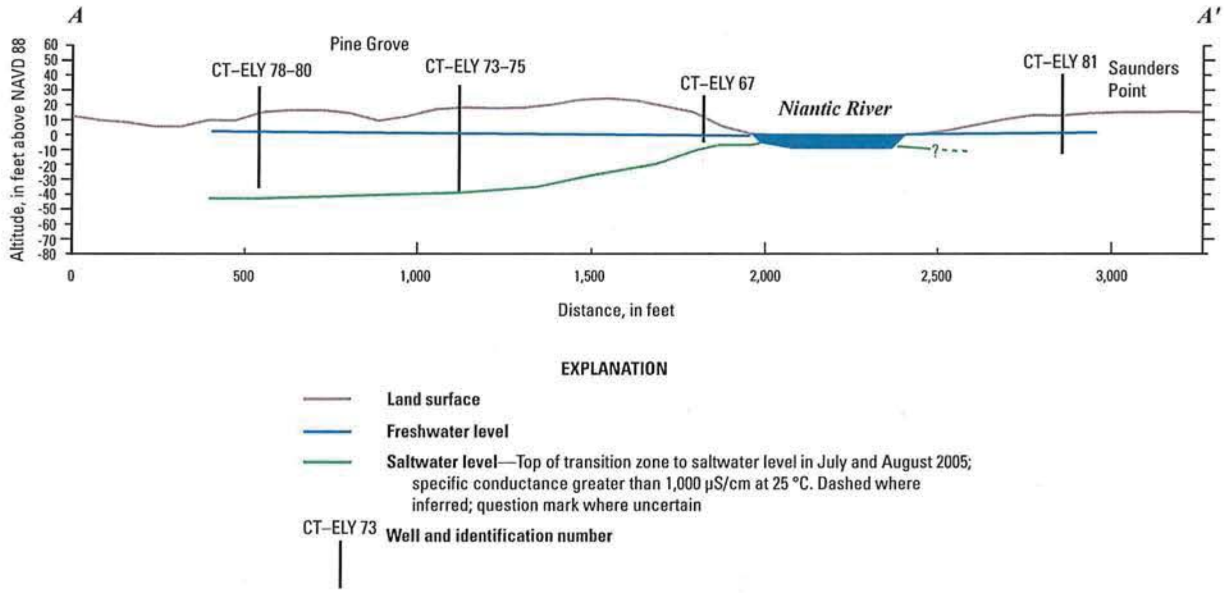


Figure 2. Cross-section *A–A′* through the Pine Grove study area showing the position of the transition zone between freshwater and saltwater in July and August 2005. µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; NAVD 88, North American Vertical Datum of 1988.

Table 3. Statistics for groundwater levels, Pine Grove, Sandy Point, and Saunders Point on the Niantic River, Connecticut, September 2005 to December 2011.

[fig., figure; USGS, U.S. Geological Survey; ID, identification number; NAVD 88, North American Vertical Datum of 1988]

Site number (fig. 1)	USGS local ID	Number of measurements	Mean depth to groundwater, in feet below land surface	Mean altitude of groundwater, in feet above NAVD 88	Interquartile range, in feet
11	CT–WT 62	25	22.25	0.55	0.27
11	CT–WT 63	18	22.26	0.54	0.45
9	CT–ELY 63	29	13.03	0.37	0.53
9	CT–ELY 65	21	13.09	0.61	0.24
3	CT–ELY 66	21	17.22	0.09	0.34
2	CT–ELY 67	41	19.55	0.30	0.38
6	CT–ELY 68	20	13.23	0.45	0.3
1	CT–ELY 69	19	19.92	0.28	0.3
3	CT–ELY 71	26	5.26	0.74	0.37
5	CT–ELY 73	27	19.65	0.84	0.36
5	CT–ELY 75	20	19.71	0.76	0.36
7	CT–ELY 76	18	11.62	0.96	0.44
7	CT–ELY 77	18	11.62	0.96	0.48
8	CT–ELY 78	18	15.96	0.97	0.4
8	CT–ELY 80	18	15.93	0.96	0.38
10	CT–ELY 81	35	13.80	0.20	0.36

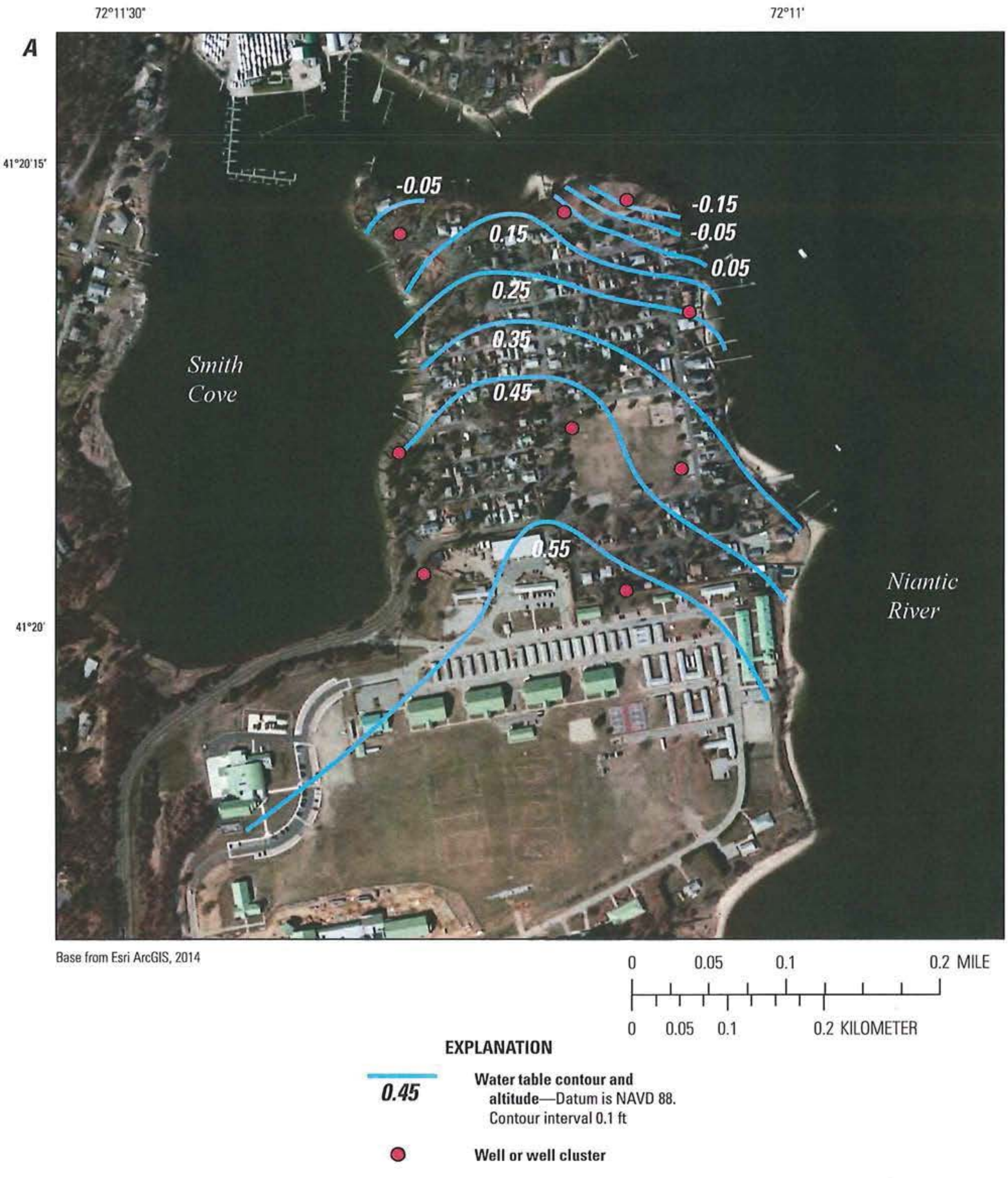


Figure 3. The water-table configuration in *A*, July 2007 and *B*, November 2010 at the Pine Grove, Connecticut, study area. ft, feet; NAVD 88, North American Vertical Datum of 1988. Satellite imagery is the intellectual property of Esri and is used under license; copyright © 2014 Esri and its licensors.

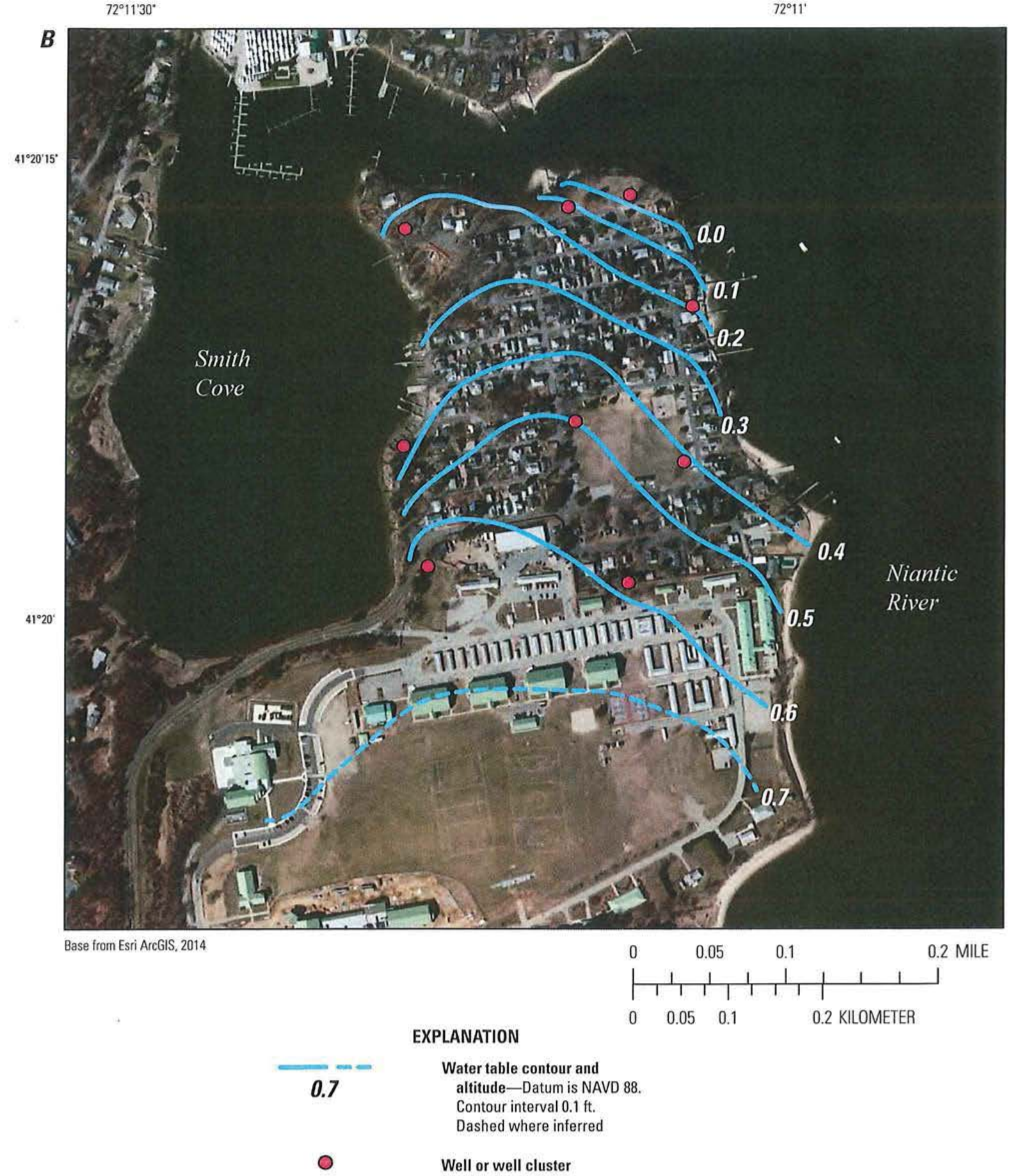
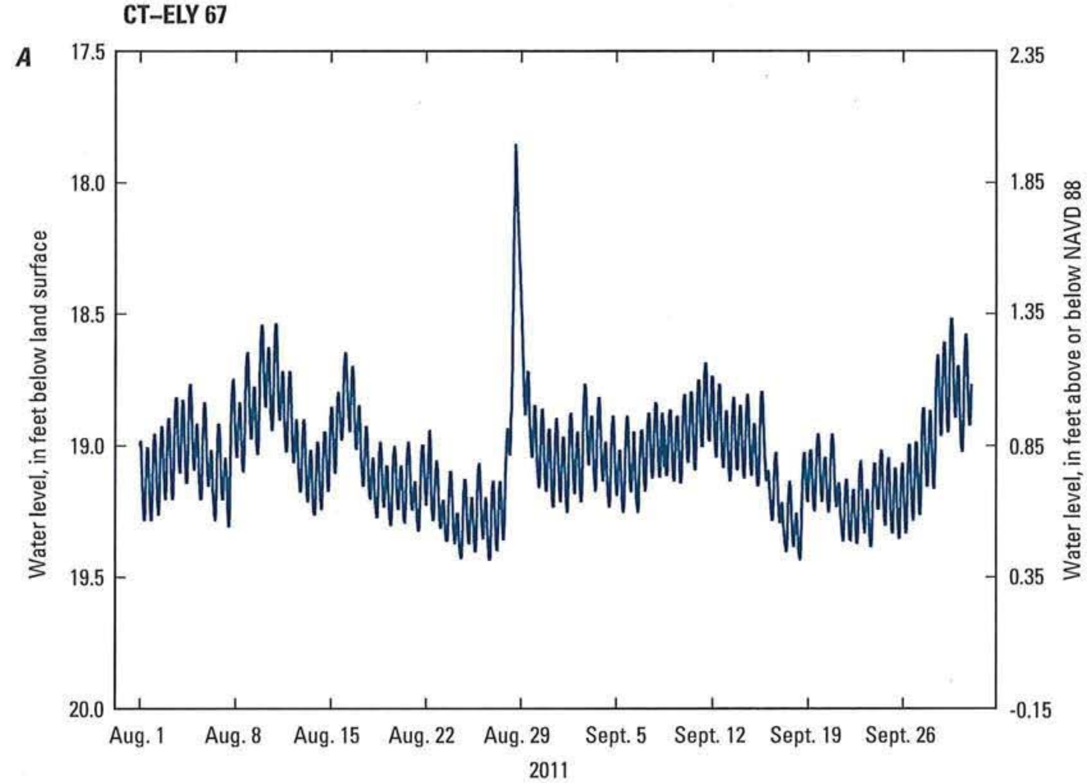


