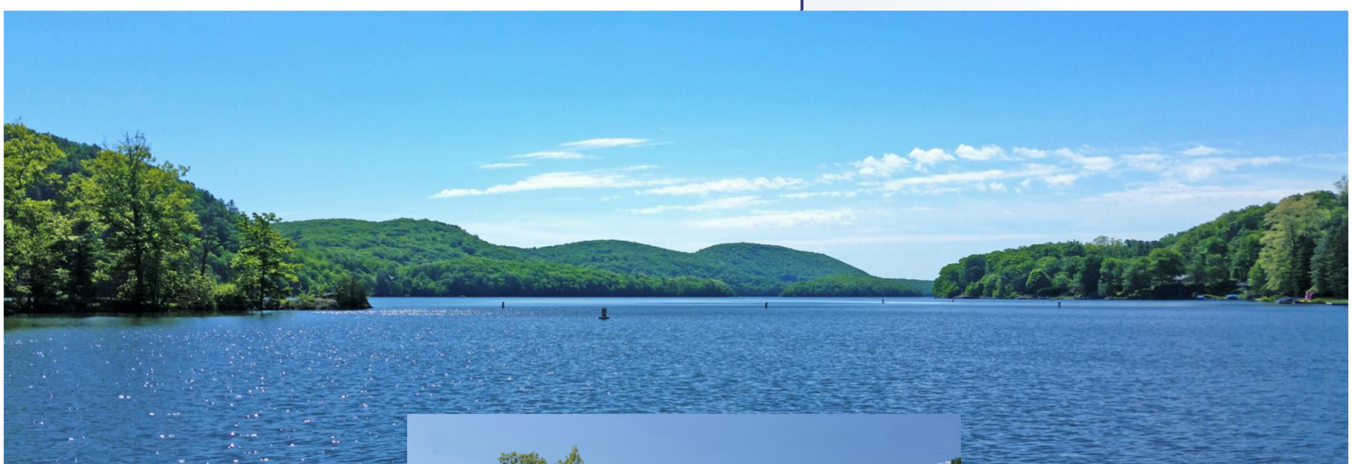
DRAFT REPORT

Sanitary Sewer Extension Study

Dean and Pocono Roads Area and Candlewood Lake Area



Brookfield Water Pollution Control Authority

Brookfield, CT

DRAFT October 2023

CDM Smith

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Section 1

Introduction

CDM Smith

Section 1

Introduction

1.1 Project Introduction and Study Areas

The Brookfield Water Pollution Control Authority (BWPCA) has contracted CDM Smith to evaluate several alternatives for the expansion of the sanitary sewer collection system. The Town currently has a wastewater collection system that consists of approximately 17 miles of gravity sewers, 14 pumping stations and seven miles of force main pipe. The system discharges to the Danbury collection system where it is conveyed to the Danbury Water Pollution Control Plant for treatment and effluent discharge to Limekiln Brook.

The scope of this project is intended to advance the planning effort and includes development of conceptual sewer layouts for extensions of the wastewater collection system in specific study areas, and preparation of preliminary opinions of probable construction cost for each alternative.

This project includes the following study areas as shown on **Figure 1-1**:

- Dean and Pocono Roads Area
- Candlewood Peninsula
- Candlewood Lake Club
- Northern Candlewood Lake Road Area
- Southern Candlewood Lake Road and Pleasant Rise Area

The current study phase of this project is being funded by a 55 percent planning grant from the Connecticut Department of Energy and Environmental Protection (CT DEEP) Clean Water Fund (CWF). If the project moves forward into the design and construction phases, it will be eligible for continued funding from the CWF likely in the form of a 20 percent grant and with low-interest loan for the balance, as long as CWF requirements continue to be followed and funding is available.

1.2 Previous Studies and Needs Definitions

1.2.1 Previous Studies

In January 2018, the Town Sanitarian and Director of Health issued a letter to the BWPCA, recommending that the BWPCA "take the necessary steps to provide sanitary sewers to the Candlewood Shores peninsula including the Candlewood Shores Tax District (CSTD), Arrowhead Point, Hickory Hills, and Candlewood Orchards." In this letter, the Sanitarian and Director of Health outline concerns including small average lot size, age of most homes, change from seasonal to year-round usage, and the "environmental sensitivity associated with managing the relatively large volume of sewage on the relatively densely populated peninsula surrounded by Candlewood Lake".

This letter, in part, prompted the reports outlined below:

- *Dean & Pocono Roads Wastewater Management Plan,* June 2020, prepared by Lombardo Associates, Inc. (LAI), recommends extending sewers to the Dean and Pocono Roads area due to unfavorable site conditions for on-site septic systems, including presence of flood plain, wetlands, and shallow restrictive layers.
- *Candlewood Lake Brookfield Study Area Wastewater Management Plan,* April 2020, also prepared by LAI, and the recommendation was to extend sewers to the Candlewood Peninsula and some surrounding areas due to potential negative impact on Candlewood Lake water quality and drinking water aquifer from nutrients in septic effluent, as well as restrictive lot sizes throughout the study areas.
- *Wastewater Facilities Plan Report* (Facilities Plan), August 2020, prepared by CDM Smith documents some characteristics of the study areas and the proposal to connect the area to the BWPCA's collection system.

1.2.2 Needs Definitions

The scope of this Report does not include further definition of environmental issues or sewering needs but focuses on collection system alternatives and potential project costs should the Town elect to extend sewers to any of the study areas. However, the prior studies noted above did document concerns with density of development and aging septic systems, further enumerated with supporting data below:

Dean and Pocono Roads Area

- Based on a review of the Brookfield Board of Health septic system data online, there is some information on approximately 57 percent of properties in the Dean and Pocono Roads Area, and approximately 34 percent have septic age information available. Of the properties with information available:
  - Average system age is 27 years
  - 65 percent have septic systems greater than 20 years old, 35 percent have septic systems greater than 30 years old, and 16 percent have septic systems greater than 40 years old
- During a geotechnical exploration program performed in 2022 as part of this study, groundwater was encountered at approximately 4 to 5 feet below grade in three borings in the central part of the study area
- As outlined in the LAI Report, approximately 50 percent of the parcels in the Dean and Pocono Roads area are within the floodplain of the Still River, and there are numerous properties with wetlands present

Candlewood Peninsula and Candlewood Lake Road Area

- Based on a review of the Brookfield Board of Health septic system data online, there is information on approximately 58 percent of properties in the Candlewood Peninsula and Candlewood Lake Road Area, and approximately 35 percent have septic age information available. Of the properties with information available:
  - Average system age is 25 years
  - 60 percent have septic systems greater than 20 years old, 30 percent have septic systems greater than 30 years old, and 13 percent have septic systems greater than 40 years old
- During the geotechnical exploration programs in 2020 and 2022 included in the Wastewater Management Plan and this study respectively, groundwater was encountered as shallow as 4 to 5 feet below grade, and evidence of bedrock was encountered as shallow as 2.5 to 3 feet below grade in numerous locations.
- Average lot size on the peninsula is approximately 0.3 acres, and typical number of bedrooms is approximately 3 per property; this yields a density of approximately 10 bedrooms per acre on the peninsula.

This density of development is one of the factors cited by the Town Sanitarian and Director of Health in their 2018 letter.

The Connecticut Department of Public Health (CT DPH), considers density greater than 1 bedroom per 0.167 acre (or 6 bedrooms per acre) to be a threshold of concern for adversely affecting groundwater quality due to nitrogen loading. In January 2000, the CT DPH issued a Circular Letter to health professionals throughout the state expressing this concern and recommending that where construction is proposed on existing or new lots, that "local health departments require nitrogen analysis for all parcels where the density of development exceeds one bedroom per 0.167 acres." A similar Circular Letter in January 2002 reiterates the 0.167 acre/bedroom threshold as a screening tool for nitrogen analysis and further explains that the EPA and CT DEEP "continue to promote reduction of nitrogen discharges into the groundwaters of our state..." Further, the letter lists several areas that warrant specific consideration, including "densely developed small lot subdivisions, ... environmentally sensitive sites adjacent to.... inland lakes, ponds and other water courses....[and] development in public water supply aquifer protection areas". It is important to note that this is not a regulation, but it is considered guidance from CT DPH regarding concerns with densely populated areas reliant on septic systems, especially in sensitive water bodies, as is the case with these study areas.

Additionally, the greater than 40 percent of the properties in the two areas with no available information could be of concern as there is no indication as to what types of septic systems these are, nor how old the systems are.

To further evaluate current septic system conditions and functionality, a detailed lot-by-lot study or inspection program would be required. To quantify impacts to groundwater, an extensive program of year-round monitoring would be needed.

Though individual septic system upgrades would not alleviate the concerns over density of development, an option for maintaining septic systems is included in this Report. This option would implement a systematic program of septic system inspections and improvements and is intended for comparison to the options presented for extending sewers to the Study Areas.

1.3 Topographic Mapping

For the preliminary sewer extension layouts and alternatives analysis, base mapping was obtained from publicly-available Light Detection and Ranging (LiDAR) data from 2016, which is available through Connecticut Environmental Conditions Online (CT ECO) maintained by the University of Connecticut, and also through cooperation with the Western Connecticut Council of Governments (WestCOG). The topography is referenced to NAVD88 datum. Water main locations were mapped using a combination of existing drawings, ground-penetrating radar, and radio detection equipment. With the varying water main materials present in the project areas, the mapping efforts had limited success but some mapped water main locations were validated. Building sill elevations were estimated from the surrounding topography. Detailed topographical survey including building sills and additional utility information would need to be obtained during the design phase for any projects that proceed to implementation.