Figure 3. The water-table configuration in *A*, July 2007 and *B*, November 2010 at the Pine Grove, Connecticut, study area. ft, feet; NAVD 88, North American Vertical Datum of 1988. Satellite imagery is the intellectual property of Esri and is used under license; copyright © 2014 Esri and its licensors.—Continued



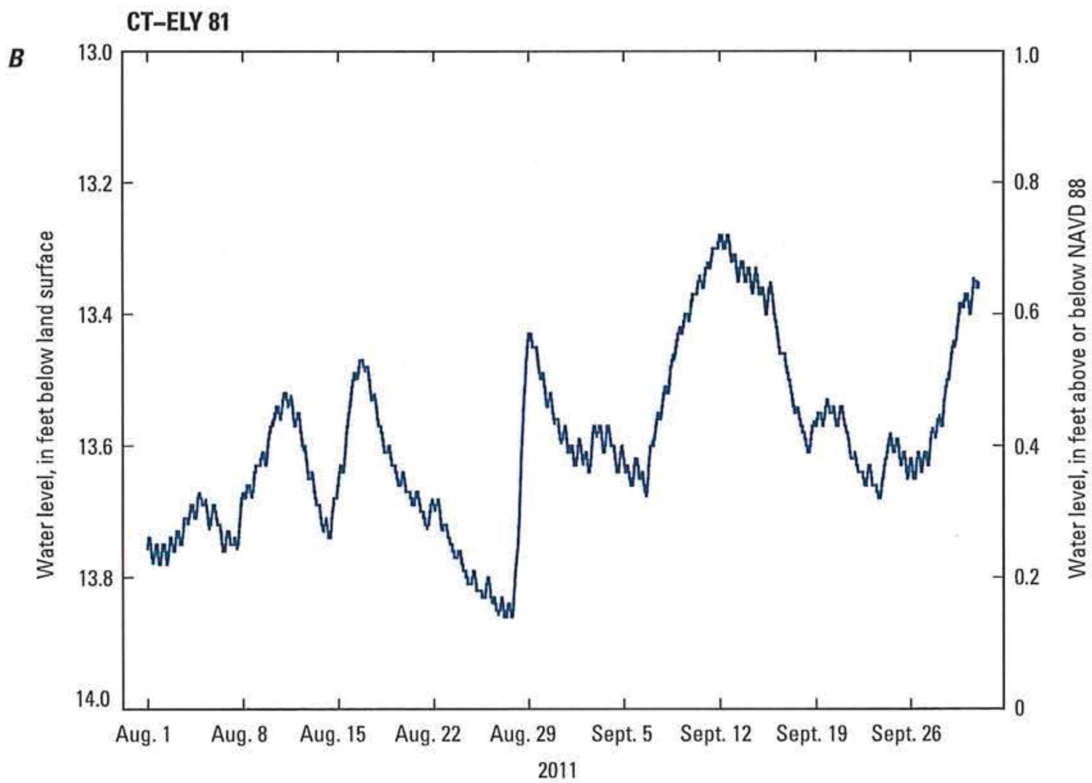


Figure 4. Water-table fluctuations in wells *A*, CT–ELY 67 (site 2 on figure 1) and *B*, CT–ELY 81 (site 10 on figure 1) in Pine Grove and Saunders Point, Connecticut, in August and September 2011. NAVD 88, North American Vertical Datum of 1988.

Water Quality in the Pine Grove Area

Changes in nitrogen concentrations were analyzed from 2005 through 2011. The initial water-quality data from the first sampling period (2005) included concentrations of nutrients, dissolved gases, major ions, bromide, and boron. Data for the other 17 sampling periods included only nutrient analyses.

Nitrogen loads from the study area were estimated for 2006 and 2011 and for a future time when nitrogen concentrations have stabilized at lower values than before sewers were installed in the study area. Regionally, nitrogen loads from groundwater to the Niantic River were estimated for 2011 on the basis of data from this and previous studies.

Water Quality Before Installation of Sewers

The initial water-quality samples were collected in 2005 at all wells installed on the Pine Grove peninsula and at two wells installed at different depths on Sandy Point. Water-quality samples were not collected from the single well on Saunders Point because the well had not yet been installed at the time the initial water-quality samples were collected. Samples were analyzed for field water-quality characteristics and concentrations of nutrients, major ions, and dissolved gases. Selected water-quality analyses from the first round of samples are shown in table 4.

Nutrients

The focus of this study was on nitrogen because of the concerns that excessive nitrogen loading was affecting the habitats along the Niantic River. Most of the nitrogen in the groundwater samples was in the form of nitrate nitrogen, suggesting that ammonification and subsequent nitrification of the organic nitrogen in wastewater had occurred in the septic systems and unsaturated zone. Concentrations of nitrite were generally below the reporting limit. Nitrate plus nitrite nitrogen ranged from 0.94 to 20 milligrams per liter (mg/L, as nitrogen), with a median value of 3.29 mg/L and a mean value of 6.7 mg/L. These values are in the range of those reported by Weiskel and Howes (1991) for areas of high-density septic systems on Cape Cod, Massachusetts. Nitrate plus nitrite concentrations are not related to the depth of the sample in the aquifer. Samples from shallow, intermediate, and deep depths in the aquifer had concentrations that exceeded the U.S. Environmental Protection Agency maximum contaminant level for drinking water of 10 mg/L nitrate plus nitrite as nitrogen. Dissolved ammonia plus organic nitrogen concentrations ranged from less than 0.06 to 0.15 mg/L and represented a small part of the TDN. The mean and median concentrations of TDN were 7.5 mg/L and 4.8 mg/L, respectively, during the period before sewering (2005–7), based on the statistics from 102 samples. Concentrations of dissolved phosphorus in the groundwater were low, ranging from below the reporting limit of 0.004 to 0.021 mg/L (as phosphorus).

Dissolved Gases

Dissolved gas measurements (appendix 1) were used to determine if denitrification was occurring in the groundwater at Pine Grove and at one well cluster on Sandy Point. These samples were collected at all wells; however, the analysis of samples from the polyethylene tubing attached to the casing at four wells showed evidence of stripping of dissolved gases, which renders the samples unusable. These samples had been collected by using a peristaltic (suction) pump.

The loss of nitrate through denitrification would be evidenced by low nitrate concentrations, low dissolved oxygen concentrations, and excess nitrogen gas in the samples. Denitrification is a biologically mediated reduction of nitrate through a series of intermediate steps to nitrogen gas (Kendall and Aravena, 2000) and typically requires a carbon source as an electron donor.

Analysis of the data show oxic conditions (dissolved oxygen greater than 2 mg/L) in the samples from most of the wells, indicating a low potential for denitrification. Samples from wells CT–ELY 73 and CT–ELY 78 (fig. 1, sites 5 and 8) had low dissolved oxygen concentrations of less than 2 mg/L. Excess nitrogen gas was estimated to be present in samples from these wells at low concentrations ranging from 0.2 to 1.2 mg/L. Both of these wells are screened in the in the upper part of the transition zone between fresh and saline groundwater, as indicated by specific conductance values greater than 1,000 µS/cm at 25 °C. The saline water that has mixed with the groundwater may be more depleted in oxygen than the local groundwater and may provide an additional organic carbon source.

The results of the dissolved gas sampling indicate that nitrate-nitrogen is generally not being attenuated by denitrification in the aquifer. Denitrification is still possible along the flow paths that pass under the Niantic River on the way toward discharge to the saltwater environment, especially if the groundwater discharges through organic muds that might be present on the bottom of the Niantic River.

Major Ions and Field Measurements

The analyses of water from the wells on Pine Grove and Sandy Point provide additional evidence of the influence of human activities on the groundwater quality. The dominant cations detected were sodium and magnesium, and the dominant anions were nitrate and chloride (fig. 5). The water-quality data (table 4) also show the influence of seawater on groundwater, particularly for wells CT–ELY 73 and CT–ELY 78, which are screened in the top of the transition zone between freshwater and saltwater and have high chloride concentrations.

Information on the source of recharge in the study area can be obtained by plotting the chloride to bromide ratio against the chloride concentrations, as was done in Mullaney and others (2009) and seen in figure 6. The curves represent binary mixtures of dilute groundwater with halite (road salt), sewage and animal waste, and seawater (fig. 6).

Table 4. Water-quality analyses of groundwater samples from August and September 2005 from Pine Grove and Sandy Point on the Niantic

[Laboratory analyses by USGS National Water Quality Laboratory; fig., figure; USGS, U.S. Geological Survey, ID, identification number; µS/cm at 25 °C, microsiemens per liter; <, less than; e, estimated]

Site number (fig. 1)	USGS local ID	Station ID	Date	Dissolved oxygen, water, unfiltered	pH, water, unfiltered, field, in standard units	Specific conductance, water, unfiltered, in µS/cm at 25 °C	Temperature, water, in °C	Calcium, water, filtered, in mg/L	Magnesium, water, filtered, in mg/L	Potassium, water, filtered, in mg/L
11	CT–WT 62	412101072105501	9/2/2005	9.1	5.3	185	11	5.3	2.77	2.91
11	CT–WT 63	412101072105502	9/2/2005	9.7	5.3	93	11.7	8.29	1.36	1.25
9	CT–ELY 63	412005072110501	8/17/2005	12.8	5.6	640	12.8	27.3	11.5	2.8
9	CT–ELY 65	412005072110503	8/17/2005	14.1	5.9	81	14.9	8.83	0.761	1.36
3	CT–ELY 66	412014072110701	8/18/2005	11	4.6	282	13	15.6	2.61	9.29
2	CT–ELY 67	412014072111001	8/17/2005	8.5	5.4	485	13.7	23.2	6.39	10.3
6	CT–ELY 68	412010072110401	8/23/2005	7.1	5.6	242	15.4	9.98	3.42	3.32
1	CT–ELY 69	412013072111701	8/18/2005	9.7	5.4	449	12.1	15.4	3.31	9.7
1	CT–ELY 70	412013072111702	8/18/2005	9.2	5.3	740	13.7	16.4	4.04	7.41
4	CT–ELY 71	412006072111801	8/23/2005	6.2	5.2	236	12.9	12.4	2.69	4.43
4	CT–ELY 72	412006072111802	8/23/2005	5.6	5.1	290	17.6	10.4	2.56	3.65
5	CT–ELY 73	412007072111001	8/19/2005	2	5.9	3,580	12.5	274	126	11
5	CT–ELY 74	412007072111002	8/19/2005	3.7	5.4	451	15.5	27.4	6.46	7.35
5	CT–ELY 75	412007072111003	8/19/2005	7.7	5.1	292	12.7	13	2.63	8.87
7	CT–ELY 76	412002072111601	8/24/2005	5.6	5.8	406	13.1	21.8	7.56	2.96
7	CT–ELY 77	412002072111602	8/24/2005	8.1	5.9	309	14.6	17.6	2.69	4.54
8	CT–ELY 78	412001072110701	9/1/2005	2.6	5.6	1,010	13.2	62.4	19	5.72
8	CT–ELY 79	412001072110702	9/1/2005	6.7	5.7	323	17.6	15.8	3.29	5.38
8	CT–ELY 80	412001072110703	9/1/2005	9	5.2	160	12.5	6.99	1.27	3.66

River, Connecticut.

per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms

Sodium, water, filtered, in mg/L	Bicarbonate, water, filtered, inflection-point titration method (incremental titration method), field, in mg/L	Bromide, water, filtered, in mg/L	Chloride, water, filtered, in mg/L	Silica, water, filtered, in mg/L as SiO_2	Ammonia plus organic nitrogen, water, filtered, in mg/L as N	Nitrate plus nitrite, water, filtered, in mg/L as N	Phosphorus, water, filtered, in mg/L as P	Boron, water, filtered, in µg/L
21.2	21	0.051	29.4	12.9	< 0.1	0.94	0.021	22
4.72	15	0.035	5.28	9.99	e 0.07	3.29	0.008	19
66.2	12	0.524	158	14.2	< 0.1	3.26	e 0.003	35
3.83	18	0.023	3.6	6.39	< 0.1	2.33	0.005	11
21.6	5	0.067	28.5	12	0.11	13.8	< 0.004	82
45.4	17	0.162	62.5	19	< 0.1	20	e 0.003	188
24.9	19	0.022	50	9.92	< 0.1	2.15	e 0.003	26
51.4	11	0.09	81.3	14.4	e 0.06	10.6	< 0.004	56
110	16	0.135	179	14.8	0.14	1.95	0.005	43
21.1	13	0.064	36.7	13.2	e 0.07	7.29	e 0.002	45
32.7	6	0.041	59.1	10.6	0.15	5.84	< 0.004	30
163	19	4.07	1,120	31.5	0.12	3.24	0.004	e 18
34.9	21	0.133	67.2	16	0.12	15.5	0.006	49
28.3	11	0.075	39.4	12.7	e 0.1	9.29	e 0.003	42
31.9	16	0.347	93	13.9	< 0.1	1.36	< 0.004	40
31.5	49	0.037	58.4	11.3	e 0.07	0.96	0.006	11
83.4	20	0.67	248	16.8	< 0.1	17.1	0.006	58
32.2	15	0.094	71.6	12.2	e 0.08	5.29	e 0.003	40
16.8	15	0.038	21.6	9.08	e 0.06	3.21	0.02	27

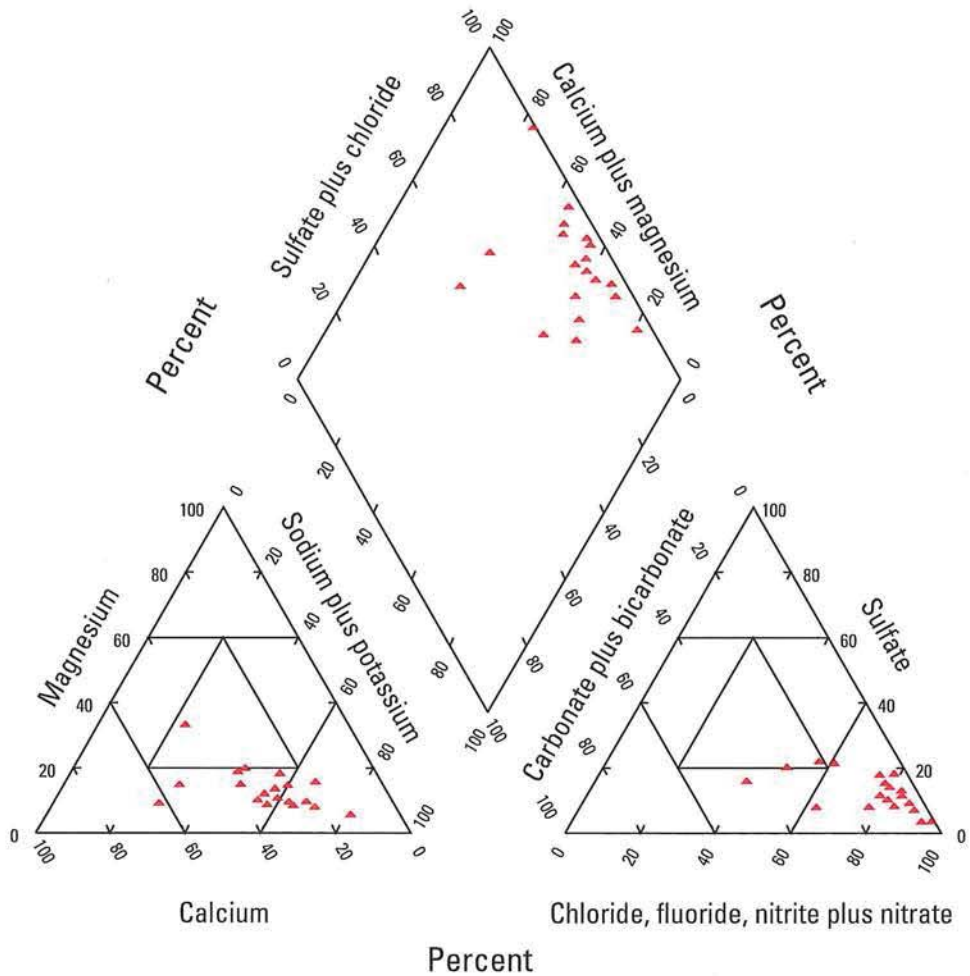
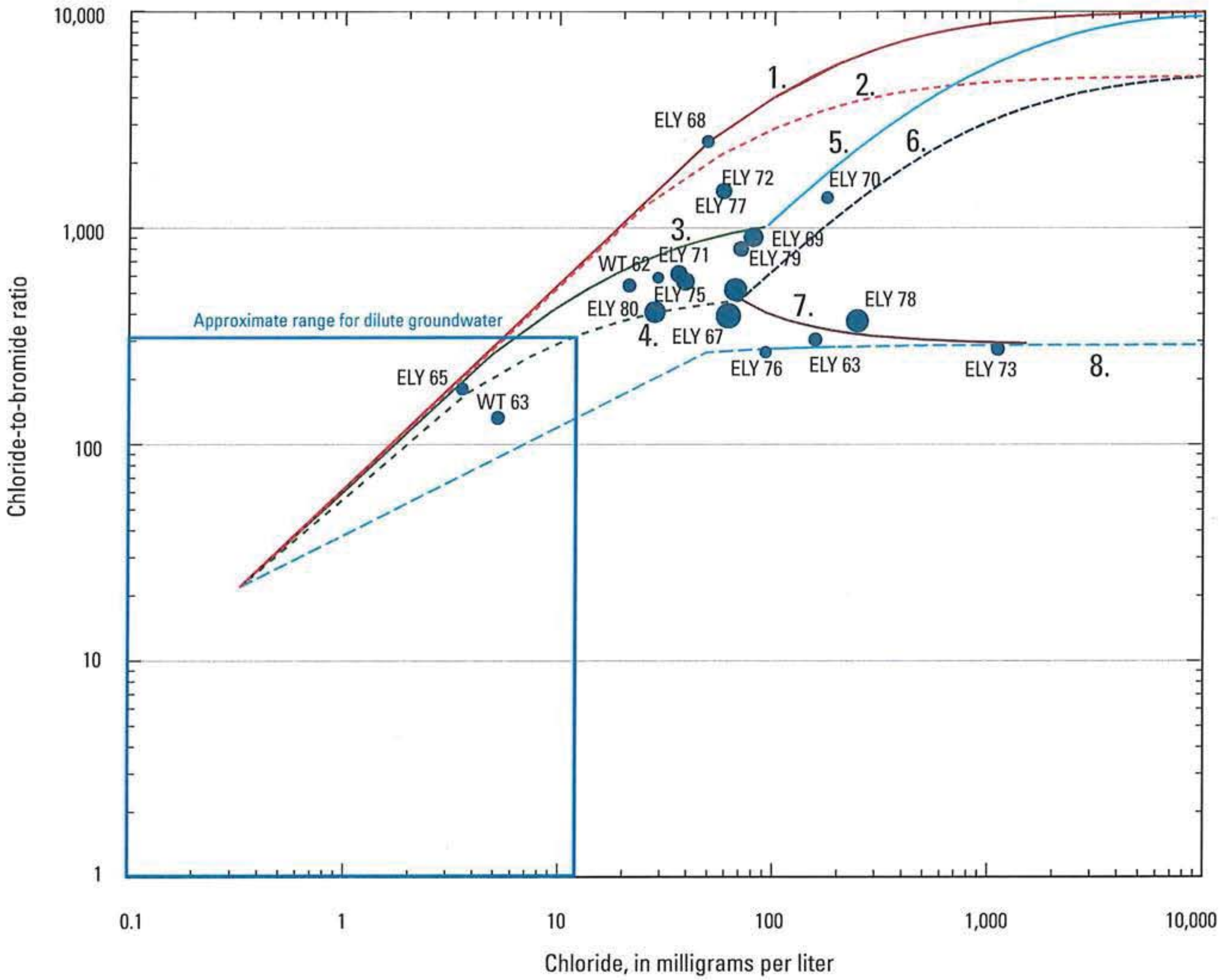


Figure 5. Relations among major anions and cations in water samples from wells at Pine Grove and Sandy Point on the Niantic River, Connecticut, in August and September 2005.



EXPLANATION

Binary mixing curves

1. Dilute groundwater/halite deicing salt, high range
2. Dilute groundwater/halite deicing salt, low range
3. Dilute groundwater/sewage or animal waste, high range
4. Dilute groundwater/sewage or animal waste, low range
5. Halite deicing salt/sewage or animal waste, high range
6. Halite deicing salt/sewage or animal waste, low range
7. Sewage or animal waste, low range/seawater
8. Dilute groundwater/seawater

ELY 78

Samples from wells—Size of circle is proportional to the total dissolved nitrogen concentration. Letter/number designation is local CT well identifier

Figure 6. The relation of chloride-to-bromide ratio to chloride concentration in groundwater samples collected during August and September 2005 at Pine Grove and Sandy Point on the Niantic River, Connecticut, and binary mixing curves representing various potential sources of chloride. mg/L, milligrams per liter; TDN, total dissolved nitrogen. See table 1 for a list of wells. From Mullaney and others (2009).

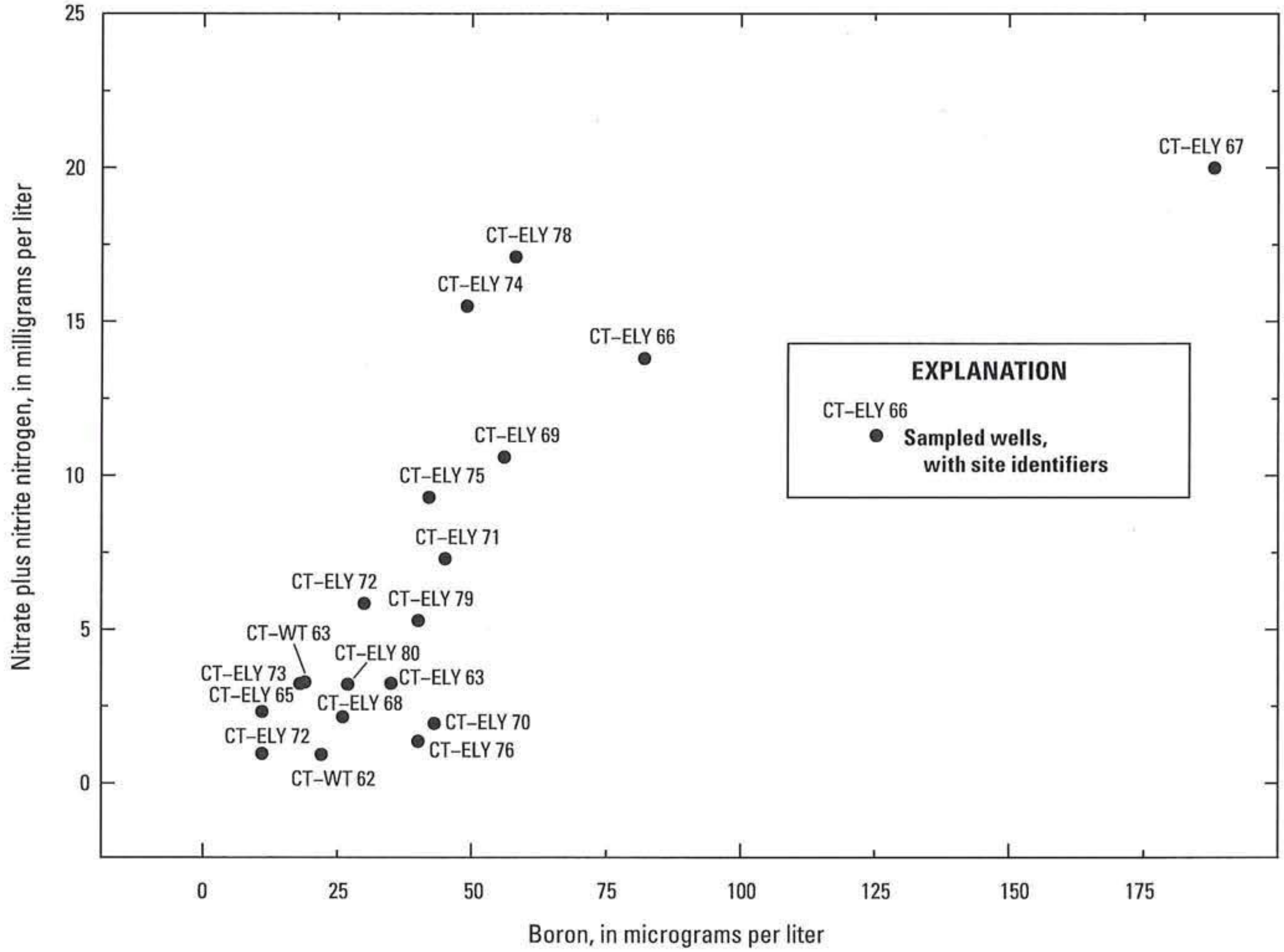


Figure 7. The relation between boron and nitrite plus nitrate nitrogen concentrations in groundwater samples collected during August and September 2005 at Pine Grove and Sandy Point on the Niantic River, Connecticut. mg/L, milligrams per liter. See table 1 for a list of wells.

The plotted positions of the samples in figure 6 indicate that the source of water for many of the samples is dominated by sewage and animal waste (wastewater). The majority of these samples plot near the sewage and animal waste end members for mixtures of dilute groundwater and sewage and animal waste, indicating a substantial contribution of water from wastewater.

Four of the samples show the influence of seawater, although one sample (from well CT–ELY 78) may indicate seawater and wastewater sources. Three of the samples (from wells CT–ELY 63, CT–ELY 65, and CT–ELY 68) show little or no influence of wastewater in their water chemistry. These samples also are associated with the lowest nitrite plus nitrate concentrations, indicating that few or no septic systems are likely in the recharge areas for these wells. Wells CT–ELY 63 and CT–ELY 65 are in a park on Pine Grove and, based on the configurations of the water table (fig. 3A, B), may receive recharge from the undeveloped lawn areas within the park. These samples have some of the lowest nitrate plus nitrite concentrations, ranging from 2.2 to 3.3 mg/L, in the study area.

Boron concentrations are generally considered to be an indicator of wastewater (LeBlanc, 1984; Katz and others, 2011). Domestic wastewater typically contains elevated concentrations of boron because of the use of sodium perborate in laundry detergents. Nitrate plus nitrite and dissolved boron data from the initial sampling of the wells in the study area are generally positively correlated and demonstrate that boron appears to be an indicator of the wastewater influence on the water quality in many of the wells in the study area (fig. 7). A simple linear regression fits a line through these data, with a coefficient of 0.1191 and an intercept of 1.4251.

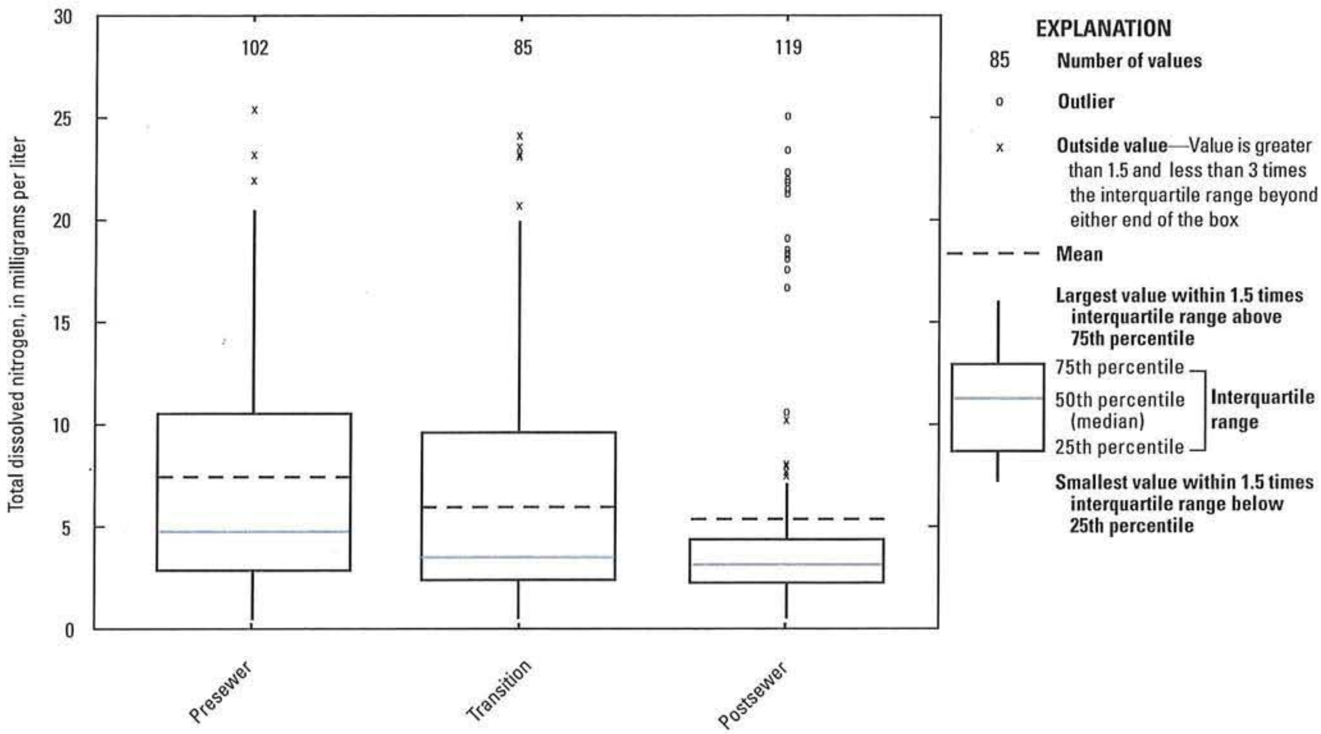


Figure 8. The distributions of total dissolved nitrogen concentrations for presewering (2005–7), transition (2008–9), and postsewering (2010–11) periods at the Pine Grove, Connecticut, study area. mg/L, milligrams per liter.