1.4 Report Organization

The remainder of this Report consists of the following Sections:

- **Section 2 – Study Areas and Flows** – Enumerates the study areas and other potential additions to the collection system and estimates wastewater flows from each area.
- **Section 3 – Collection System Alternatives** – Outlines general principles of various alternatives for the study areas, including gravity sanitary sewer systems with gravity or pumped connections and BWPCA pumping stations where needed; low-pressure sewer systems with all-pumped connections; septic tank effluent pumping or gravity (STEP or STEG) systems; hybrid gravity and low-pressure systems; and the alternative to maintain and improve existing septic systems.
- **Section 4 – Dean and Pocono Roads Area** – Examines the layout and topography of the Dean Road and Pocono Road area, and evaluates alternatives and potential project costs for extending sewers to the neighborhood.
- **Section 5 – Candlewood Peninsula and Surrounding Areas** – Examines the layout and topography of the Candlewood Peninsula, Candlewood Lake Club, Candlewood Lake Road and Pleasant Rise areas, and evaluates alternatives and potential project costs for extending sewers to each of these neighborhoods.
- **Section 6 – Discharge Locations and In-Town Wastewater Treatment Evaluation** – Evaluates options for discharge to the New Milford Water Pollution Control Facility or

construction of an in-town wastewater treatment facility, should sewer extensions exceed Brookfield's ability to discharge to the Danbury Water Pollution Control Plant.

- **Section 7 – Cost Summary and Implementation Considerations** – Summarizes costs and financing options for potentially feasible sewer extension alternatives and discusses permitting and implementation considerations.

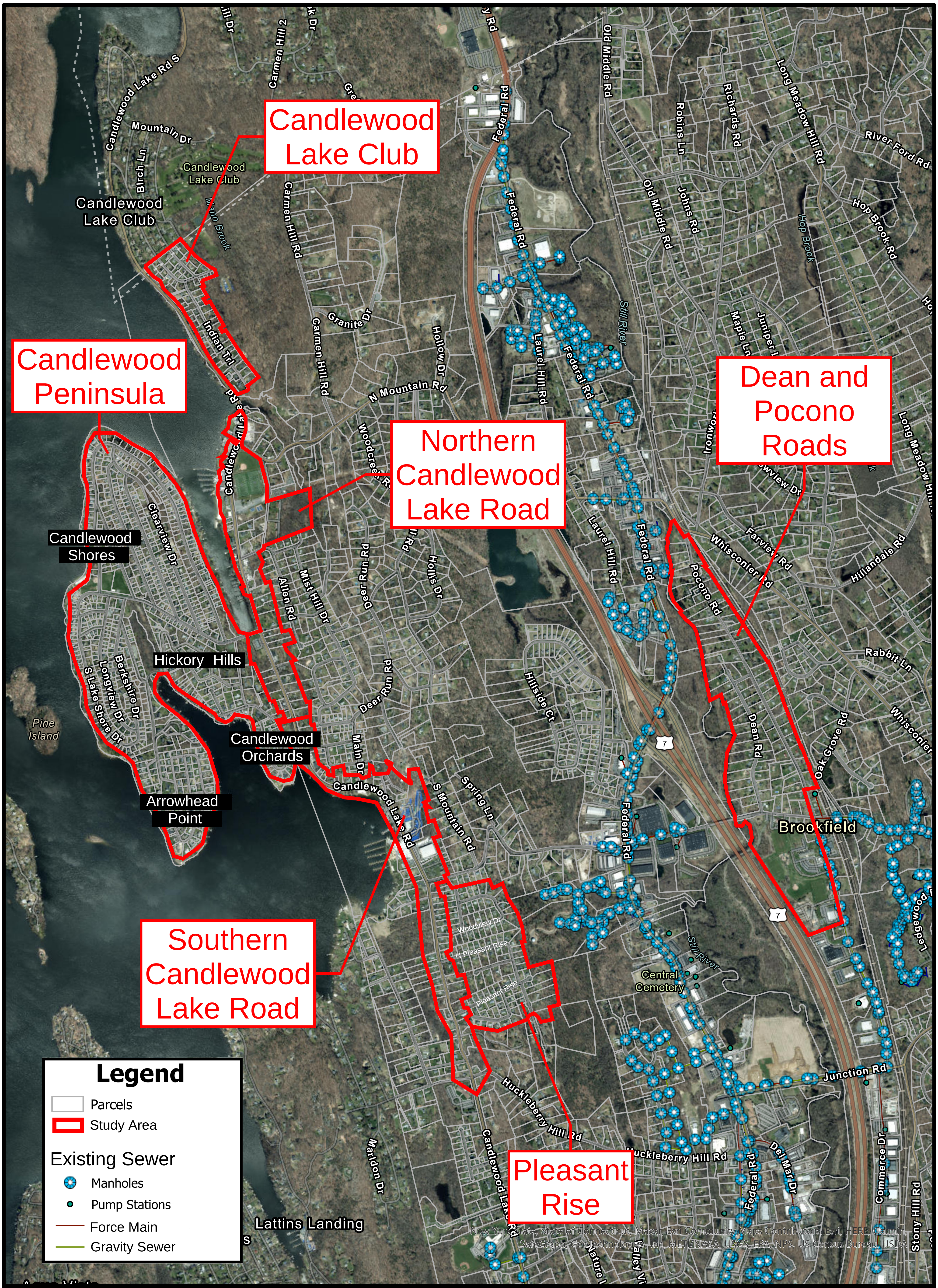

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Figure 1-1
Study Areas
Sanitary Sewer Extension Study
Dean and Pocono Roads and Candlewood Lake Area
Brookfield, Connecticut

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Section 2

Project Study Areas and Wastewater Flow Analysis

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Section 2

Project Study Areas and Wastewater Flow Analysis

This section describes the alternatives for the expansion of the sanitary sewer collection system and summarizes the projected future wastewater flows from the current sewer service areas (SSAs) and the project study areas, should sewer extensions be constructed. The BWPCA provided wastewater flow meter data and information on some anticipated developments; this was reviewed in conjunction with the data in the 2020 Facilities Plan. This Section summarizes the current and projected future wastewater flows to help evaluate the collection system expansion options.

2.1 Project Study Areas

The proposed sewer extensions for the Candlewood Lake area that have been evaluated and are presented in this report are shown on **Figures 2-1 through 2-5** and include the following:

- Dean and Pocono Roads Area (91 residential properties plus Municipal Center)
- Candlewood Peninsula Area (802 properties)
- Candlewood Lake Club Area (72 properties)
- Northern Candlewood Lake Road Area (46 properties)
- Southern Candlewood Lake Road and Pleasant Rise Area (183 properties)

It is noted that study area boundaries were generally defined in the previous reports noted in Section 1; exact boundaries and extents of sewer extensions would need to be refined during final design efforts for any sewer extension projects that proceed.

Table 2-1 summarizes the estimated additional average daily wastewater flow from each proposed sewer extension area in gallons per day (gpd). Two different planning flows are presented in the table, based on both metered water use data and the New England Interstate Water Pollution Control Commission *Guides for the Design of Wastewater Treatment Works* (Technical Report No. 16, commonly referred to as TR-16) to create a range of “low” and “high” flow projections. The flow rates from TR-16 are more conservative than the flows calculated from the available meter data but are commonly referenced as planning values for municipal wastewater systems.

Table 2-1 Summary of Average Daily Flows from Potential Sewer Extension Areas

Potential Sewer Extension Area	Approximate Number of Properties	Approximate Average Daily Flow From Aquarion Water Use Data (133 gpd per property) [1]	Approximate Average Daily Flow Per TR-16 and US Census Reference (195 gpd per property)[2]
Dean and Pocono Roads	91	12,100	17,800
Municipal Center[3] (included adjacent to Dean and Pocono)	1	1,500[3]	1,500[3]
Candlewood Lake Peninsula	802	106,700	156,400
Candlewood Lake Club	72	9,600	14,000
Northern Candlewood Lake Road	46	6,100	9,000
Southern Candlewood Lake Road and Pleasant Rise	183	24,300	35,700
Total (rounded)	**1,200**	**160,000**	**235,000**

Notes:
1. Water consumption data from Aquarion Water Company, August 2016 to July 2019; average of 133 gpd for 1–3-bedroom properties. (Facilities Plan, Aug 2020, 2-14). The sewer extension areas average 3 bedrooms per property based on available assessor data.
2. Planning value 70 gallons per capita per day, per Technical Report No. 16 (TR-16), *Guides for the Design of Wastewater Treatment Works* by the New England Interstate Water Pollution Control; 2.73 people per household average for Brookfield per 2020 US Census data; Approximately 195 gpd per residential property.
3. Municipal Center includes the Town Hall, Senior Center, Police Station, and a former residence; 1,500 gpd is assumed for this projection.

The total projected average daily flow from the approximately 1,200 properties within the project study areas ranges from 160,000 gpd calculated from Aquarion Water Data to 235,000 gpd calculated using TR-16 and census data.

As noted in the table, the available Aquarion Water Company data was from properties ranging from 1 to 3 bedrooms in size, whereas the current study areas average approximately 3 bedrooms. As such, the Aquarion data likely underestimates the anticipated water usage of the study areas. For planning purposes, it is recommended that the higher end of this range be used, particularly in discussions and planning for treatment and effluent disposal options. Typically, an additional allowance for infiltration and inflow (I/I) is included when planning for large sewer extensions. This is not factored in at present given the spread of planning values, and since some of the options presented herein include high percentages of low-pressure sewers which are not subject to I/I intrusion. Additional validation of flows in the specific project area would be warranted during the design of any sewer extension projects that proceed. As such, a total of 235,000 gpd is carried below in the summary of potential future flows from Brookfield.