Water Quality After Installation of Sewers

Concentrations of TDN were generally lower during the transition time period, when the sewers had been connected to residences, than during the period before sewering (fig. 8) and were lowest during the period after sewering. The mean and median concentrations of TDN were 6.7 mg/L and 3.5 mg/L, respectively, in the transitional period (85 samples) and 5.2 mg/L and 3.1 mg/L, respectively, during the monitoring period after sewering (119 samples). The decrease in the mean concentration of TDN during the study period (2005–11) was 2.3 mg/L. The significance of the decrease in the concentrations of TDN before and after sewering was evaluated with the use of a Wilcoxon rank-sum test, which indicated that the groups of data were significantly different at a p-value of 0.0002.

When comparing the changes among individual wells, sample numbers were generally too few for any statistical comparison tests. Therefore, the means and medians for each of the three periods described above were compared qualitatively (table 5). Of the wells sampled on Pine Grove, only two had medians and three had means that were larger at the end of the study (postsewer period) than at the beginning of the study (presewer period). Of these three wells, samples from two wells had very small differences, likely indicating no significant change. Concentrations of TDN at well CT–ELY 67 (fig. 1, site 2) increased by more than 1 mg/L. Concentrations of TDN remained above 20 mg/L at this location, indicating a continuing source of nitrogen or insufficient groundwater-travel time for a difference to be observed.

The wells with some of the smallest decreases or increases, including wells CT–ELY 63, CT–ELY 68, CT–ELY 73, and CT–ELY 76, are where the sources of water as indicated in figure 6 were less likely to be sewage or animal-waste related. The possibility that the source was not onsite sewage disposal could explain the absence of changing TDN concentrations at these wells in the period after sewering.

The wells with the largest decreases in TDN concentrations between presewer and postsewer periods included wells CT–ELY 66, CT–ELY 70, CT–ELY 74, CT–ELY 75, and CT–ELY 80. The well cluster that includes wells CT–ELY 78, CT–ELY 79, and CT–ELY 80 (fig. 1, site 8) had decreases in TDN in all three wells at deep, intermediate, and shallow depths in the aquifer. This likely represents groundwater entering the Pine Grove neighborhood from Camp Niantic to the south, where sewers were connected before the beginning of this study.

Table 5. Median and mean concentrations of total dissolved nitrogen[1] in groundwater samples from wells at Pine Grove, Sandy Point, and Saunders Point on the Niantic River, Connecticut, before, during, and after sewering was completed at Pine Grove.

[Sites shaded in gray are at Sandy Point and Saunders Point. fig., figure; USGS, U.S. Geological Survey; ID, identification number, hyperlinked to data for each well; No., number of samples; TDN, total dissolved nitrogen; mg/L, milligrams per liter]

Site number (fig. 1)	USGS local ID	Presewering			Transitional period			Postsewering			Difference in medians, presewer to postsewer, in mg/L	Difference in means, presewer to postsewer, in mg/L
		No.	Median TDN, in mg/L	Mean TDN, in mg/L	No.	Median TDN, in mg/L	Mean TDN, in mg/L	No.	Median TDN, in mg/L	Mean TDN, in mg/L		
9	CT–ELY 63	6	3.48	3.47	5	3.28	2.80	7	3.43	3.13	0.05	0.34
9	CT–ELY 65	6	3.22	3.62	5	3.28	3.24	7	2.26	2.57	0.96	1.05
3	CT–ELY 66	6	9.33	9.44	5	12.95	16.06	7	4.53	5.11	4.79	4.33
2	CT–ELY 67	6	21.07	21.27	5	23.41	22.06	7	22.18	22.69	-1.12	-1.43
6	CT–ELY 68	6	2.36	2.32	5	2.25	2.33	7	2.39	2.38	-0.03	-0.06
1	CT–ELY 69	6	12.53	12.17	5	10.69	11.03	7	8.25	10.00	4.28	2.17
1	CT–ELY 70	6	4.45	5.37	5	5.22	4.86	7	2.51	2.79	1.94	2.58
4	CT–ELY 71	6	4.62	4.13	5	1.86	2.01	7	2.28	2.33	2.34	1.80
4	CT–ELY 72	6	4.76	4.55	5	5.16	5.25	7	3.43	3.77	1.33	0.78
5	CT–ELY 73	6	3.53	3.51	5	3.42	3.45	7	3.45	3.23	0.08	0.28
5	CT–ELY 74	6	15.80	15.20	5	8.00	8.97	7	3.33	3.51	12.47	11.69
5	CT–ELY 75	6	9.47	10.48	5	2.87	4.75	7	2.08	2.22	7.39	8.26
7	CT–ELY 76	6	1.52	1.52	5	1.34	1.37	7	1.26	1.59	0.26	-0.07
7	CT–ELY 77	6	0.95	0.94	5	0.54	0.68	7	0.55	0.60	0.41	0.34
8	CT–ELY 78	6	19.92	19.55	5	19.70	19.47	7	18.58	18.29	1.34	1.26
8	CT–ELY 79	6	4.77	4.56	5	4.10	3.88	6	2.71	2.90	2.07	1.66
8	CT–ELY 80	6	3.75	5.40	5	2.32	2.38	7	2.12	2.11	1.63	3.29
11	CT–WT 62	6	0.98	1.00	5	1.01	1.13	7	1.61	1.69	-0.63	-0.69
11	CT–WT 63	6	3.80	3.74	4	5.15	5.11	6	3.66	3.72	0.14	0.03
10	CT–ELY 81	4	6.41	6.37	6	6.71	6.68	6	6.06	6.43	0.35	-0.06

[1]TDN was determined from the sum of nitrite plus nitrate nitrogen and dissolved ammonia plus organic nitrogen. If dissolved ammonia plus organic nitrogen was less than the reporting limit, only nitrite plus nitrate values were used.

Estimated Nitrogen Loads From Groundwater to the Niantic River

Estimates of nitrogen load from groundwater discharge from the study area were made for three time periods: (1) before the installation of sewers in 2006, (2) after installation of sewers in 2011, and (3) in the future when concentrations of nitrogen have stabilized. Loads were estimated by using estimated effective recharge rates from precipitation and septic systems combined with mean TDN concentrations in the aquifer and estimated future TDN concentrations. Nitrogen loads from groundwater were estimated for other regions of the Niantic River by using estimated recharge rates and measured or estimated TDN concentrations for different regions of the lower watershed.

Water use in the Pine Grove study area ranged from 5.41 to 5.51 million gallons per year [Mgal/yr]) from 2006 through 2010 (table 6; Brad Kargl, East Lyme Water and Sewer Department, written commun., 2011). Water-use values from 2006 were used to estimate recharge from septic systems because these data precede the connection to sewers. Water use during 2006 was 5.51 million gallons (Mgal). It was assumed that 86 percent (U.S. Geological Survey, 1995) of the water used, or 4.7 Mgal, was returned to the aquifer. When distributed evenly over the 35-acre study area, this wastewater discharge is equivalent to 4.98 in. of recharge. Therefore, before the installation of sewers, the total estimated recharge from precipitation (23.2 in/yr) and artificial recharge from septic systems (4.98 in/yr) totaled 28.2 in.

Following the installation and connection by 2009 of all properties in the area to the sewer system, discharge from septic systems had ended, and recharge rates had dropped to 23.2 in. The effect of eliminating the discharge from septic systems should be to reduce the rate of discharge of freshwater from the Pine Grove study area to the coast, thereby reducing nitrogen loads to the adjacent surface-water bodies even in the absence of changing concentrations of TDN.

Table 6. Water use at Pine Grove, Connecticut, 2006–10.

[Data were compiled for the period from 2006 through 2010 from meter readings for individual properties in the study area (Brad Kargl, East Lyme Water and Sewer Department, written commun., 2011)]

Year	Gallons
2006	5,506,351
2007	5,414,971
2008	5,498,900
2009	5,250,995
2010	5,046,200

Nitrogen Loads Estimated for Pine Grove

At the beginning of this study, before the extension of the municipal sewer system to the Pine Grove area, the mean concentration of TDN in samples from all wells was 7.5 mg/L, based on data from 2005 through 2007 (102 samples). If this mean concentration is representative of the concentration of TDN for the fresh groundwater in the study area, and taking into account that the recharge rate before sewering was 28.2 in/yr on 35 acres, then the estimated dissolved nitrogen load to the surrounding surface waters before sewering was about 1,675 lb/yr. This value compares well with estimates made on the basis of the estimated return flow multiplied by an assumed concentration of total nitrogen in septic system leachate. Concentrations in the literature vary, but the CTDEEP summarized data from around the United States and estimated the mean concentration of total nitrogen to be 50.9 mg/L in residential septic tank effluent (Connecticut Department of Environmental Protection, 2006a). This compares with 45 mg/L as reported by the U.S. Environmental Protection Agency (1980). Using these concentrations multiplied by the return flow to the aquifer in 2006 (table 7) produces load estimates of 1,780 to 2,012 lb/yr, which compares well with the values calculated for this study.

Table 7. Estimates of total dissolved nitrogen load from the Pine Grove peninsula area to the Niantic River Estuary, Connecticut, before and after sewering and after total dissolved nitrogen concentrations have stabilized.

[in., inches; TDN, total dissolved nitrogen; mg/L, milligrams per liter; lb/yr, pounds per year]

Time period	Annual recharge rate (in.)		Mean measured or estimated TDN concentration (mg/L)	Estimated TDN load (lb/yr)
	Natural	From septic systems		
Recharge over entire area				
Presewer (2005–07)	23.2	4.98	7.50	1,675
Postsewer (2010–11)	23.2	0.00	5.24	963
After stabilization of total dissolved nitrogen concentrations	23.2	0.00	2.30	423
No recharge over impervious areas				
Presewer (2005–07)	17.8	4.98	7.50	1,358
Postsewer (2010–11)	17.8	0.00	5.24	742
After stabilization of total dissolved nitrogen concentrations	17.8	0.00	2.30	326

Immediately following installation of the sewers and connection of most residences to the system (2010–11), the mean concentration of TDN decreased to 5.24 mg/L, which indicates that some changes to concentration had occurred as a result of the sewer system installation. The load from the study area during this period was estimated by multiplying the recharge rate of 23.2 in/yr, which is solely from precipitation, by the area of the study site and the mean concentration for the postsewering period. The estimated load of TDN for the postsewering period is 963 lb/yr. This reduction from the presewering period is caused by the decrease in concentrations of TDN and a reduction in the water discharge as a result of sewering.

Predicted Future Nitrogen Loads From Pine Grove

As the aquifer beneath the Pine Grove area adjusts to a new steady state from the changes in nitrogen loading and the discontinuation of wastewater discharge to the subsurface, concentrations of TDN are likely to continue to decrease. The long-term changes in the loading of nitrogen to the Niantic River are dependent on the travel time of groundwater across the study area, the time for any nitrogen stored in the unsaturated zone to be flushed from the system, the final steady-state concentrations of TDN in the groundwater, and the length of additional pathways of discharge beneath the estuary that continue beyond the shoreline.

Based upon the mean saturated thickness of freshwater (27 ft) when the wells were drilled in 2005, a land area of about 35 acres, and an estimated porosity of 0.3, the freshwater zone in the study area contains approximately 12.3 Mgal of water in storage. The mean recharge rate of 23.2 in/yr is equivalent to 2.9 Mgal/yr over the study area of 35 acres. This indicates that the mean replacement time for the total annual recharge volume of water in the aquifer underlying the study area is about 4.2 years, excluding groundwater flow from upgradient areas. The associated residence time of TDN in the aquifer is likely longer than the replacement time for recharge due to hydrodynamic dispersion.

Groundwater enters the study area from the south from Camp Niantic. The estimated annual flow across the southern boundary of the study area is 5.5 to 13.8 Mgal/yr, some of which discharges into the Niantic River and some of which mixes with the recharge from precipitation in the study area. This conclusion is based the use of Darcy's law, and the typical range in gradient (0.0004–0.0005), the estimated hydraulic conductivity of the glacial stratified deposits (100–200 feet per day, based on the material composition and associated values in Mazzaferro and others [1979]), and the mean thickness of the freshwater layer of 37 ft across the southern boundary (1,370 ft) of the study area. This additional water likely decreases the residence time of recharge to the study area but also adds additional nitrogen. Sewers were installed at Camp Niantic in 2000, and concentrations of TDN in the groundwater (fig. 1, site 8, with three wells) on the northern part of Camp Niantic have been decreasing.

The groundwater travel time across the longest dimension of the study area can be estimated on the basis of the typical water-table gradient, the travel distance from the Camp Niantic boundary to the northern end of the peninsula (1,400 ft), and an estimated mean hydraulic conductivity. Assuming a porosity of 0.3 and mostly horizontal flow, the estimated travel time across the longest dimension of the study area ranges from 11.5 to 29 years. Most groundwater flow paths from the study area to the shore of the Niantic River are shorter than 1,400 ft, so travel times will be less than this estimate (less than 6 to 15 years). However, some flow paths may extend some distance beneath the Niantic River rather than ending at discharge points at the shoreline. Therefore, it is difficult to estimate the overall timing of the decrease in nitrogen loading to the river owing to the installation of the sewer system.

Concentrations of nitrogen in groundwater in the future are estimated to be similar to those in other parts of Connecticut with high density of development and sanitary sewers. Grady (1994) determined that the median nitrate plus nitrite concentration in groundwater in glacial stratified deposits beneath 21 sewered areas in Connecticut was 2.3 mg/L. This compares with a value of 1.1 mg/L of nitrate plus nitrite beneath undifferentiated urban areas in the Connecticut River, Housatonic River, and Thames River Basins (Grady and Mullaney, 1998). These concentrations are higher than those for undeveloped or forested areas where median values for nitrate plus nitrite ranged from 0.11 to 0.14 mg/L. When the range of values for typical urban areas are applied to the analysis of the potential for future nitrogen loads, the range in estimated future nitrogen loads to the Niantic River from the study area is 202 to 423 lb/yr. Remaining sources of nitrogen input to the groundwater at Pine Grove include atmospheric deposition, lawn fertilizers, and pet and animal wastes.

The method used to estimate the nitrogen loads described above and in the following section has several limitations resulting from the assumptions used in the analyses. These assumptions include that concentrations of TDN measured in the wells are representative of the concentrations in the study area, both vertically and areally, and that concentrations of TDN from different depths in the aquifer have equal weight (contribute equally to the load) in the analyses. The use of this method assumes a discharge of water from the study area that is equivalent to the estimated annual recharge from precipitation and septic systems.

Comparison of Nitrogen Loads From Pine Grove and Other Niantic River Subwatersheds

Estimates of the nitrogen loads that discharge directly to the Niantic River were made for other regions abutting the Niantic River. These estimates were made by using a combination of estimated recharge rates, which varied by surficial geology type (glacial till or glacial-stratified deposits), and measured or estimated nitrogen concentrations (fig. 9; table 8). Estimates from each region were summed for a total load to the river. The total annual estimated nitrogen load from

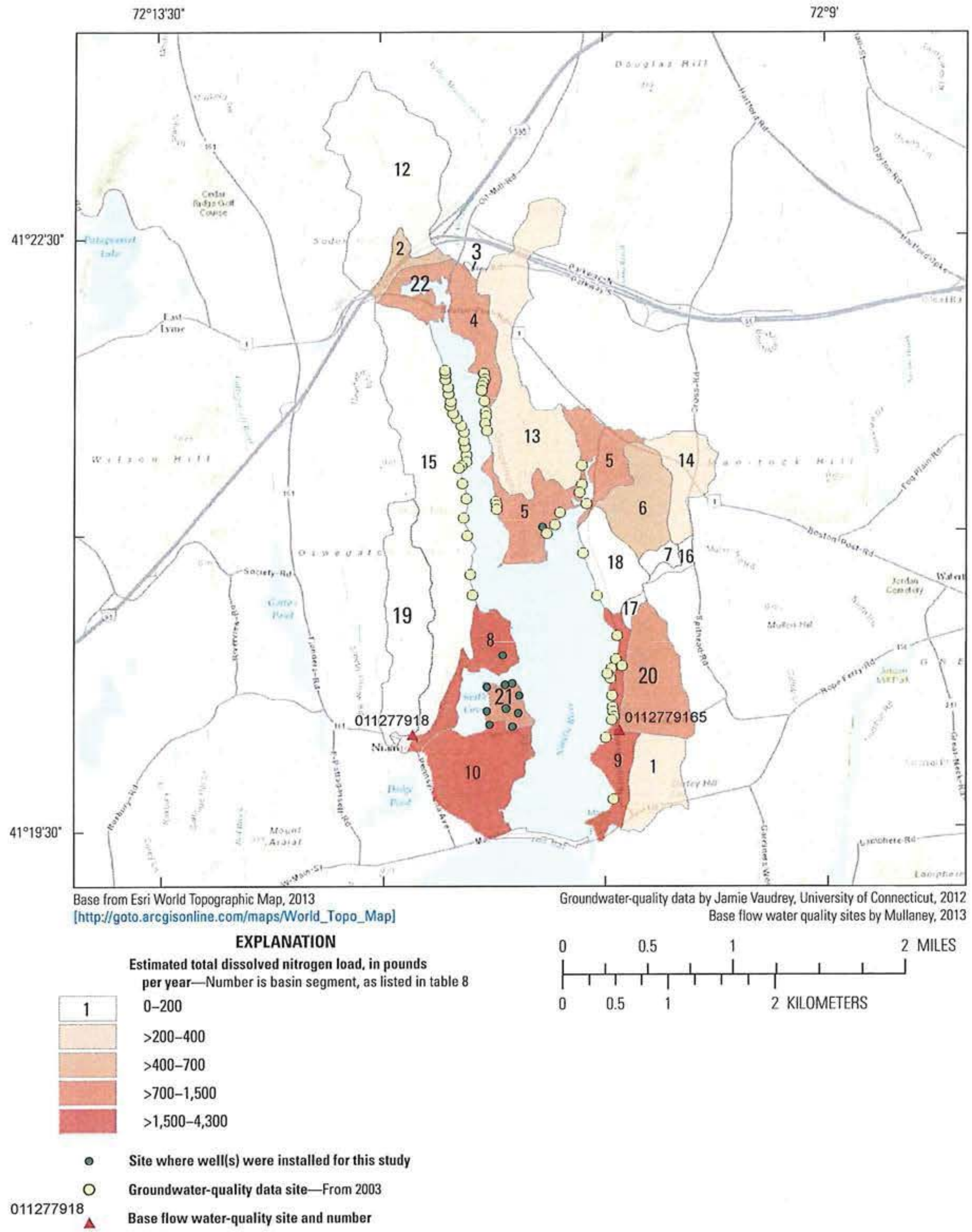


Figure 9. Total dissolved nitrogen load estimates from groundwater to the lower Niantic River, Connecticut. >, greater than.

Table 8. Total dissolved nitrogen loads from groundwater discharge for the lower Niantic River, Connecticut, estimated for 2011.

[fig., figure; TDN, total dissolved nitrogen; mg/L, milligrams per liter; lb, pounds; USGS, U.S. Geological Survey; GSD, glacial stratified deposit; NA, not applicable]

Map number (fig. 9)	Surficial geology	TDN concentration (estimated or measured), in mg/L	Size of basin segment, in acres	Recharge from septic systems, in inches	Recharge, in inches	Estimated number of residences using septic systems	Estimated per household water use, in gallons per day	Estimated percentage of water from septic systems returned to aquifer	Estimated annual load of TDN, in lb[1]	Other USGS station identification number[2]
1	Till	1.2	98.3	0.15	8.75	0	NA	NA	234	NA
2	GSD	4.0	31.7	0	23.20	0	NA	NA	666	NA
3	GSD	1.6	2.7	0	23.20	0	NA	NA	22	NA
4	GSD	1.6	84.9	0	23.20	0	NA	NA	714	NA
5	GSD	1.5	187.1	0	23.20	0	NA	NA	1,475	NA
6	GSD	0.8	116.4	0	23.20	0	NA	NA	490	NA
7	GSD	1.5	17.0	0	23.20	0	NA	NA	134	NA
8	GSD	6.5	87.6	2.71	25.91	130	160	0.85	3,350	NA
9	GSD	6.0	94.6	0	23.20	0	NA	NA	2,974	NA
10	GSD	4.0	186.1	2.12	25.32	216	160	0.85	4,272	NA
11	GSD	0.0	11.6	0	23.20	0	NA	NA	0	NA
12	Till	0.2	344.0	0	8.60	0	NA	NA	147	NA
13	Till	0.5	290.6	0	8.60	0	NA	NA	283	NA
14	Till	1.5	88.3	0	8.60	0	NA	NA	258	NA
15	Till	0.1	435.3	0.27	8.87	65	160	0.85	79	NA
16	Till	3.3	14.6	0	8.60	0	NA	NA	94	NA
17	Till	3.3	9.7	0	8.60	0	NA	NA	62	NA
18	Till	0.8	89.0	0	8.60	0	NA	NA	139	NA
19	GSD and Till	0.5	191.8	0	23.2/8.6	0	NA	NA	216	011277918
20	GSD and Till	2.4	149.2	0	23.2/8.6	0	NA	NA	1,181	0112779165
21	GSD	5.3	35.3	0	23.20	0	NA	NA	970	NA
22	GSD	4.0	51.6	0	23.20	0	NA	NA	1,084	NA

[1]Data are presented unrounded.

[2]From Mullaney (2013).

groundwater discharge from the areas identified in table 8 is 18,800 lb/yr, including the nitrogen loads estimated for Pine Grove in 2011. Data and analyses in Mullaney (2013) indicate that the mean total of nitrogen loads from the tributaries of the Niantic River from 2009 through 2011 was about 51,000 lb/yr. With the additional estimated total nitrogen load from direct groundwater discharge of 18,800 lb, the combined total nitrogen load to the Niantic River is greater than 69,800 lb/yr. The only component not accounted for in this total nitrogen load estimate is direct overland runoff from the areas of the watershed that are downstream of the USGS water-quality monitoring stations.

The predicted change in nitrogen load from the system resulting from the sewering at Pine Grove is about 1,250 lb/yr, representing about 1.8 percent of the estimated nitrogen load from upstream watershed and lower watershed groundwater sources combined.

Summary and Conclusions

A study of the concentration and estimated loads of nitrogen to adjacent surface waters before, during, and after sewers were installed was conducted at the Pine Grove neighborhood on the Niantic River Estuary in southeastern Connecticut. The study was conducted from 2005 through 2011 by the U.S. Geological Survey (USGS) in cooperation with the Connecticut Department of Energy and Environmental Protection (CTDEEP).

The Niantic River Estuary is impaired through excessive nitrogen loading, which is considered to be a major cause of the decline and fluctuation in the density of eelgrass populations. The CTDEEP has listed the Niantic River on the impaired waters list of the State of Connecticut and considers the river to be an impaired habitat for marine fish, aquatic life, and wildlife. Excess nitrogen in groundwater discharge from developed lands, including onsite wastewater treatment systems, has been implicated as a cause in the decline of the eelgrass habitats.

The Pine Grove neighborhood has 172 homes on the northern part of a peninsula, which is surrounded by the Niantic River. In 2005, all residences were served by septic systems and public water supply. In 2006, a project was begun to install sanitary sewers. The project was completed by connecting all residences to the sewer system from 2007 through 2009.

The USGS installed 17 wells throughout the neighborhood and 3 wells in two other regions adjacent to the Niantic River. The wells were sampled 18 times over the course of the study, primarily for analysis of nutrients but also for analysis of dissolved gases, bromide, boron, and other major ions during the first sampling period in 2005. Water levels were measured periodically at all wells and continuously at selected sites. The drilling and water-level monitoring indicated the Pine Grove area has a freshwater layer from 10 to 45 feet (ft) thick. Mean water levels ranged from 5.26 to 19.92 ft below land surface, or from 0.09 to 0.97 ft above the North American Vertical Datum of 1988. Groundwater flow directions were toward the north and toward the shorelines of Pine Grove. The horizontal hydraulic gradient is shallow, ranging from 0.0004 to 0.0005.

At the beginning of the study in 2005, analyses of water samples indicated that nitrate nitrogen was the primary component of the total dissolved nitrogen (TDN) in the groundwater. Nitrate plus nitrite concentrations ranged from 0.94 to 20 milligrams per liter (mg/L), with dissolved ammonia plus organic nitrogen concentrations ranging from less than 0.06 to 0.15 mg/L. The dissolved gas measurements indicated that the samples from most of the wells were oxic and denitrification was not a widespread process. Nitrate plus nitrite nitrogen concentrations were positively correlated with boron, which is an indicator of a wastewater source.

Chloride to bromide ratios were used along with chloride concentrations to understand sources of water entering the aquifer at Pine Grove. Many of the samples plotted near the binary mixing line for dilute groundwater and sewage or animal waste, indicating likely substantial input from septic systems. Five samples showed the influence of seawater, which likely is due to the proximity of the sampling depth to the transition zone between freshwater and saltwater.

TDN concentrations were compared for samples from all wells across the presewering period, the transitional period when residences were being connected to the sewer system, and the postsewering period when almost all residences had been connected. Mean and median TDN concentrations began to decrease during the transitional period and continued to decrease in the postsewering period. A Wilcoxon rank-sum test indicated a significant difference between the sample concentrations of TDN before and after sewering. The mean concentration of TDN for groundwater samples collected during the presewering period was 7.5 mg/L and for samples collected during the postsewering period was 5.2 mg/L. The median and mean TDN concentrations decreased in 14 of the 17 wells between the presewering and postsewering periods. Decreases in mean concentrations of TDN ranged from 0.34 to 11.7 mg/L.

Nitrogen loads from groundwater in the Pine Grove area were calculated for the periods before and after sewering and estimated for the future when nitrogen concentrations have stabilized to levels typical of similarly developed sewered areas. Estimated TDN loads were calculated by using estimates of recharge under presewering and postsewering conditions and mean measured or estimated future TDN concentrations. Water-use records from 2006 were used to calculate an estimated recharge from septic systems of 4.98 inches per year (in/yr) for the presewering period. Recharge from precipitation for the presewering period was estimated to be 23.2 in/yr. Given the combined recharge rate of 28.2 in/yr, an area of 35 acres, and a mean TDN concentration of 7.5 mg/L, the estimated TDN load from the Pine Grove area before sewering was 1,675 pounds per year (lb/yr).

Following the sewer installation, the estimated combined recharge rate was reduced to 23.2 in/yr, and the mean concentration of TDN was 5.2 mg/L, yielding an estimated TDN load of 963 lb/yr. The timing of the eventual stabilization of TDN concentrations in the aquifer at Pine Grove to steady-state, lower values, reflecting the new sewered hydrologic system, is dependent on the amount of residual nitrogen from septic systems remaining in the saturated and unsaturated zones and the travel time and residence time of water in the aquifer. The mean replacement time for the zone of freshwater was estimated to be about 4.2 years based on estimated recharge rates and the volume of freshwater in the aquifer but is probably less because of inflow from upgradient areas. The longest flow paths across the study area were estimated to have travel times of 11.5 to 29 years based on measurements of the water-table gradient and estimates of the hydrologic properties of the aquifer materials. When concentrations of TDN reach new quasi-stable values, reflecting the sewered condition, they are estimated to be in the range of 1.1 to 2.3 mg/L based on previous studies in Connecticut. Therefore, the estimated annual TDN load from the study area in the future could be as low as 202 to 423 lb/yr.