2.2 Summary of Sewer Service Area Flows

Currently, all flow from Brookfield's current collection system is pumped through the Caldor Pump Station on Federal Road. The available flow meter data from the Caldor Pump Station indicates an average daily flow of approximately 320,000 gpd over the past five years, trending upwards with a projection of approximately 345,000 gpd for 2023.

As outlined in the Facilities Plan, additional wastewater flows are anticipated from the following sources within approximately the next ten years:

- Failure only connection properties
- Future commercial/industrial connections from properties that have been assessed and are within the current SSA, but are not currently connected to the system
- Future developments within the current SSA
- Sanitary extensions to the SSA, including the current study areas

The additional wastewater flow from each source is summarized and totaled in **Table 2-2**.

Table 2-2 Total Projected Brookfield Wastewater Flows

Wastewater Source	Estimated Average Daily Flow (GPD)
Current Collection System Flow[1]	345,000
Failure Only Connections[2]	68,000
Future Commercial/Industrial Connections, Assessed but Not Currently Connected[3]	167,000
Future Development Within Existing SSA[4]	26,000
Greenridge Area of Environmental Concern[5]	35,000
Proposed Sewer Extension Areas	235,000
Total Projected Brookfield Sewer Flow (rounded)	**900,000**

Notes:

1. Anticipated 2023 average daily flow from Caldor Pump Station provided by BWPCA, September 2022.
2. Properties that have sewer available and are within the SSA, and would connect in the event of an on-site sewage disposal system failure; flow estimate from Section 2 of Facilities Plan.
3. Properties that have been Assessed by the BWPCA but are Not Currently Connected, commercial/industrial central corridor; flow projection from BWPCA October 2022
4. Expected developments within the existing SSA; flow projection from BWPCA October 2022.
5. Timeline for Greenridge Sewer Extension unclear; flow estimate from Section 2 of Facilities Plan.

Based on the available data, it is estimated that Brookfield 's average daily wastewater flow may increase to approximately 900,000 gpd if the connections and potential sewer extensions outlined above move forward. Given the uncertainty associated with potential developments, it is recommended that a conservative value of up to 1 million gallons per day (mgd) be used for planning purposes.

Brookfield's agreement with Danbury allowed Brookfield to discharge approximately 500,000 gpd to the Danbury treatment plant, but in 2000 that allotment was reduced to 380,000 gpd. Negotiations are currently ongoing to allow restoration of the initial allotment plus an additional 80,000 gpd – which would bring Brookfield's allocation at the Danbury plant to 580,000 gpd. Alternatives for discharge and treatment of flows above that amount are discussed in **Section 6**.

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Figure 2-1

Dean and Pocono Roads Study Area

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

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Figure 2-2

Candlewood Peninsula Study Area

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023

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Figure 2-3
Candlewood Lake Club Study Area
Sanitary Sewer Extension Study
Dean and Pocono Roads and Candlewood Lake Area
Brookfield, Connecticut

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Figure 2-4

Northern Candlewood Lake Road Study Area

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023

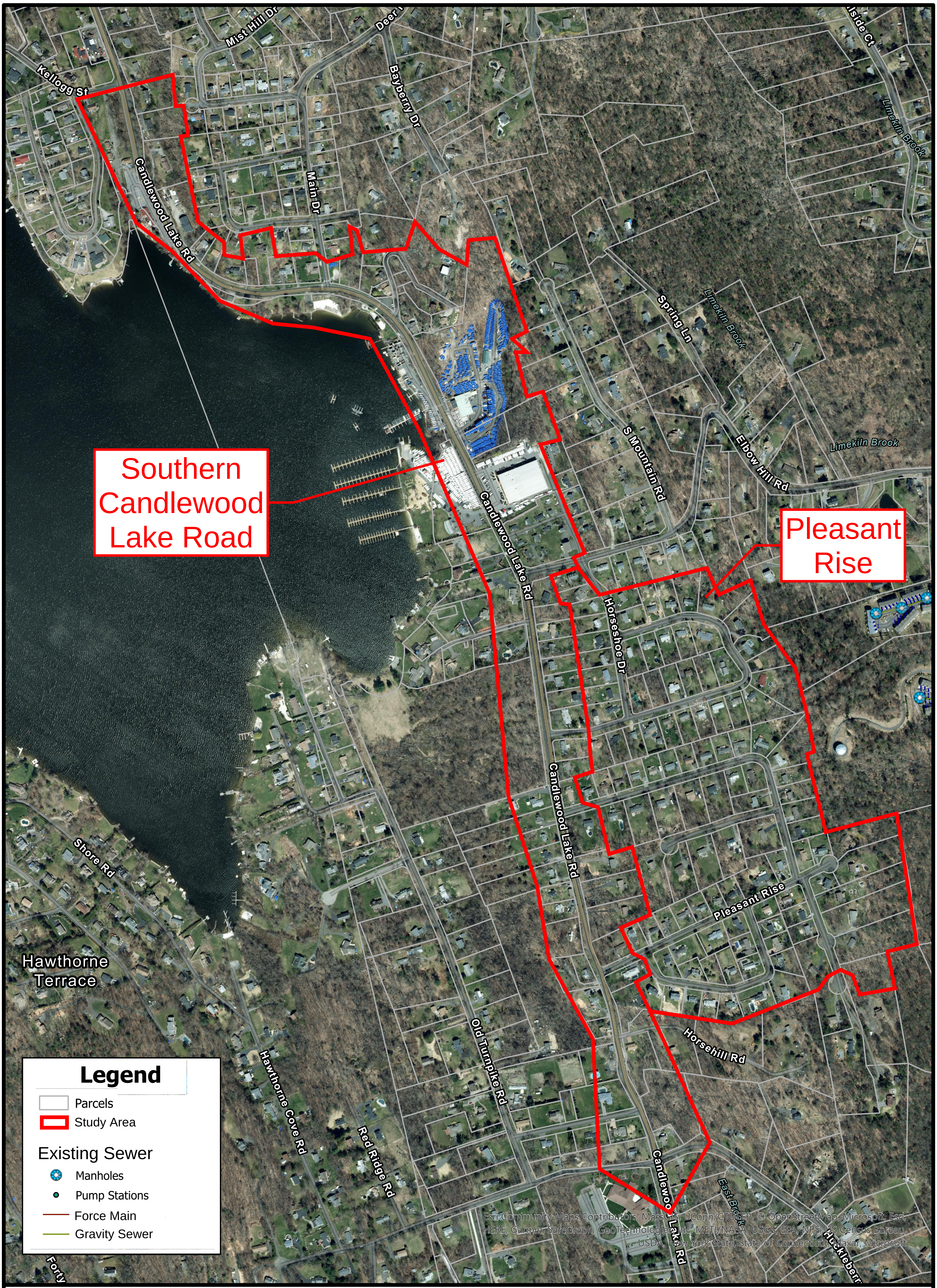

Figure 2-5
Southern Candlewood Lake Road and Pleasant Rise Study Area
Sanitary Sewer Extension Study
Dean and Pocono Roads and Candlewood Lake Area
Brookfield, Connecticut
DRAFT October 2023

Section 3

Collection System Alternatives

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Section 3

Collection System Alternatives

3.1 Sewering Alternatives

This Section describes several collection system alternatives for the potential sewer extension areas being studied. These alternatives include:

- Traditional gravity sewers with all-gravity connections and BWPCA pump stations where required by topography
- Traditional gravity sewers with a limited number of residential grinder pumps and BWPCA pump stations where required by topography
- Low-pressure systems where every property is served by an individual grinder pump
- Septic Tank Effluent Pumping (STEP) or Septic Tank Effluent Gravity (STEG) systems
- Hybrid systems that would combine both gravity and low-pressure mains in different areas
- Septic System Upgrade and Reuse alternative that would maintain and improve existing septic systems on an as-needed basis

The following paragraphs outline the general principles associated with each type of system, and details of each feasible option for the neighborhoods in this project are evaluated in Sections 4 and 5.

3.1.1 Traditional Gravity Sewers with Gravity Connections

Conventional gravity sewers are the most common and simple form of wastewater conveyance. The technology relies on installing sewer pipes at downhill slopes within roadways or rights-of-way. Pipe diameter sizes and slopes are designed to maintain adequate velocities that keep solids suspended within the conveyed wastewater. *Guides for the Design of Wastewater Treatment Works, Technical Report No. 16* (commonly referred to as TR-16), published by the New England Interstate Water Pollution Control Commission (NEIWPCC), recommends that public gravity sewers have a minimum pipe diameter of 8 inches to facilitate equipment access during maintenance. Downstream pipe sizes increase proportionately as flow is collected. Where topography allows, gravity connections can be used from each house to the main sewer pipe in the road or right-of-way and are typically 4 to 6 inches in diameter. Most main sewer pipes are constructed of polyvinyl chloride (PVC) plastic pipe and buried at least 5 to 6 feet deep to allow for gravity house connections, protect infrastructure from frost effects, and to avoid other utilities in the road, but this changes with topography; generally the average depth of sewers ranges from 8 to 14 feet deep. For deeper sections of pipe (greater than 20 feet) alternative materials such as ductile iron are typically used. Manholes are periodically located along the main sewer pipelines at changes in direction and/or slope or connection of side street sewers, with a maximum spacing of 400 feet, to allow for maintenance access. New manholes are typically constructed of precast concrete with cast iron frames and covers.

Flows collected at low points require pump stations to be installed to convey the wastewater via a pressure pipe known as a force main to another gravity sewer or to the treatment facility. Areas where topography changes frequently can require multiple pump stations and significantly impact the cost and maintenance requirements for conventional gravity sewers.