Nitrogen load estimates from groundwater discharge were made for other areas of the lower Niantic River watershed adjacent to the river. Estimates were made by applying recharge rates for different geologic materials (23.2 in/yr for glacial stratified deposits and 8.6 in/yr for till) to previously measured or estimated nitrogen concentrations to determine loads for selected areas. The estimated TDN load from groundwater discharge for the lower watershed, including the Pine Grove study area, for 2011 was 18,800 lb/yr, compared with 51,000 lb/yr from the tributaries computed in a previous study (2009–11). The predicted change in nitrogen load from the system resulting from the sewering at Pine Grove is 1,250 lb/yr, representing about 1.8 percent of the estimated nitrogen load from upstream watershed and lower watershed groundwater sources combined. Further research is needed to confirm these estimates of TDN load for the lower watershed and the remaining TDN loads to the Niantic River from stormwater surface runoff from the lower watershed.

References Cited

Brown, C.J., Mullaney, J.R., Morrison, Jonathan, and Mondazzi, Remo, 2011, Preliminary assessment of chloride concentrations, loads, and yields in selected watersheds along the Interstate 95 corridor, southeastern Connecticut, 2008–09: U.S. Geological Survey Open-File Report 2011–1018, 41 p., http://pubs.usgs.gov/of/2011/1018/.

Busenberg, Eurybiades, Plummer, L.N., Bartholomay, R.C., and Wayland, J.E., 1998, Chlorofluorocarbons, sulfur hexafluoride, and dissolved permanent gases in ground water from selected sites in and near the Idaho National Engineering and Environmental Laboratory, Idaho, 1994–97: U.S. Geological Survey Open-File Report 98–274, 72 p., http://pubs.usgs.gov/of/1998/0274/report.pdf.

Chabaeva, A.A., Civco, D.L., and Prisloe, Sandy, 2004, Development of a population density and land use based regression model to calculate the amount of imperviousness: American Society of Photogrammetry and Remote Sensing, annual conference, Denver, Colo., May 23–28, 2004, Proceedings, [n.p.], accessed September 10, 2009, at http://nemo.uconn.edu/tools/impervious_surfaces/pdfs/Chabaeva_etal_2004.pdf.

Clesceri, L.S., Greenberg, A.E., and Eaton, A.D., eds., 1998, Standard methods for the examination of water and wastewater (20th ed.): Washington, D.C., American Public Health Association, American Water Works Association, and Water Environment Federation, 3120, p. 3–37 to 3–43.

Connecticut Department of Energy and Environmental Protection, 2012, State of Connecticut integrated water quality report, Final—December 17, 2012: Connecticut Department of Energy and Environmental Protection, 343 p., accessed August 25, 2014, at http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2012_iwqr_final.pdf.

Connecticut Department of Environmental Protection, 2006a, Guidance for design of large-scale on-site wastewater renovation systems: Connecticut Department of Environmental Protection, [variously paged], accessed May 29, 2014, at http://www.ct.gov/deep/cwp/view.asp?a=2721&q=332888&deepNav_GID=1654.

Connecticut Department of Environmental Protection, 2006b, Niantic River watershed protection plan: Connecticut Department of Environmental Protection, 180 p. plus 7 appendixes, http://www.ct.gov/dep/cwp/view.asp?A=2719&Q=379296#nianticriver.

Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p., http://pubs.usgs.gov/twri/twri5-a1/.

Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93–125, 217 p., at http://pubs.usgs.gov/of/1993/0125/report.pdf.

Georgas, Nickitas, Rangarajan, Srinivasan, Farley, K.J., and Jagupilla, S.C.K., 2009, AVGWLF-based estimation of nonpoint source nitrogen loads generated within Long Island Sound subwatersheds: Journal of the American Water Resources Association, v. 45, no. 3, p. 715–733.

Grady, S.J., 1994, Analysis of nonpoint-source ground-water contamination in relation to land use, chap. B *of* Effects of land use on quality of water in stratified-drift aquifers in Connecticut: U.S. Geological Survey Water-Supply Paper 2381, p. B1–B56, http://pubs.usgs.gov/wsp/2381b/report.pdf.

Grady, S.J., and Mullaney, J.R., 1998, Natural and human factors affecting shallow water quality in surficial aquifers in the Connecticut, Housatonic, and Thames River Basins: U.S. Geological Survey Water-Resources Investigations Report 98–4042, 81 p., http://pubs.usgs.gov/wri/1998/4042/report.pdf.

Katz, B.G., Eberts, S.M., and Kauffman, L.J., 2011, Using Cl/Br ratios and other indicators to assess potential impacts on groundwater quality from septic systems—A review and examples from principal aquifers in the United States: Journal of Hydrology, v. 397, no. 3–4, p. 151–166, http://dx.doi.org/10.1016/j.jhydrol.2010.11.017.

Kendall, Carol, and Aravena, Ramon, 2000, Nitrate isotopes in groundwater systems, chap. 9 *of* Cook, P.G., and Herczeg, A.L., eds., Environmental tracers in subsurface hydrology: Kluwer Academic Publishers, p. 261–297.

Latimer, J.S., Tedesco, M.A., Swanson, R.L., Yarish, Charles, Stacey, P.E., Garza, Corey, eds., 2014, Long Island Sound—Prospects for the urban sea: New York, Springer Science and Business Media, 558 p.

LeBlanc, D.R., 1984, Sewage plume in a sand and gravel aquifer, Cape Cod, Massachusetts: U.S Geological Survey Water-Supply Paper 2218, 28 p., http://pubs.usgs.gov/wsp/wsp2218/.

Lindsey, B.D., and Burton, W.C., 2003, East Mahantango Creek watershed, *in* Lindsey, B.D., Phillips, S.W., Donnelly, C.A., Speiran, G.K., Plummer, L.N., Böhlke, J.K., Focazio, M.J., Burton, W.C., and Busenberg, Eurybiades, 2003, Residence times and nitrate transport in ground water discharging to streams in the Chesapeake Bay watershed: U.S. Geological Survey Water-Resources Investigations Report 03–4035, 201 p., http://pa.water.usgs.gov/reports/wrir03-4035.pdf.

Marshall, Nelson, 1994, The scallop estuary—The natural features of the Niantic River: St. Michaels, Maryland, Th'Anchorage Publisher, 152 p.

Mazzaferro, D.L., Handman, E.H., and Thomas, M.P., 1979, Quinnipiac River basin, pt. 8 *of* Water resources inventory of Connecticut: Connecticut Water Resources Bulletin 27, 86 p., http://pubs.usgs.gov/ctwrb/0027/report.pdf.

McCallum, B.E., Painter, J.A., and Frantz, E.R., 2012, Monitoring inland storm tide and flooding from Hurricane Irene along the Atlantic coast of the United States, August 2011: U.S. Geological Survey Open-File Report 2012–1022, 28 p., http://pubs.usgs.gov/of/2012/1022/.

Mullaney, J.R., 2013, Nutrient concentrations and loads and *Escherichia coli* densities in tributaries of the Niantic River estuary, southeastern Connecticut, 2005 and 2008–2011: U.S. Geological Survey Scientific Investigations Report 2013–5008, 27 p., http://pubs.usgs.gov/sir/2013/5008/.

Mullaney, J.R., Lorenz, D.L., and Arntson, A.D., 2009, Chloride in groundwater and surface water in areas underlain by the glacial aquifer system, northern United States: U.S. Geological Survey Scientific Investigations Report 2009–5086, 41 p., http://pubs.usgs.gov/sir/2009/5086/.

National Oceanic and Atmospheric Administration, [undated], Datums for 8461490, New London CT: National Oceanic and Atmospheric Administration, accessed January 3, 2014, at http://tidesandcurrents.noaa.gov/datums.html?id=8461490.

Patton, C.J., and Kryskalla, J.R., 2011, Colorimetric determination of nitrate plus nitrite in water by enzymatic reduction, automated discrete analyzer methods: U.S. Geological Survey Techniques and Methods, book 5, chap. B8, 34 p., http://pubs.usgs.gov/tm/05b08/.

Patton, C.J., and Truitt, E.P., 2000, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of ammonium plus organic nitrogen by a Kjeldahl digestion method and an automated photometric finish that includes digest cleanup by gas diffusion: U.S. Geological Survey Open-File Report 00–170, 31 p., http://pubs.usgs.gov/of/2000/0170/report.pdf.

Prisloe, Michael, Wilson, E.H., and Arnold, Chester, 2003, Final report—Refinement of population-calibrated land-cover-specific impervious surface coefficients for Connecticut: Haddam, Conn., University of Connecticut, 20 p., http://nemo.uconn.edu/tools/impervious_surfaces/pdfs/Prisloe_etal_2003.pdf.

Stone, J.R., Schafer, J.P., London, E.H., and Thompson, W.B., 1992, Surficial materials map of Connecticut: U.S. Geological Survey Special Map, scale 1:125,000, 2 sheets, http://pubs.er.usgs.gov/publication/70046712.

Struzeski, T.M., DeGiacomo, W.J., and Zayhowski, E.J., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of dissolved aluminum and boron in water by inductively coupled plasma-atomic emission spectrometry: U.S. Geological Survey Open-File Report 96–149, 17 p., http://pubs.usgs.gov/of/1996/0149/report.pdf.

Thomas, M.P., 1966, Effect of glacial geology upon the time distribution of streamflow in eastern and southern Connecticut, *in* Geological Survey research 1966, chapter B: U.S. Geological Survey Professional Paper 550–B, p. B209–B212, http://pubs.usgs.gov/pp/0550b/report.pdf.

U.S. Environmental Protection Agency, 1993, Determination of phosphorus by semi-automated colorimetry (revision 2.0), method 365.1 *of* Methods for the determination of inorganic substances in environmental samples: U.S. Environmental Protection Agency EPA/600/R–93/100, p. 365.1–1—365.1–17.

U.S. Environmental Protection Agency, 1980, Onsite wastewater treatment and disposal systems: U.S. Environmental Protection Agency design manual, 391 p., accessed May 29, 2014, at http://water.epa.gov/infrastructure/septic/upload/septic_1980_osdm_all.pdf.

U.S. Geological Survey, 1995, Water use, chap. 11 *of* National handbook of recommended methods for water-data acquisition: U.S. Geological Survey Web site, accessed May 29, 2014, at http://water.usgs.gov/pubs/chapter11/.

U.S. Geological Survey, [undated]a, Dissolved gas N_2 / Ar and ^{4}He sampling: U.S. Geological Survey Reston Dissolved Gases Laboratory, accessed July 15, 2014, at http://water.usgs.gov/lab/dissolved-gas/sampling/.

U.S. Geological Survey, [undated]b, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9, accessed May 29, 2014, at http://pubs.water.usgs.gov/twri9A.

Valiela, Ivan, Costa, Joseph, Foreman, Kenneth, Teal, J.M., Howes, Brian, and Aubrey, David, 1990, Transport of groundwater-borne nutrients from watersheds and their effects of coastal waters: Biogeochemistry, v. 10, no. 3, p. 177–197.

Weiskel, P.K., and Howes, B.L., 1991, Quantifying dissolved nitrogen flux through a coastal watershed: Water Resources Research, v. 27, no. 11, p. 2929–2939, http://dx.doi.org/10.1029/91WR01910.

Weiss, L.A., 1983, Evaluation and design of a streamflow-data network for Connecticut: Connecticut Department of Environmental Protection Connecticut Water Resources Bulletin 36, 31 p.

Appendix 1. Dissolved Gas Measurements in Groundwater Samples From Pine Grove and Sandy Point, Niantic River, Connecticut, August and September 2005

Table 1–1. Dissolved gas measurements, August and September 2005.

[Laboratory analyses by the U.S. Geological Survey, Chlorofluorocarbon Laboratory, Reston, Virginia. USGS, U.S. Geological Survey; ID, identification number; °C, degrees Celsius; mg/L, milligram per liter; N2, nitrogen; Ar, argon; O_2, oxygen; CO_2, carbon dioxide; CH_4, methane; cm^3 STP/L, cubic centimeters at standard temperature and pressure per liter; --, no excess N_2]

USGS local identifier	Date collected	Time collected	Field temperature (°C)	N_2 (mg/L)	Ar (mg/L)	O_2 (mg/L)	CO_2 (mg/L)	CH_4 mg/L	Estimated excess N_2 (mg/L)	Recharge temperature, (°C)	Excess air (cm^3 STP/L)
CT–ELY 63	08/17/05	1005	12.9	18.4	0.7	6.7	28.8	0.000	--	12.4	1.1
CT–ELY 63	08/17/05	1005	12.9	17.9	0.7	6.4	29.4	0.000	--	12.2	0.6
CT–ELY 65	08/17/05	1210	14.9	17.8	0.7	8.8	21.0	0.000	--	12.2	0.4
CT–ELY 65	08/17/05	1210	14.9	18.0	0.7	8.9	20.4	0.000	--	11.8	0.5
CT–ELY 66	08/18/05	915	13.0	18.1	0.7	5.8	56.6	0.000	--	12.8	1.0
CT–ELY 66	08/18/05	950	13.0	18.0	0.7	5.8	56.5	0.000	--	12.3	0.7
CT–ELY 67	08/17/05	1350	13.7	17.2	0.6	4.7	84.9	0.000	--	13.7	0.3
CT–ELY 67	08/17/05	1350	13.7	17.5	0.6	3.2	85.9	0.000	--	13.8	0.7
CT–ELY 68	08/23/05	955	15.4	17.5	0.6	6.6	31.8	0.000	--	12.9	0.3
CT–ELY 68	08/23/05	955	15.4	17.4	0.7	6.5	32.2	0.000	--	12.7	0.3
CT–ELY 70	08/18/05	1110	13.7	18.3	0.7	4.2	99.1	0.000	--	11.7	0.8
CT–ELY 70	08/18/05	1110	13.7	18.3	0.7	4.2	101.9	0.000	--	11.6	0.7
CT–ELY 71	08/23/05	1210	12.9	18.8	0.7	5.2	41.6	0.000	--	13.4	1.9
CT–ELY 71	08/23/05	1210	12.9	18.2	0.7	5.4	39.6	0.000	--	13.8	1.4
CT–ELY 73	08/19/05	1055	12.5	20.2	0.7	0.1	27.2	0.003	1.2	10.9	1.3
CT–ELY 75	08/19/05	1205	12.7	17.9	0.7	7.0	61.1	0.000	--	13.0	0.8
CT–ELY 75	08/19/05	1205	12.7	17.9	0.7	7.0	60.8	0.000	--	13.0	0.8
CT–ELY 76	08/24/05	935	13.1	18.9	0.7	5.2	18.2	0.001	--	10.7	1.0
CT–ELY 76	08/24/05	935	13.1	18.9	0.7	5.3	18.4	0.001	--	10.8	1.0
CT–ELY 77	08/24/05	1110	14.6	18.3	0.7	7.0	43.6	0.000	--	12.5	1.1
CT–ELY 77	08/24/05	1110	14.6	18.0	0.7	6.6	43.8	0.000	--	12.8	0.9
CT–ELY 78	09/01/05	1000	13.2	18.5	0.7	1.6	34.9	0.000	0.2	12.5	1.3
CT–ELY 78	09/01/05	1000	13.2	18.4	0.7	1.6	35.5	0.000	0.2	12.8	1.3
CT–ELY 80	09/01/05	1150	12.5	16.9	0.6	7.7	35.8	0.000	--	14.5	0.3
CT–ELY 80	09/01/05	1150	12.5	17.2	0.6	7.6	36.4	0.000	--	14.6	0.6
CT–WT 62	09/02/05	1005	11.0	20.1	0.7	7.5	52.4	0.000	--	7.9	1.1
CT–WT 62	09/02/05	1005	11.0	20.0	0.7	7.9	52.3	0.000	--	7.7	0.9

Prepared by the Pembroke Publishing Service Center.