Advantages of gravity sewer systems:

- Typically requires the least amount of energy to operate, gravity components work during power outages, and BWPCA pump stations can have backup generators
- Least amount of long-term system maintenance required
- Well-designed systems can handle seasonal flow fluctuations
- Gravity sewers can accept pressurized flow discharges from grinder pumps or pump stations
- Simple system to expand to service additional areas or receive flows from adjacent areas, if pipe size is adequate
- Common for collection system operations staff to be familiar with this type of pipe construction and network

Disadvantages of gravity sewer systems:

- Requirement for downward sloping pipes in changing topographic areas can lead to an increased quantity of manholes, pump stations, and deep sewer pipes
- In high groundwater areas, infiltration into pipes can lead to costly conveyance and treatment, particularly as the system ages
- Some odor potential during periods of low flow

A full-gravity sewer alternative would replace all septic tanks within each project area with a traditional gravity sewer system and connect all homes via gravity connections. The gravity sewers in each project area would be conveyed to new pump stations at relative low points, that would pump sanitary flow to higher receiving sewers in the new or existing collection system.

3.1.1.1 Pump Stations

For this study, a standardized conceptual submersible pump station design was developed. This concept includes a below-grade pre-cast concrete wet well with two submersible pumps and a below-grade pre-cast concrete valve vault. The pump station would operate in a duty-standby pump configuration with the standby pump being fully redundant (i.e., each pump can handle peak flow to the station individually) as recommended by TR-16.

For most wastewater pumping stations, TR-16 recommends an automatically activated generator for operation during a power failure. This is consistent with the existing BWPCA collection system where generators are permanently installed at the larger stations, and some of the smaller stations are served by a portable generator that relies on operations staff to bring to the site and connect during power outages.

For this study, the general pump station concept includes an emergency generator and provisions and connections for bypass pumping for station maintenance. Depending on the details of the pump station sites, including available space and character of surrounding properties, the pump station electrical equipment and controls could either be housed in a premanufactured building or surface mounted on a weatherproof electrical cabinet. Pump station architecture, fencing and landscaping would be provided to blend the station into the surrounding area as needed.

For each potential pump station needed for the alternatives evaluated in this study, several criteria were evaluated to narrow down potential sites. This screening criteria included pump station hydraulics (locations at or near relative low points and required force main length), proximity to wetlands, flood vulnerability, ease of access for construction and future maintenance, and discussions with the BWPCA. Publicly owned parcels were identified and targeted where feasible. Potential pump station sites are identified for each study area and described in **Sections 4 and 5**. It is noted that the current study did not include a detailed evaluation of potential pump station sites; geotechnical and environmental investigations would be required as part of the design process and before any property acquisition is completed. A supplemental geotechnical program for the selected pump station sites is recommended before property acquisition, which would be conducted as part of the future final design phase.

3.1.2 Gravity Sewers with Limited Individual Grinder Pumps

In many areas, and including most of the study areas, topography of certain properties limits the ability of those lots to connect to a gravity sewer system with gravity connections. There are numerous properties in the study areas that are at lower elevations than the road; in some cases, gravity connections for these homes would drive the main line sewer deeper than needed for most other properties, resulting in significantly increased construction costs. Serving select homes with individual grinder pumps rather than gravity lateral connections can reduce the overall depth of the gravity main.

This alternative has the same advantages and disadvantages of a full-gravity system, but the addition of a limited number of grinder pumps can help to control construction costs by reducing the depth of the main line sewer.

3.1.3 Low-Pressure Sewer Alternative

A low-pressure sewer system would replace all the septic tanks within the project area with private grinder pumps; one grinder pump would serve each property. The individual grinder pumps are smaller than septic tanks and would typically be installed approximately where each septic tank currently is located, although homeowners may opt to reconfigure their plumbing and identify a different location for the grinder pump. In a low-pressure system, wastewater from each home flows by gravity into the pump chamber where the grinder pump starts once the depth of wastewater in the chamber reaches a specific level. The grinder pump then pumps from each residence to a low-pressure sewer main that is installed within the town's right-of-way. Grinder pump systems use smaller diameter force main pipes compared to gravity sanitary sewer systems. Typically, the force mains are 1.25- to 2-inch diameter high-density polyethylene (HDPE) pipe for systems of this size, and they can be installed at shallower depths (approximately 5 feet of cover) since they are not limited by the need to flow by gravity through variable topography.

The low-pressure system then pumps flow from the project area to an existing gravity sanitary sewer or pumping station. Pressure sewers require air release and flow isolation valves for maintenance of the piping network. Individual homeowners may be responsible for the long-term maintenance of the grinder pump, which is typically 1 horsepower (hp) per pump, unless the BWPCA opts to maintain the individual components of the system. With grinder pump systems, extended power outages have the potential to cause sewer backups unless the homes have permanently installed generators or provisions for connections to a portable generator are incorporated into the design of the system.

Advantages:

- Less expensive pipeline system installation due to smaller diameter pipes at shallower depth
- The low-pressure piping system typically uses fused joints and is more watertight than a gravity sewer system since it constantly operates under pressure, thus eliminating future concerns about infiltration
- Can more readily provide service to areas with either very flat or changing topography
- Simpler to install leading to shorter construction duration and less residential disruption in construction areas

Disadvantages:

- Requires a mechanical component (pump) at each home to discharge to and operate the sewer system
- Potential for overall higher energy use, compared to a gravity system with minimal pump stations
- Requires specialized operator training for the system and regular maintenance of the grinder pump units, whether the responsibility of the homeowner or the BWPCA
- More sensitive to wastewater flow fluctuations (daily and seasonal variation in pumping needs and power consumption)
- Prolonged power outages can lead to sanitary sewer backups if standby power is not provided at each individual property

The low-pressure sewer alternative would replace all septic tanks within the project area with a grinder pump. The low-pressure sewer system would discharge into the existing collection system as described in **Sections 4 and 5**.

3.1.4 STEP/STEG Alternative

A Septic Tank Effluent Pumping (STEP) system involves the installation of an effluent pump in the back end of the septic tank or in a separate pump chamber after the septic tank. The septic tank captures solids as it would for a traditional septic system, and the pump conveys the partially clarified wastewater to a pressurized piping network similar to the pressure sewer system described above. Individual homeowners or the BWPCA would be responsible for the long-term maintenance of the pump. A Septic Tank Effluent Gravity (STEG) system operates similar to a STEP system except that the effluent is conveyed by gravity to a gravity sewer system with potentially smaller diameter pipes than a conventional gravity sewer; this is only possible in areas where topography permits gravity flow throughout the area. For both STEP/STEG systems, each septic tank is inspected periodically (about every 3 to 5 years) and the solids are removed for treatment at a wastewater treatment facility that accepts septage, similar to what is required for typical septic systems.

Advantages:

- Potential to re-utilize an existing septic tank (if the tank is confirmed watertight and is sufficiently sized; otherwise this could be a disadvantage as noted below)
- Fewer solids are transported in the sewer system minimizing potential for blockages
- STEP has similar advantages to a low-pressure sewer system, including small-diameter shallow piping
- STEG has similar advantages to a conventional gravity sewer system, with potentially smaller diameter pipes

Disadvantages:

- The solids (septage) must be pumped periodically from the septic tanks similar to current practice, which may have a negative impact on user perception
- Difficult to assess watertightness and volume of existing septic tanks; tank replacement is often required, especially in areas with older septic systems
- STEP has similar disadvantages to the pressure sewer system alternative described above
- Potential concerns about equitable billing among sewer users with different types of systems due to varying loads on the treatment plant

Based on discussions with the BWPCA, the STEP/STEG alternative is no longer being considered for the study areas. Many existing septic tanks are old and below the groundwater table, so the likelihood of reuse of existing septic tanks is low. There has also been vocal public opposition from homeowners having a new sewer system (whether pumped or gravity) that still requires them to continue maintaining and pumping their septic tanks.

3.1.5 Hybrid Gravity and Low-Pressure Sewer System

In some areas, the combination of wastewater flow fluctuations, topography, groundwater conditions, and the sequencing of sewer construction over several phases can result in a combination of sewer system technologies being utilized. This combination of sewer systems (gravity sewers and low-pressure sewers) is commonly referred to as a hybrid system.

Conventional gravity sewer systems are often the backbone of a hybrid system due to their ability to accept wider flow fluctuations and to be expanded in the future. Low-pressure sewer systems with clusters of grinder pumps can supplement the gravity systems in certain areas (either low-lying or where locating a pump station may be a challenge) to help offset deep sewer construction and limit the number of pump stations.

3.2 Septic System Upgrade and Reuse Alternative

All residences within the study areas currently have septic systems. However, as noted in LAI's 2020 *Dean & Pocono Roads Wastewater Management Plan* and the 2020 *Candlewood Lake Brookfield Study Area Wastewater Management Plan,* many of the existing septic systems are faced with physical limitations, such as high groundwater levels or limited lot size, that reduce the potential for adequate subsurface sewage disposal.

Advantages:

- No/low disruption to the roads and low construction traffic
- Potentially not all systems will require modification or replacement
- No annual user fees (though there is a cost for periodic pumping)
- No change in practice for homeowners

Disadvantages:

- Similar potential of failure as current system based on existing ground conditions
- Engineered and elevated septic solutions raise the system replacement cost
- Lot sizes, density of development, presence of wetlands, flood hazards, and areas reliant on wells for water supply would still be areas of environmental concern for septic tank usage.

For this alternative to be successful, additional research on the existing septic systems, soil conditions and groundwater would be required. The additional research for this alternative would include a complete physical inspection of all septic systems and more comprehensive geotechnical analysis on the soils within the study area. Residences that have lot sizes large enough for code compliant septic with appropriate soil conditions can replace damaged or failed septic systems, including tanks and leachate fields. Residences with smaller lots or poor soil conditions will require mounded, elevated above the groundwater, or advanced treatment solutions. Individual homeowners would be responsible for the costs of improvements.

The environmental concerns would not all be solved with septic system upgrades; in particular the density of development would remain. However, mounded or engineered systems could help where shallow groundwater exists. The Town may elect to implement a systematic program of septic system inspections and improvements to confirm septic system condition and functionality on each property. This alternative is included in the cost analysis presented herein for comparison to sewering alternatives.

Section 4

Dean and Pocono Roads Area

Section 4

Dean and Pocono Roads Area

4.1 Study Area Definition

As noted in prior Sections, the Dean and Pocono Roads area includes approximately 91 residential parcels (85 developed and 6 vacant) on Dean Road, Pocono Road, and Silvermine Road. For this study, the area also includes the Brookfield Municipal Complex which generally spans the large southwest corner of Silvermine Road and Pocono Road, and includes the Town Hall, Senior Center, Police Station, and a former residential property at 43 Silvermine Road.

4.2 Subsurface Conditions

CDM Smith conducted a preliminary geotechnical investigation program in the Dean and Pocono Roads Area consisting of five drive-and-wash borings and six direct-push borings (geoprobes); one environmental sample was also collected. Geologic-Earth Exploration (Geologic) of Norfolk, Massachusetts, under subcontract to CDM Smith, advanced the drive-and-wash borings to depths ranging from about 7 to 20 feet and the geoprobes to depths ranging from about 12 to 20 feet during April and May 2022. The preliminary borings and geoprobes were spaced approximately several hundred feet apart throughout the study area, generally including borings at intersections and geoprobes in between. Ground-penetrating radar (GPR) and radio detection equipment was used to mark the location of utilities in the vicinity of borings and geoprobes.

The locations of the subsurface investigations are shown on **Figure 4-1**, and data obtained is summarized below**.**

4.2.1 Geotechnical Data

Table 4-1 below summarizes key information from the explorations in the Dean and Pocono Roads area, and boring and probe logs are included in **Appendix A**.

Table 4-1 Geotechnical Exploration Summary – Dean and Pocono Roads Area

Exploration ID	Street / Intersection	Total Depth of Exploration (ft)	Approximate Depth to Groundwater	Approximate Depth to Refusal (Possible Bedrock)
B-35 (2022)	Silvermine Road/Dean Road	16.3	--	15.3
B-36 (2022)	Pocono Road/Silvermine Road	20.2	4.0	--
B-37 (2022)	Dean Road	19.0	4.0	18.0
B-38 (2022)	Pocono Road/Dean Road	17.5	--	16.5
B-39 (2022)	Pocono Road	7.0	--	6.0
G-32 (2022)	Silvermine Road	20.0	11.0	--
G-33 (2022)	Pocono Road	12.0	9.0	12.0
G-34 (2022)	Dean Road	20.0	7.0	--
G-35 (2022)	Pocono Road	20.0	10.0	--
G-36 (2022)	Dean Road	20.0	5.0	--
G-37 (2022)	Pocono Road	20.0	9.0	--

Evidence of groundwater was encountered in most of the explorations, at depths ranging from 4 to 11 feet below ground surface; in three borings, no evidence of groundwater was observed.

Refusal on presumed bedrock was encountered in several borings and geoprobes at depths generally ranging from 12 to 18 feet below ground surface; at one location at the northern end of Pocono Road presumed bedrock was encountered at approximately 6 feet. A roller-bit was advanced 1 foot after refusal in borings B-35, B-37, B-38, and B-39 to verify bedrock, but the possibility remains that the refusal was on a boulder greater than 1 foot in diameter.

Most of the soil samples collected from the geoprobes and borings were visually classified as dense to very dense silty sand and sandy silt with varying amounts of gravel.

Selected soil samples collected from the geoprobes and borings were tested for grain size analysis testing in accordance with ASTM D6913 at the CDM Smith Geotechnical Testing Laboratory in Chelmsford, Massachusetts. The test results indicated that samples consisted of silty sand, sandy silt, or silt, which generally confirms the visual classifications.

One sample collected from geoprobe G-35 (2-10 feet depth) was transported to Alpha Analytical laboratory of Westborough, Massachusetts for corrosion potential testing (specific conductance, chloride, pH, and sulfates). The results, presented in **Table 4-2**, indicate that the soil has low corrosion potential for concrete and reinforcing steel; additional corrosivity testing should be completed during the design phase to determine any protection needs for ductile iron pipe.

Table 4-2 Boring G-35 (2-10 feet) Corrosion Potential Test Results

Testing Parameter	Result	Units
Specific Conductance @ 25 °C	80	µmhos/cm
Chloride	190	mg/kg
pH	9.2	SU
Sulfate	ND	mg/kg

Additional geotechnical investigations will be required to fill in data gaps and better define the subsurface conditions if the project moves forward to design.

4.2.2 Environmental Data

One environmental sample was taken from boring B-37. Soil was inspected for evidence of visual or olfactory impacts (e.g. soil staining, sheen, odor, etc.) and field screened for volatile organic compounds (VOCs) using a photoionization detector (PID). A soil sample from 4 to 6 feet below ground surface was then selected for environmental purposes. The soil sample was sent to Pace Analytical Laboratory, Inc. (Pace), a state-certified laboratory located in East Longmeadow, Massachusetts (CT Certification #PH-0165). Results are summarized in **Appendix A**.

Soil data from boring B-37 was compared to CT DEEP Remediation Standard Regulations (RSRs). The sample from B-37 contained low concentrations of a few metals (arsenic, barium, chromium, and lead) but all were below RSR criteria. No ETPH or VOCs were detected in the B-37 soil sample. Additionally, no semi-volatile organic compounds (SVOCs) were detected in the B-37 soil sample, but, for several of the difficult to analyze compounds, the laboratory minimum detection limit was above the RSR criteria.

Soil from this location would likely be considered clean fill, as defined in Sec. 22a-209-1 of the Regulations of Connecticut State Agencies (RCSA), which includes natural soil that does not contain any substances above natural background levels. If the project moves forward to final design, further environmental sampling and laboratory analyses should be conducted to confirm that these conditions are representative throughout the project area.

No groundwater samples were collected as part of the field investigations conducted; therefore, groundwater is considered uncharacterized. There is no reason to suspect contaminated groundwater based on the data collected.

4.3 Discharge Locations and Downstream Capacity

The alternatives completed in this analysis include conveyance of the wastewater from the Dean and Pocono Roads area to a connection point in the existing BWPCA system. CDM Smith evaluated three alternatives for that connection point. Each of these alternative options would ultimately flow through the Route 133 Pump Station and the Caldor Pump Station before being conveyed to the Danbury system for final conveyance and treatment. The three discharge locations are shown in **Figure 4-2**, and important considerations of each configuration are outlined below.

Alternative 1 conveys the project area south and west to the Silvermine Pump station on Silvermine Road, west of the project area. It was determined to not be possible to serve the study area entirely by gravity due to elevation differences and the crossing of Route 7, so pumping within the study area would be required. This route also requires longer pipe length than other alternatives identified herein. In addition to pumping required within the Dean and Pocono Roads area, the flow would be pumped by the existing Silvermine Pump Station, Route 133 Pump Station, and the Caldor Pump Station.

Alternative 2 would convey the project area towards the north end of Pocono Road and discharge the wastewater to the 777 Federal Road Pump Station by conveying flow under wetlands and the Still River. This option could eliminate the need for a new pump station in the study area, but due to topography it would require gravity sewers approximately 25 feet deep towards the north part of Pocono Road. Manhole covers near the river would need to be elevated above the floodplain and structures could not be located in the floodway. The river crossing would likely require the installation of a siphon. It would also require additional permitting, regulatory approvals, and multiple easements on private property. The flow would be pumped by the 777 Federal Road Pump Station, Route 133 Pump Station, and the Caldor Pump Station.

Alternative 3 would convey the project area south to an existing gravity sewer manhole on Pocono Road, south of Silvermine Road. Pumping would be required within the study area, but the discharge gravity sewer is in close proximity to the study area and no river or highway crossings would be required. Downstream of the Dean and Pocono Roads area, the flow would be pumped by the existing Route 133 Pump Station and the Caldor Pump Station.

Alternative 1 requires the greatest amount of new sewer and pumping through an additional pump station, and Alternative 2 has significant constructability constraints. Alternative 3 is the simplest and most constructable of the three alternatives and is the selected alternative for conveyance from the Dean and Pocono Roads area.

The Facilities Plan included an analysis of pump station capacity with projected future flows. The Facilities Plan analysis identified a lack of capacity at both the Route 133 and the Caldor Pump Stations in the future if the potential growth in the sewer service area was realized. The current flows and timing of future developments in the sewersheds for both of these pump stations need to be evaluated if the Dean and Pocono Road sewer system proceeds to final design.

4.4 Evaluation of Feasible Alternatives

As outlined in **Section 3**, six general alternatives for serving the project area were initially examined (five sewering options and one to maintain septic systems). Of these, three feasible alternatives were developed in more detail for cost comparison in the Dean and Pocono Roads project area. The three alternatives discussed below are:

1. Gravity sewer main with a small number of individual grinder pumps and one BWPCA pump station

2. Low-pressure sewer system with all homes served by individual grinder pumps

3. Septic System Rehabilitation/Replacement

The gravity sewer (Alternative 1) and low-pressure sewer (Alternative 2) concepts are shown in **Figures 4-3 and 4-4**, respectively**.** Septic tank replacement/rehabilitation (Alternative 3) would require an additional study on the existing septic systems and site-specific drawings have not been produced.