For more information concerning this report, contact:

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http://ct.water.usgs.gov

USGS

Mullaney—**Evaluation of the Effects of Sewering on Nitrogen Loads to the Niantic River, Southeastern Connecticut, 2005–11**—Scientific Investigations Report 2015–5011

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APPENDIX C: 2016 HEALTH DEPARTMENT NOTICE

TOWN OF OLD LYME

HEALTH DEPARTMENT
52 Lyme Street
Old Lyme, CT 06371
Tel. (860) 434-1605 x214
Fax (860) 434-4135

January 12, 2016

To: The Water Pollution Control Authority, Town of Old Lyme, CT:

Regarding Pathogenic Contamination of Groundwater in the Vicinity of Hawk's Nest Beach Area, Old Lyme, CT

Good evening and thank you for asking me to present to this commission my assessment and direction regarding this vitally important and potentially serious health problem as it has reached a critical juncture for the Town of Old Lyme to forthwith commence specific concrete steps to remediate.

As Director of Health for the Town of Old Lyme, many present this evening know me well and others may not. I arrived in town 30 years ago to join the original Old Lyme Family Practice on Davis Road West in 1985. Since then, I have been privileged to serve as the Lyme/Old Lyme Public Schools medical advisor for 23 years and Director of Health of the Town of Old Lyme for the past 16 years. During my tenure in all of these public health related roles, I have had the opportunity to develop a broad and deep understanding of the health status of this community. One salient characteristic that I have come to recognize in Old Lyme is the importance and priority its residents place in matters regarding good health for their families. Furthermore, I have consistently been impressed by this town's commitment to do what is right and to take whatever actions are necessary to promote public health whenever significant threats arise.

Over these many years, for example, residents have brought to my attention concerns about air quality in buildings, possible lead exposures, emissions of idling school buses, mosquito and tick-borne diseases, pandemic influenza and many other potential threats to their good health. In all of these situations, we have identified problems, evaluated risks scientifically and undertaken the best feasible remedial actions with the mutual collaboration of public health authorities, concerned citizens in the community, elected officials and dedicated volunteer town boards. The WPCA is one such essential commission charged with the vital responsibility of ensuring the quality and purity of the town's water resources and I commend you for your diligence toward that goal to help remedy the current public health hazard of contaminated ground water.

The threat to public health of contaminated groundwater in the Hawk's Nest vicinity and neighboring beach areas has been of growing concern to town governance, the WPCA, the Old Lyme Health Department, Connecticut State Department of Public Health, the Department of Energy and Environmental Protection as well as potentially affected residents in recent years. Existing onsite sanitary disposal systems are progressively aging, failing and increasingly noncompliant with basic acceptable standards of hygiene. Unfavorable soil and other site conditions as well as excessively high development density and septic system crowding have created a perfect storm for serious health hazards to residents exposed to the groundwater in those areas.

Recognizing these potential hazards, the town has done commendable due diligence over recent years to study the water pollution problem and evaluated alternatives to rectify identified hazards. Specific proposed piecemeal remedial options such as upgrading existing onsite wastewater treatment systems, small community systems conveying wastewater to centralized locations and decentralized wastewater management of individual lots have all been carefully evaluated with considerable expenditure of time and fiscal resources. Unfortunately, none of these approaches offers a long-term comprehensive solution that is practically feasible. It should be noted that no personal, financial or other private considerations of individual lot owners have had any influence in reaching these conclusions. Indeed, there is now a consensus among experts whose sole motivation is to propose a realistic solution to this public health hazard that the only means of permanently overcoming this difficult predicament is construction of sanitary sewers.

As a scientist, I need hard data before I can come to intelligent credible and rational conclusions regarding health. We have now collected enough objective information to conclude that groundwater in the areas studied is undeniably contaminated with infectious pathogens that pose a real and present public health threat. What am I worried about? My concern is that no citizen of this town should be exposed to disease-causing microorganisms or associated toxins. The comprehensive data we have accumulated reveal that groundwater in these areas is polluted and an obvious hazard to health judged by current clean water standards. I am troubled by the possibility that infants, pregnant or breast-feeding women, the elderly and other vulnerable individuals with compromised immune systems might develop serious preventable diseases from exposure to water that is contaminated by pathogens or excess nitrates. Furthermore, I am concerned that there may be possible cancer risks from other potential toxins besides excess nitrates that may exist in polluted ground water that are currently the subject of research into water quality and its effects on human health. Even one individual developing serious disease from polluted water in this town is too many for me.

It has been brought to my attention that some residents in the affected areas question the veracity of the evidence documenting pollution of the groundwater referenced here. In my work, politics, personal agendas and financial considerations have absolutely no place in matters of public health. No matter how you slice and dice the data, an objective analysis in a nonpartisan scientific manner confirms the existence of a hazard. Just as denial of climate change is a recipe for future environmental disasters, I believe that ignoring the real and growing presence of pathogenic contamination of our ground waters is a sure path to adverse health events in the future.

The Health Department and consultants have provided relevant documentation from multiple sources to this commission. The detailed Public Health Assessment of Pathogenic Contamination of Ground Water in the Vicinity of Hawk's Nest Beach Area provided to you today delineates a summary of these contamination issues that pose significant hazards to residents in contact with the affected groundwater. Besides the scientific, microbiologic and engineering details, it is important to note that this assessment also addresses potential violations of state and federal statutes regarding public health nuisance and pollution of water occurring within municipal jurisdictions for which the town is potentially liable if remedial actions are not undertaken.

The Town of Old Lyme conducts its business in accordance with Connecticut State Statute Law. Public Health Code Section 19-13-B2 charges any local health director to investigate, within a reasonable time, the existence of a nuisance or any pollution occurring within his jurisdiction and to direct its abatement in writing. Pursuant to this mandate from the State of Connecticut, I state herewith my professional opinion as Director of Health that due diligence has now been thoroughly undertaken by the town, its WPCA and its Health Department to study all aspects of this matter and that a public health nuisance is thus identified. With this notification, it is now incumbent on the town to proceed forthwith to do what is right and practically feasible to abate the public health hazard.

In concluding this report, as a physician who also treats patients in clinical practice, I would like to present an analogy that may help to illustrate the scope and approach needed for the health problems we face with septic issues in our beach areas. Imagine a patient who comes to me complaining of chest pain. After careful examination and collection of data from stress tests or angiograms, I conclude that he has angina and blockage of arteries in the heart that may lead to a heart attack. If it's only one artery, I might recommend a simple, economical and less invasive approach like medications or a balloon angioplasty procedure to open up that artery and allow the blood to flow. If there are multiple arteries and heart areas involved in the disease, I would recommend open-heart surgery, creating multiple new channels for clean oxygenated blood to flow freely. This would be an invasive and more expensive procedure involving more pain, more time in the hospital and extended recovery, but this option would provide the best long-term solution to the problem, avoiding a heart attack and the many complications that arise when shortcuts or easier temporary measures are taken. Let's acknowledge the scope of the potentially serious public health problem we have with pollution of ground water on our shoreline and do the major surgery required to adequately address it.

Respectfully submitted,

V Sikand, M.D.

Vijay Sikand, MD, FAAFP
Director of Health

CC First Selectwoman and Board of Selectmen, Town of Old Lyme

APPENDIX D: CT-DEEP AND USFWS CORRESPONDENCE

- CT-DEEP Natural Diversity Database Determination Letter
- USFWS Federally Listed Endangered and Threatened Species in Connecticut
- USFWS Endangered Species Act Coordination Letter

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
http://www.fws.gov/newengland

January 20, 2017

To Whom It May Concern:

This project was reviewed for the presence of federally listed or proposed, threatened or endangered species or critical habitat per instructions provided on the U.S. Fish and Wildlife Service's New England Field Office website:

http://www.fws.gov/newengland/EndangeredSpec-Consultation.htm (accessed January 2017)

Based on information currently available to us, no federally listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area(s). Preparation of a Biological Assessment or further consultation with us under section 7 of the Endangered Species Act is not required. No further Endangered Species Act coordination is necessary for a period of one year from the date of this letter, unless additional information on listed or proposed species becomes available.

Thank you for your cooperation. Please contact Maria Tur of this office at 603-223-2541 if we can be of further assistance.

Sincerely yours,

Thomas R. Chapman
Supervisor
New England Field Office

FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES IN CONNECTICUT

COUNTY	SPECIES	FEDERAL STATUS	GENERAL LOCATION/HABITAT	TOWNS
Fairfield	Piping Plover	Threatened	Coastal Beaches	Westport, Bridgeport and Stratford
	Roseate Tern	Endangered	Coastal beaches, Islands and the Atlantic Ocean	Westport and Stratford
	Bog Turtle	Threatened	Wetlands	Ridgefield and Danbury.
	Red knot[1]	Threatened	Coastal Beaches and Rocky Shores, sand and mud flats	Coastal towns
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide
Hartford	Dwarf wedgemussel	Endangered	Farmington and Podunk Rivers, Muddy Brook, Philo Brook, Stony Brook	South Windsor, East Granby, Suffield, Simsbury, Avon and Bloomfield.
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide
Litchfield	Small whorled Pogonia	Threatened	Forests with somewhat poorly drained soils and/or a seasonally high water table	Sharon.
	Bog Turtle	Threatened	Wetlands	Sharon and Salisbury.
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide
Middlesex	Roseate Tern	Endangered	Coastal beaches, islands and the Atlantic Ocean	Westbrook and New London.
	Piping Plover	Threatened	Coastal Beaches	Clinton, Westbrook, Old Saybrook.
	Puritan Tiger Beetle	Threatened	Sandy beaches along the Connecticut River	Cromwell, Portland
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide
New Haven	Bog Turtle	Threatened	Wetlands	Southbury
	Piping Plover	Threatened	Coastal Beaches	Milford, Madison and West Haven
	Roseate Tern	Endangered	Coastal beaches, Islands and the Atlantic Ocean	Branford, Guilford and Madison
	Indiana Bat	Endangered	Mines, Caves	
	Red knot[1]	Threatened	Coastal Beaches and Rocky Shores, sand and mud flats	Coastal towns
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide

Updated 02/05/2016

COUNTY	SPECIES	FEDERAL STATUS	GENERAL LOCATION/HABITAT	TOWNS
New London	Piping Plover	Threatened	Coastal Beaches	Old Lyme, Waterford, Groton and Stonington.
	Roseate Tern	Endangered	Coastal beaches, Islands and the Atlantic Ocean	East Lyme and Waterford.
	Small whorled Pogonia	Threatened	Forests with somewhat poorly drained soils and/or a seasonally high water table	Waterford
	Red knot[1]	Threatened	Coastal Beaches and Rocky Shores, sand and mud flats	Coastal towns
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide
Tolland	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide
Windham	Sandplain Gerardia	Endangered	Dry, sandy-loam, nutrient-poor soils of sandplain grasslands	Plainfield
	Northern Long-eared Bat	Threatened Final 4(d) Rule	Winter- mines and caves, Summer – wide variety of forested habitats	Statewide

[1]Migratory only, scattered along the coast in small numbers

- Eastern cougar, gray wolf, Indiana bat, Seabeach amaranth and American burying beetle are considered extirpated in Connecticut.
- There is no federally-designated Critical Habitat in Connecticut.

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

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April 18, 2017

Aaron Brennan
Woodard & Curran
1699 King Street, Suite 406
Enfield, CT 06082
abrennan@woodardcurran.com

Project: Old Lyme Coastal Wastewater Management Project, construction of a wastewater collection system including pump station at jct. Pond Rd and Hartford Ave, a transmission main along Hartford Avenue and Route 156 and gravity sewer pipes within public roadways in project area between Billow Road and Robbin Ave/Prospect Street, and including West End Drive in Old Lyme
NDDB Determination No.: 201703255

Dear Aaron Brennan,

I have reviewed Natural Diversity Database (NDDB) maps and files regarding the area of work provided for the proposed construction of a wastewater collection system in Old Lyme, Connecticut. I do not anticipate negative impacts to State-listed species (RCSA Sec. 26-306) resulting from your proposed activity at the site based upon the information contained within the NDDB. The result of this review does not preclude the possibility that listed species may be encountered on site and that additional action may be necessary to remain in compliance with certain state permits. This determination is good for two years. Please re-submit a new NDDB Request for Review if the scope of work changes or if work has not begun on this project by April 18, 2019.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey, cooperating units of DEEP, landowners, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the NDDB should not be substitutes for on-site surveys necessary for a thorough environmental impact assessment. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the database as it becomes available.

Please contact me if you have further questions at (860) 424-3378, or karen.zyko@ct.gov . Thank you for consulting the Natural Diversity Database.