4.4.1 Alternative 1 – Gravity Sewer Main with Limited Number of Private Grinder Pumps and One BWPCA Pump Station

Alternative 1 utilizes a gravity sewer system with individual grinder pumps at five low-elevation homes to minimize the overall depth of the gravity sewer network. This gravity sewer alternative is limited by the topography and depth of bedrock in this area. Residential homes at 123 and 176 Pocono Road, as well as 4, 6, and 8 Dean Road, are at lower elevations that would drive the gravity sewer system up to 20 feet deep if they were served by gravity. The depth of the sewer required to make an entirely gravity sewer system make this alternative not financially feasible. The proposed gravity sewer alternative includes a limited number of grinder pumps for these five low-lying properties to minimize the depth of the sewer at these critical locations.

The remaining 80 existing homes in the project area would connect to the system by gravity. The gravity system in this alternative is shown on concept design drawings included in **Appendix B.**

Conveyance out of the project area entirely by gravity is not feasible; therefore, a pump station is required. This alternative for the project area will require approximately 8,700 feet of 8-inch gravity sanitary sewer, one BWPCA pump station, approximately 3,000 feet of 4-inch force main, and five individual grinder pumps. The topography of the area generally slopes downhill towards the Dean and Pocono Road intersection.

There is a low elevation area on Dean Road east of the Still River oxbow that controls the depth of the gravity sewer to the required pump station. Upstream of the low point, at the intersection of Dean and Pocono Roads, the gravity sewer reaches its greatest depth of approximately 18-feet below the ground surface; however, the majority of the gravity sewers are less than 10 feet deep. The proposed gravity sewer alternative would require one BWPCA pump station. Three potential locations for the BWPCA pump station have been preliminarily identified; all are located on private land and would require an easement.

4.4.1.1 Pump Station

The pump station will receive the gravity flow from the newly installed sewer system and pump to the existing gravity sewer on Pocono Road south of Silvermine Road. The conceptual design for the new pump station includes a concrete wet well with two submersible pumps and an integral concrete valve vault area. The pump station would operate in a duty-standby pump configuration with the standby pump being fully redundant. The pump station concept includes provisions and connections for bypass pumping for station maintenance. The pump station power and controls can be surface mounted on a weatherproof electrical cabinet or housed in a premanufactured building if desired. Pump station architecture, fencing and landscaping would be provided to blend the station into the surrounding area as needed.

TR-16 recommends that wastewater pump stations have an automatically activated generator for operation during a power failure. TR-16 does allow alternatives such as portable generator connection or system storage for small pump stations, but the proposed pump station for the project area would serve approximately 85 existing homes and thus is not considered small. TR-16 recommends a permanently installed generator for a sewer system of this size; as such, a generator should be included in the design for this project. This is consistent with the rest of the BWPCA collection system where generators are permanently installed at the larger stations.

There are three locations within the Dean and Pocono service area that were identified as potentially viable for the proposed pump station. The screening criteria for the pump station was based on a preference for Town-owned parcels, relative low topography, pump station hydraulics, distance from wetlands, flood vulnerability, ease of access for construction and future maintenance, distance to receiving sewers, and discussions with the BWPCA. The three possible pump station locations are identified on **Figure 4-3** and summarized below:

- Pump Station Location Alternative 1: One possible pump station location is on the corner of Dean Road and Pocono Road, on the property of 25 Dean Road. Based on the site selection criteria, the proposed pump station location is at the southwest corner of the Dean Road and Pocono Road intersection, on the northeast corner of 25 Dean Road. While this is a privately-owned parcel, the pump station would be located partly in the town right-of-way, close to the road in an area that would be easily accessible for the BWPCA and the least disruptive to the residents. This proposed pump station location is inside the 500-year floodplain but outside of the 100-year floodplain. This location appears to be several feet above the base flood elevation (approximately elevation 275 referenced to NAVD88 datum) based on the most recent available FEMA mapping (reference to Flood Insurance Rate Map No. 09001C0132F dated June 18, 2010). The available GIS data also shows a wetlands delineation in the vicinity; although it appears possible to keep the pump station outside of the wetlands, it would be within the buffer zone.

- Pump Station Location Alternative 2: The second possible location is on the east side of Dean Road on the southwest corner of Pocono Road property #136, which has relatively low ground elevation. While this is a privately-owned parcel, the pump station would be located close to the road in an area that would be accessible for the BWPCA. This location was identified in a preliminary concept prepared by Langan Engineering and Environmental Services, Inc (Langan) in 2018 and also in the 2020 LAI Wastewater Management Plan. This proposed pump station location is inside the 500-year floodplain but outside of the 100-year floodplain; similar to Alternative 1, this location appears to be several feet above the base flood elevation based on the most recent available FEMA mapping. The available GIS data also shows a wetlands delineation in the vicinity, though it appears possible to keep the pump station outside of the wetlands but within the buffer zone.

- Pump Station Location Alternative 3: The third proposed location of the pump station is on the northern dead-end section of Dean Road, on the rear portion of 27 Dean Road. This pump station location would be the least obtrusive for the majority of the residents. The pump station would be located on the east side of the cul-de-sac close to the road and away from the nearby homes. This location would be easily accessible for the BWPCA. This site is not located in proximity to wetlands based on the delineation in the available GIS. However, this location is partially within the mapped 100-year floodplain per the above-referenced current FEMA mapping, and elevations in this vicinity (approximately 272 to 273 in the cul-de-sac) indicate that this site would be below the base flood elevation of 275. Construction of a pump station in this location would require flood protection (to 3 feet above the flood elevation) and may require Flood Management Certification from CT DEEP.

While these three potential pump station locations are also shown on the concept design drawings in **Appendix B;** the sewer layout shown on the drawings is based on Pump Station Location Alternative 1, as it appears to have the fewest constructability constraints. However, the pump station site selection process should be completed as a collaborative effort with the BWPCA, stakeholders, and property owners and the sewer system layout would be refined accordingly during the final design process.

A fourth alternative was considered; the 2020 LAI Wastewater Management Plan identified an additional potential pump station location on Pocono Road, north of the Dean Road intersection at 152 Pocono Road. This is another relative topographic low point in the area. The Dean Road gravity sewer line depth is controlled by a low point in the area of 22 Dean Road. If the pump station were to be located in the vicinity of 152 Pocono Road, the gravity sewer north of the Dean Road and Pocono Road intersection would be greater than 22 feet deep, several feet deeper than the current maximum dept of approximately 18 feet. Therefore, this location is less desirable and is not currently recommended for further consideration.

Additionally, an undated figure on the BWPCA website also includes a figure showing a possible pump station at the north end of the project near the Pocono Road and Whisconier Road intersection. This location is uphill, approximately 30-feet above the low point in the project area, so this is not a suitable location for a pump station. This site has been ruled out due to the high elevation and difficulty of construction.

Each of the possible pump station locations would require an easement. A supplemental geotechnical program for the selected pump station site is recommended before property acquisition, which would be conducted as part of the future final design phase.

4.4.1.2 Alternative 1 Summary

A summary of Alternative 1, Gravity Sewer with Limited Individual Grinder Pumps and One BWPCA Pump Station, for the Dean and Pocono Roads study area is shown in **Table 4-3** below. Estimated project costs are presented in Section 4.5.

Table 4-3 Dean and Pocono Roads Area – Alternative 1 Summary

Item	Total
Total Gravity Sewer Main (LF)	8,700
8-inch Gravity Sewer <10' Depth	*6,900*
8-inch Gravity Sewer 10'-15' Depth	*1,500*
8-inch Gravity Sewer 15'-20' Depth	*300*
8-inch Gravity Sewer 20'-25' Depth	*0*
8-inch Gravity Sewer >25' Depth	*0*
BWPCA Pump Stations (each)	1
± 4-inch Pump Station Force Main (LF)	3,000
Private Grinder Pumps (each)	5
± 2-inch Low Pressure Sewer Main (LF)	0

4.4.2 Alternative 2 – Low-Pressure Sewer System with Private Grinder Pumps

It is also feasible to serve the Dean and Pocono Roads area with a fully low-pressure sewer system. The low-pressure sewer alternative would require approximately 8,900 feet of approximately 2-inch and smaller low-pressure sewer and 85 grinder pumps (one on each developed property). The low-pressure sewer system would be installed at approximately 5 feet below ground surface and would connect to the existing gravity sewer on Pocono Road, south of the Silvermine Road intersection. The low-pressure sewer system would not require a BWPCA pump station, but every property would require an individual grinder pump.

The full low-pressure sewer alternative is shown on the concept design drawings included in **Appendix B.**

4.4.2.1 Alternative 2 Summary

A summary of Alternative 2, Low-Pressure Sewer with Individual Grinder Pumps for all Properties, for the Dean and Pocono Roads study area is shown in **Table 4-4** below. Estimated project costs are presented in Section 4.5.

Table 4-4 Dean and Pocono Roads Area – Alternative 2 Summary

Item	Total
Total Gravity Sewer Main (LF)	0
8-inch Gravity Sewer <10' Depth	*0*
8-inch Gravity Sewer 10'-15' Depth	*0*
8-inch Gravity Sewer 15'-20' Depth	*0*
8-inch Gravity Sewer 20'-25' Depth	*0*
8-inch Gravity Sewer >25' Depth	*0*
BWPCA Pump Stations (each)	0
± 4-inch Pump Station Force Main (LF)	0
Private Grinder Pumps (each)	85
± 2-inch Low Pressure Sewer Main (LF)	8,900

4.4.3 Alternative 3 – Septic System Rehabilitation/Replacement

The project area faces many challenges for septic systems. Though most lots in the Dean and Pocono Roads area are greater than 0.75 acres in size, current Federal Emergency Management Agency (FEMA) mapping shows that large portions of the area are within the 0.2 percent annual chance flood hazard (the 500-year floodplain), the 1 percent annual chance flood hazard (the 100-year floodplain), or the regulatory floodway of the Still River.

Many parcels also include the presence of wetlands, and much of the project area is reliant on wells for water supply.

The National Resources Conservation Service (NRCS) characterizes soils by slope, percolation, depth to groundwater, depth to bedrock, and flooding. These criteria are combined to assess the ability to support a typical subsurface disposal system, defined as being for a single family, 4-bedroom home on a 1-acre lot with a private well, or a ½-acre lot with public water supply. Portions of the Dean and Pocono Roads project area are rated by NRCS as having low, very low, or extremely low potential for subsurface sewage disposal; some are not rated. Based on the Connecticut Environmental Conditions Online (accessed through www.cteco.uconn.edu):

- Low potential soils are defined as having "one or more limitations, such as low percolation rate and depth to seasonal highwater table, that require extensive design and site preparation to overcome".
- Very low potential soils are defined as having "major soil limitations, such as depth to bedrock, that require extensive design and site preparation. A permit for a Subsurface Disposal System (SSDS) may not be issued unless the naturally occurring soils meet the minimal requirements outlined in the state health code. It is unlikely that these soils can be improved sufficiently to meet state health code regulations."
- Extremely low potential soils are defined as having "multiple major limitations, such as flooding and depth to seasonal high-water table, which are extremely difficult to overcome. A permit for a Subsurface Disposal System (SSDS) may not be issued unless the naturally occurring soils meet the minimal requirements outlined in the state health code. It is unlikely that these soils can be improved sufficiently to meet state health code regulations."
- Soils that are not rated "have characteristics that show extreme variability from one location to another. The work required to overcome adverse soil properties cannot be estimated. Often these areas are urban land complexes… onsite investigation is required to determine soil conditions present at the site."

The soils mapped in the Dean and Pocono Roads area indicate that it is an area of environmental concern in relation to continued use of onsite subsurface sewage disposal systems.

Further, as noted in Section 4.2 above, during the geotechnical exploration program in 2022, groundwater was encountered at approximately 4 feet below grade in the central part of the study area; shallow groundwater with minimal unsaturated soil hinders natural wastewater renovation from septic systems and is consistent with the low potential soil descriptions above.

Further, as noted in Section 1, based on a review of the Brookfield Board of Health septic system data online, there is information on approximately 57 percent of properties in the Dean and Pocono Roads Area, and approximately 34 percent have septic age information available. Of the properties with information available:

- Average system age is 27 years
- 65 percent have septic systems greater than 20 years old, 35 percent have septic systems greater than 30 years old, and 16 percent have septic systems greater than 40 years old
- Of properties that have information on replacement in the file, the average age at replacement was 39 years

Numerous properties in the area, that were generally constructed in the 1960s to early 1970s, still have their original systems; those systems are well beyond their expected useful life and are likely to require replacement in the near future.

4.4.3.1 Septic Inspection Program

As noted in Section 3, for this alternative to be successful, additional research on the existing septic systems, soil conditions and groundwater would be required. If this alternative is pursued, it is recommended that a systematic program of septic system inspections and improvements is undertaken to ensure that septic systems are properly maintained and functioning as well as possible on each property.

This program would include a complete physical inspection of all septic systems and more comprehensive geotechnical analysis of the soils on each lot. Residences that have lot sizes large enough for code compliant septic with appropriate soil conditions can replace damaged or failed septic systems, including tanks and leaching fields. Residences that have poor soil conditions would require mounded, elevated above the groundwater, or advanced treatment solutions (though it is noted that advanced treatment solutions may not be permissible for private residential parcels per CT DEEP). Individual homeowners would be responsible for the costs of improvements. It is expected that an inspection program would trigger replacement of some systems earlier than homeowners would make this investment in the absence of a program.

It is estimated that approximately 3 percent of septic systems in the project area may require replacement each year; this is consistent with typical industry expectations that a reasonable septic system life is in the range of 30 years.

This program would have to be defined by the Town Board of Health in conjunction with the BWPCA, but a reasonable starting point would be to have each system professionally inspected every five years. The cost of a program would likely be borne by each individual homeowner.

4.5 Summary of Alternatives and Cost Analysis

Three alternatives have reached this stage of consideration in the Dean and Pocono Roads study area. Alternative 1 is a gravity sewer system with one BWPCA pump station, corresponding 4-inch force main, and limited individual grinder pumps. Alternative 2 is a low-pressure sewer option with individual grinder pumps for every developed property. Alternative 3 would not require the installation of pumps or pipes but would instead involve a systematic septic system inspection program and replacement or rehabilitation of septic systems when required.

4.5.1 Capital Cost Summary of Feasible Alternatives

Using the concept design drawings for the gravity sewer with minimal individual grinder pumps (Alternative 1) and pressure sewer with all grinder pumps alternatives (Alternative 2) included in **Appendix B**, approximate quantities of major system components were determined. The approximated quantities for all alternatives were used in combination with unit prices provided by CDM Smith's professional cost estimators to create an Opinion of Probable Construction Cost (OPCC). The OPCC includes contractor general conditions of the contract, overhead and profit, and construction estimating contingency. Additionally, to arrive at an overall Project Cost overall project costs that need to be budgeted for by the BWPCA including escalation, engineering and implementation costs, and project contingency are included in the total planning-level figures presented below. **Table 4-5** summarizes the key features and Total Estimated Project Costs for both sewer extension alternatives.

Table 4-5 Dean and Pocono Roads Area - Sewering Alternatives Project Cost Summary

Summary of Alternative		Total Estimated Project Cost (rounded) (1)
Alternative 1 – Gravity Sewer with Limited Number of Private Grinder Pumps and One BWPCA Pump station		$6,700,000
± 8-inch Gravity Sewer Main	8,700 LF	
BWPCA Pump Stations	1	
± 4-inch Pump Station Force Main	3,000 LF	
Individual Grinder Pumps	5	
± 2-inch Low Pressure Sewer Main	0	
Alternative 2 – Low-Pressure Sewer System with Private Grinder Pumps		$3,400,000
± 8-inch Gravity Sewer Main	0	
BWPCA Pump Stations	0	
± 4-inch Pump Station Force Main	0	
Individual Grinder Pumps	85	
± 2-inch Low Pressure Sewer Main	8,900	

Project cost estimating notes are detailed further in **Appendix E** and summary of major items are below:

- Total Project Costs for all Items include Engineer's Opinion of Probable Construction Cost including contractor labor, equipment, materials, general conditions, overhead & profit, construction contingency, plus Project Costs including engineering and implementation, project contingency, and escalation to 2025.
- Costs include service connections from the gravity sewer main to the property line. Service connection work on private property is not included in the project costs and would be the responsibility of the individual homeowners.

- Grinder pump costs include purchase of one pump per residence; installation and work on private property is not included.
- Pavement restoration is assumed to be an average of 8 feet wide for all gravity sewer and force main work, with force main in the same trench for the gravity sewer option. For low-pressure sewer, pavement is assumed to be 4 feet wide. For the full low-pressure sewer option in the Dean and Pocono Roads area, the low-pressure sewer is intended to be installed in the Town right-of-way outside of the pavement; paving will be required where service connections need to cross the street to the opposite property line.

For Alternative 3, Septic System Rehabilitation/Replacement, all costs would be borne by homeowners and there would not be a capital project undertaken by the BWPCA, so that option is not included in Table 4-5. However, this option has significant long-term costs to be borne by homeowners, and those are further explored in the life cycle cost analysis presented in Section 4.5.2 below.

4.5.2 Life Cycle Cost Effectiveness

To compare the full cost of the three alternatives, a 50-year life cycle cost analysis calculation was performed. This interval was chosen based on the varied equipment life of the proposed alternatives.

The life cycle costs for the system includes the capital construction project costs, periodic replacement of equipment, and recurring costs such as electrical usage, septic tank pumping costs and sewer user fees (from years 2025 through 2074). A present worth analysis was conducted to compare the alternatives presented above. This is a relative analysis designed to present the equalized costs over the life of the alternatives. This analysis was intended to compare the major capital and equipment costs and may not include all minor maintenance costs.

The life cycle analysis costs include both the residents' costs and the BWPCA costs combined. A summary of the life cycle cost analysis is included in **Table 4-6** and includes the following assumptions:

1. The gravity sewer system has an expected life cycle of greater than 50 years for pipes, manholes and force mains, with major pump station equipment replacements every 20 years. Pipes will have some remaining life at the end of this analysis period, but this salvage value is not quantified as a credit herein.
2. The grinder pumps have a shorter life cycle with grinder pump replacement approximately every 15 years. Low pressure sewer main pipes are expected to have a life cycle of greater than 50 years, similar to gravity sewers; the pipes will have some remaining life at the end of this life cycle analysis, but this salvage value is not quantified as a credit herein.
3. The available data and typical industry expectations suggest that septic systems in this area have a typical life cycle between 30 and 40 years; this equates to approximately 3 percent of systems requiring replacement each year. With the shallow groundwater

throughout much of the project area, it is expected that many systems may require mounding to improve performance and reliability. An estimated cost of $35,000 (in today's dollars) is assumed for each septic system replacement.