Sincerely,

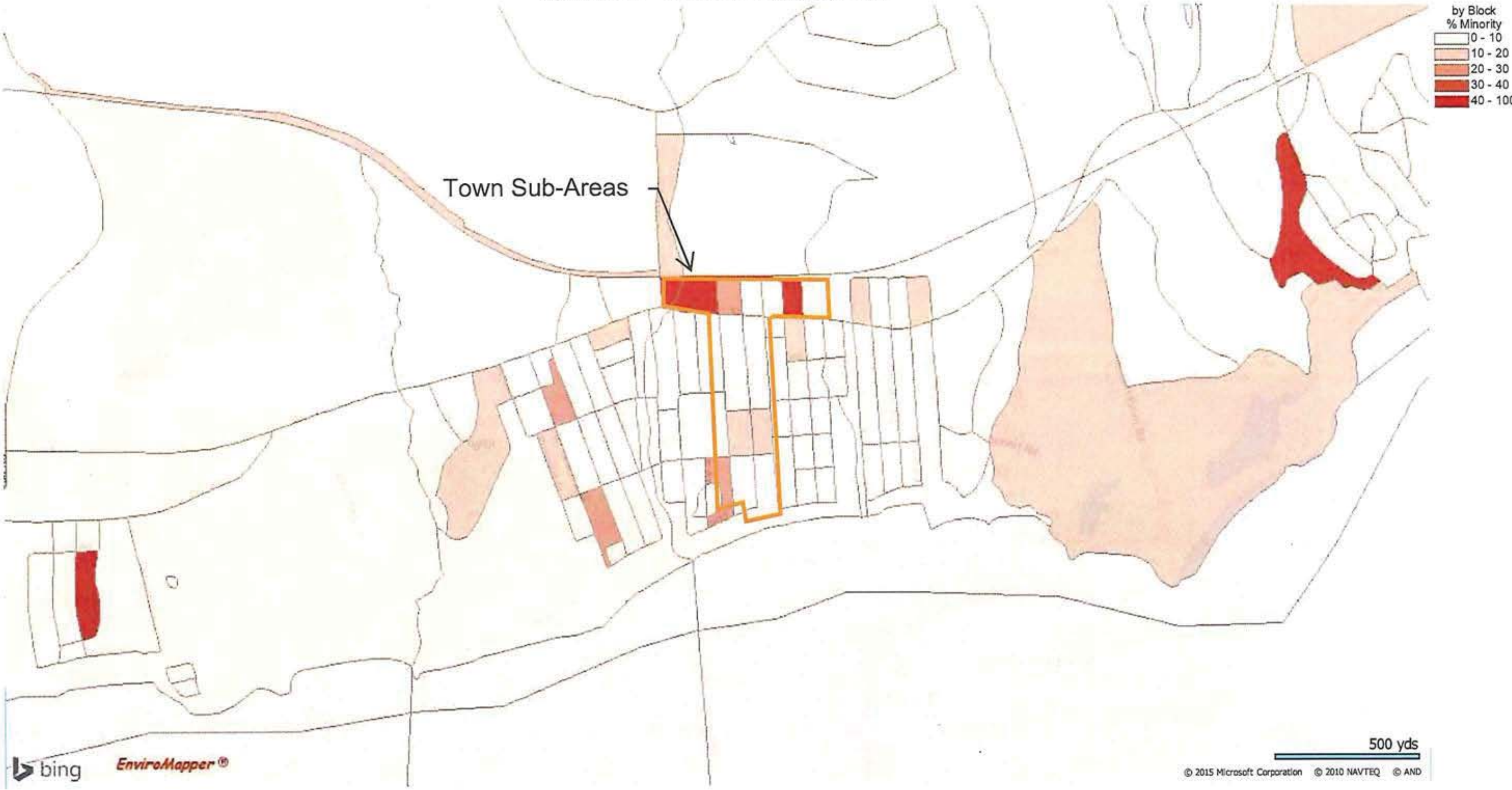
Karen Zyko

Karen Zyko
Environmental Analyst

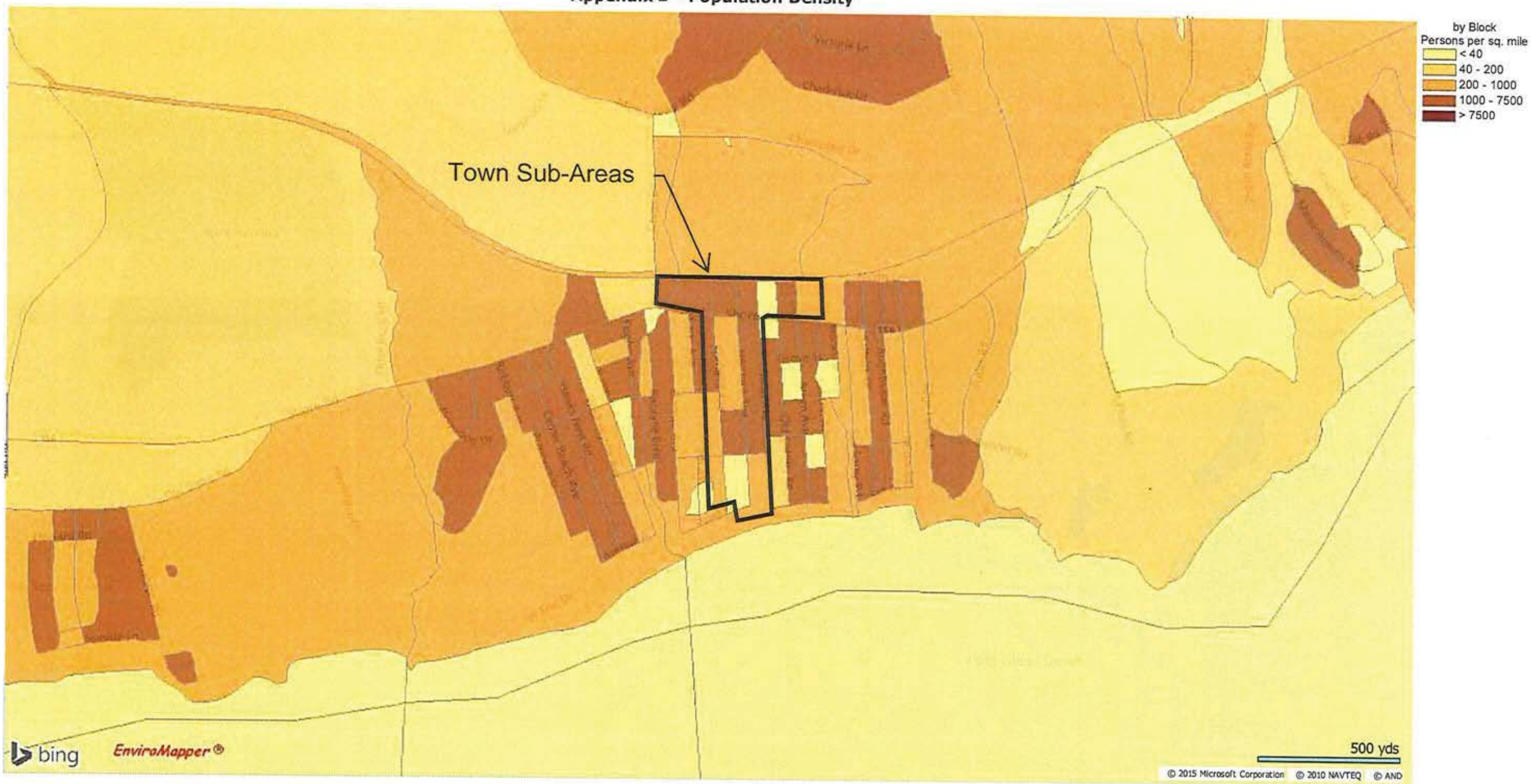
APPENDIX E: USEPA EJVIEW MAPPING TOOL OUTPUT

Appendix B - Per Capita Income

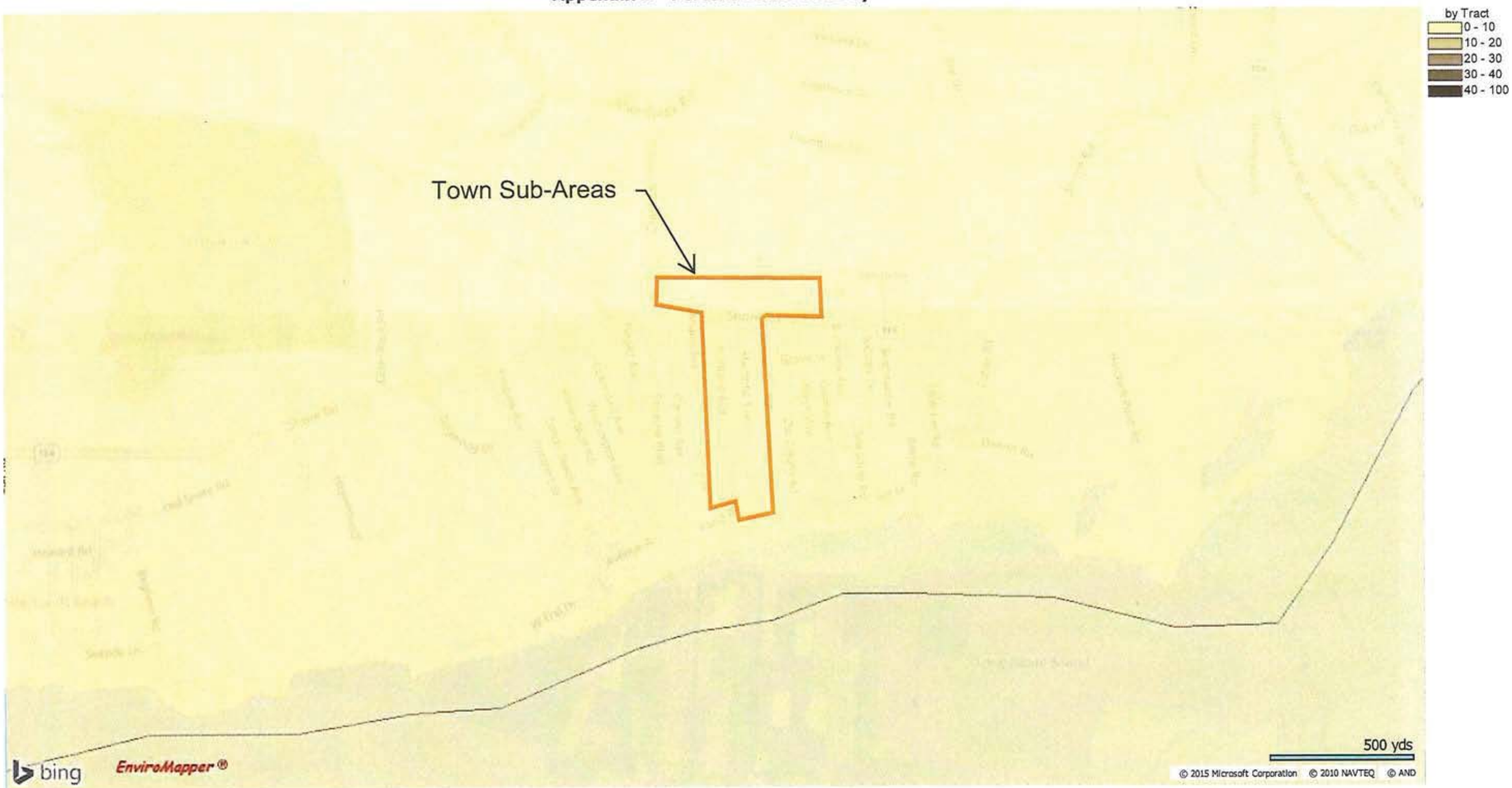
Appendix B - Percent Minority by Block



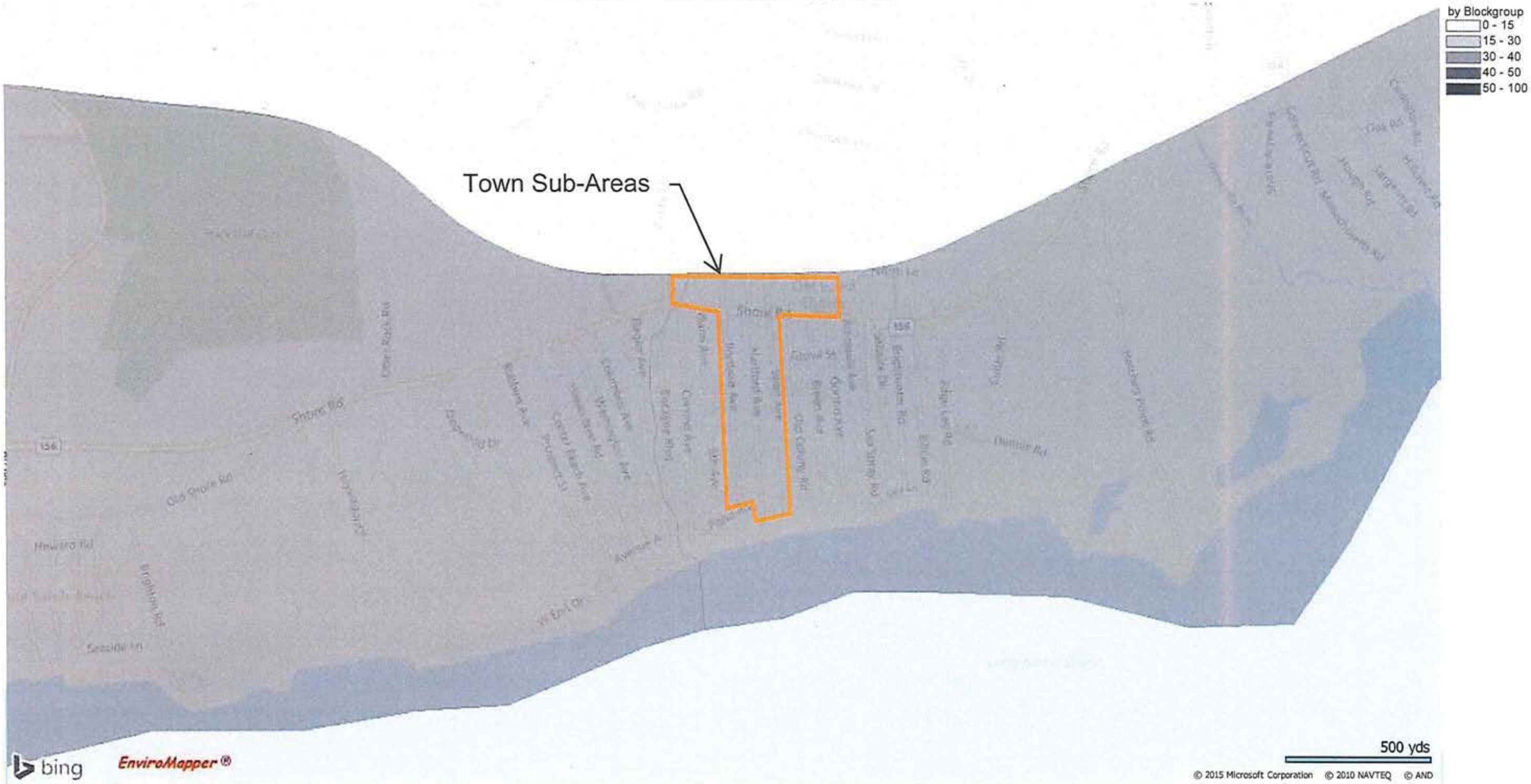
Appendix B - Population Density



Appendix B - Percent Below Poverty



Appendix B - Percent Rental Properties



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