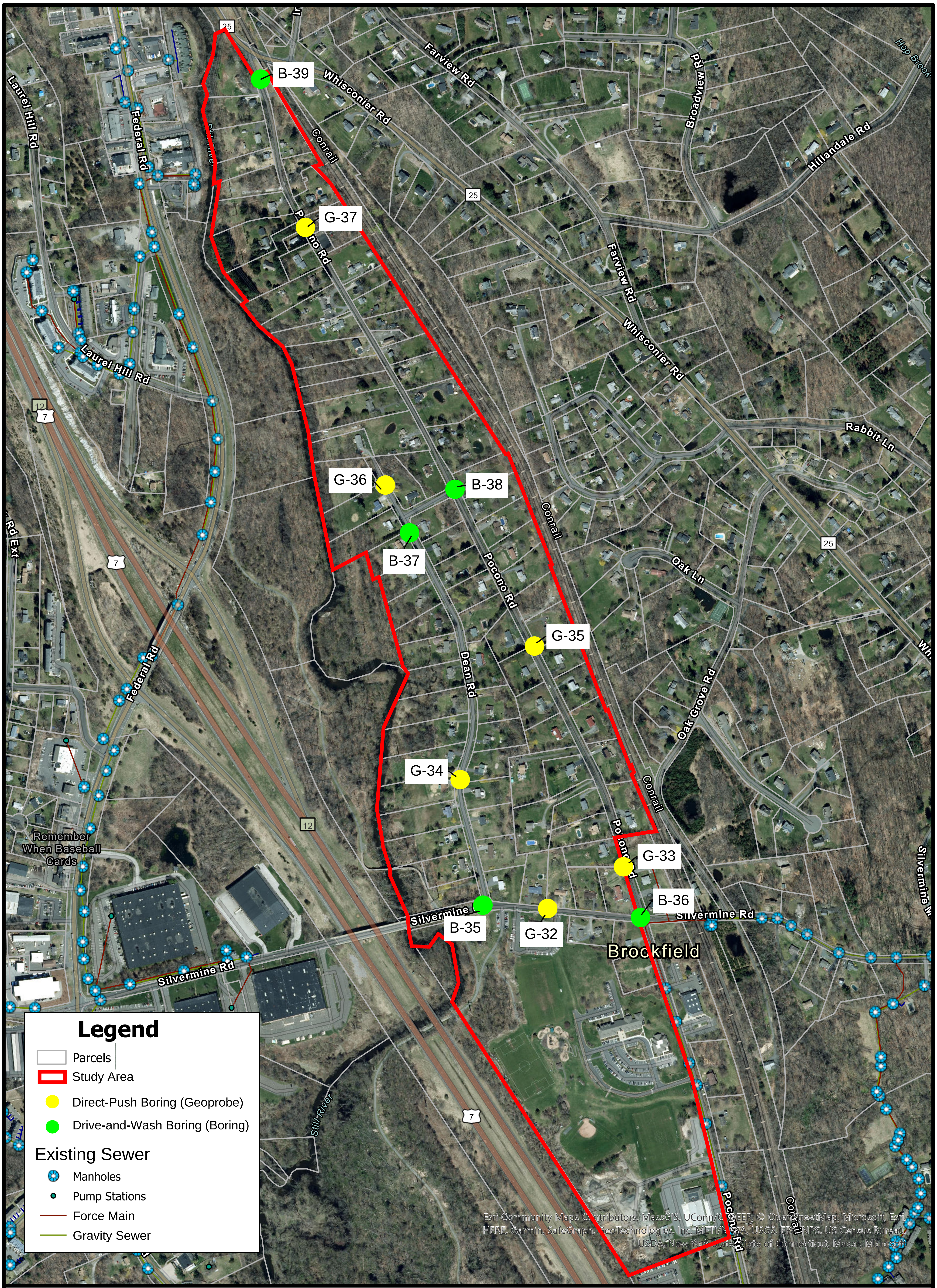
4. Annual escalation of 4 percent over the planning period is assumed;
5. The USEPA 2023 discount rate of 2.5-percent was used;
6. Salvage values of equipment are assumed to be zero;
7. For the septic option, an estimated $400 every three years for septic tank pumping and $600 every five years for the septic inspection program is carried;
8. For the sewer options, a sewer user bill of $520 per year is carried, as is an average allowance of $10,000 per property for each homeowner to connect to the system;
9. Utility Power Costs are estimated at $0.25/kWh;
10. A sewer extension project would be eligible for a 20 percent grant through the Connecticut Clean Water Fund; septic tank replacement would not be.

Table 4-6 50-Year Life Cycle Cost Summary of Alternatives

Alternative	Estimated Initial Project Capital Cost ($) (after 20% CWF Grant)	50 Year Estimated Life Cycle Cost	Approximate Annual Cost, $/year per property
Alternative 1 – Gravity Sewer with Limited Individual Grinder Pumps and One BWPCA Pump station	$ 5,400,000	$ 9,700,000	$ 2,100
Alternative 2 – Low-Pressure Sewer with All Grinder Pumps	$ 2,700,000	$ 9,200,000	$ 2,000
Alternative 3 – Septic System Replacement	n/a	$ 9,300,000	$ 2,000

This life cycle cost analysis shows that Alternative 1, gravity sewer with five individual grinder pumps and one BWPCA pump station, has the highest initial project cost, but with higher operational costs of the pressure sewer alternative, the 50-year life cycle cost of Alternatives 1 and 2 are relatively close. The septic system replacement alternative has no initial capital project cost for the BWPCA, but it also has very similar long-term costs to the average homeowner, though this would be variable depending on actual septic system replacement costs on each property. With the factors outlined above, the 50-year life cycle costs of all three alternatives are within about 5 to 6 percent of each other.

This analysis assumes a 20 percent CWF grant on the initial project construction costs. Any additional grants, such as a higher CWF grant percentage or other funding sources that can be applied to the project would further improve the life cycle cost analysis in favor of Alternatives 1 and 2, and particularly in favor of Alternative 1, because grants would be applied to the initial capital costs. Long-term operational costs and septic programs are not likely to be reduced with grant funding. Funding and implementation considerations are discussed further in Section 7.



0 500 1,000 Feet

N

CDM Smith

Figure 4-1

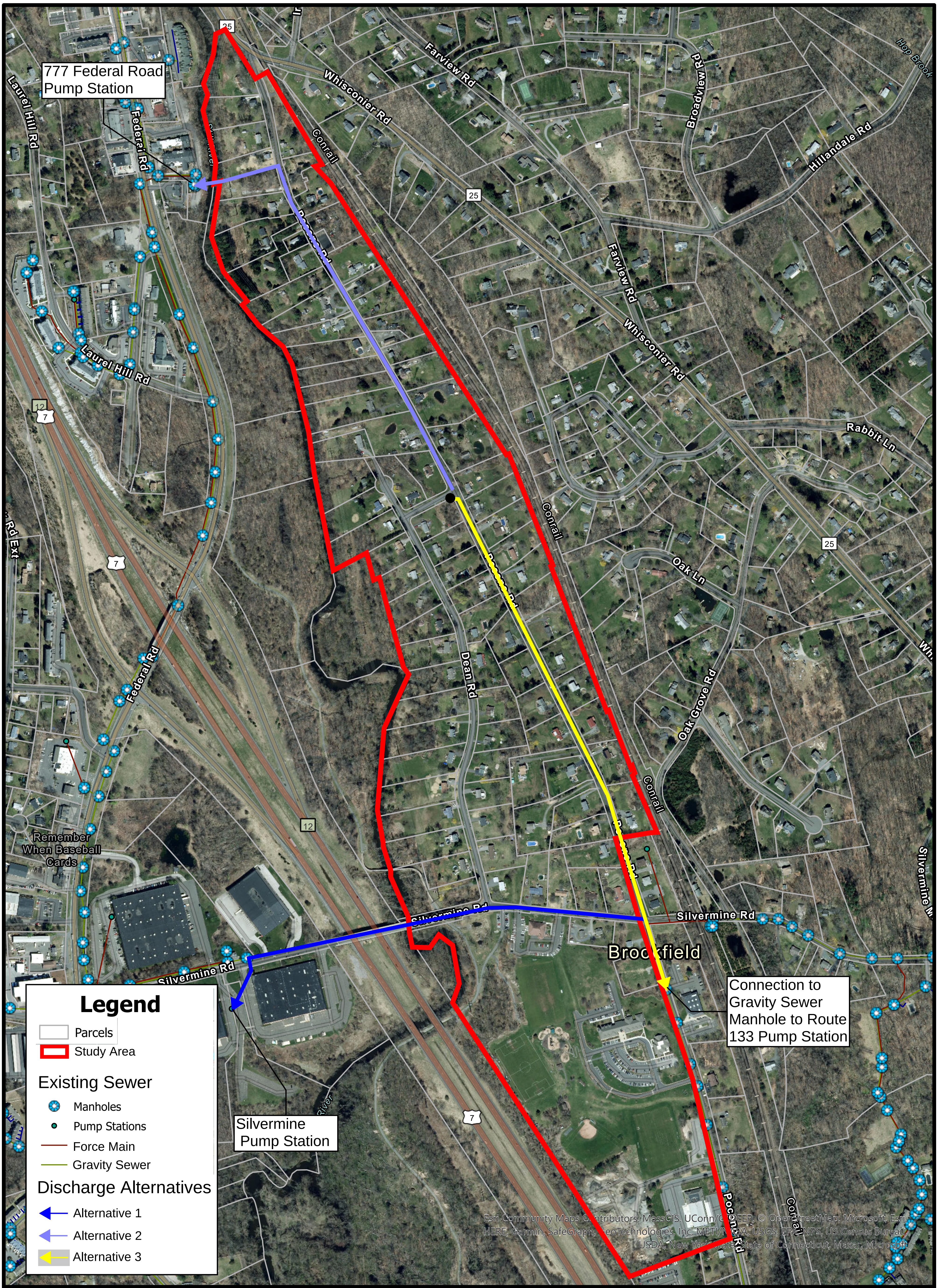
Dean and Pocono Roads Study Area; Subsurface Investigation Locations

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023



0 500 1,000 Feet

N

Figure 4-2

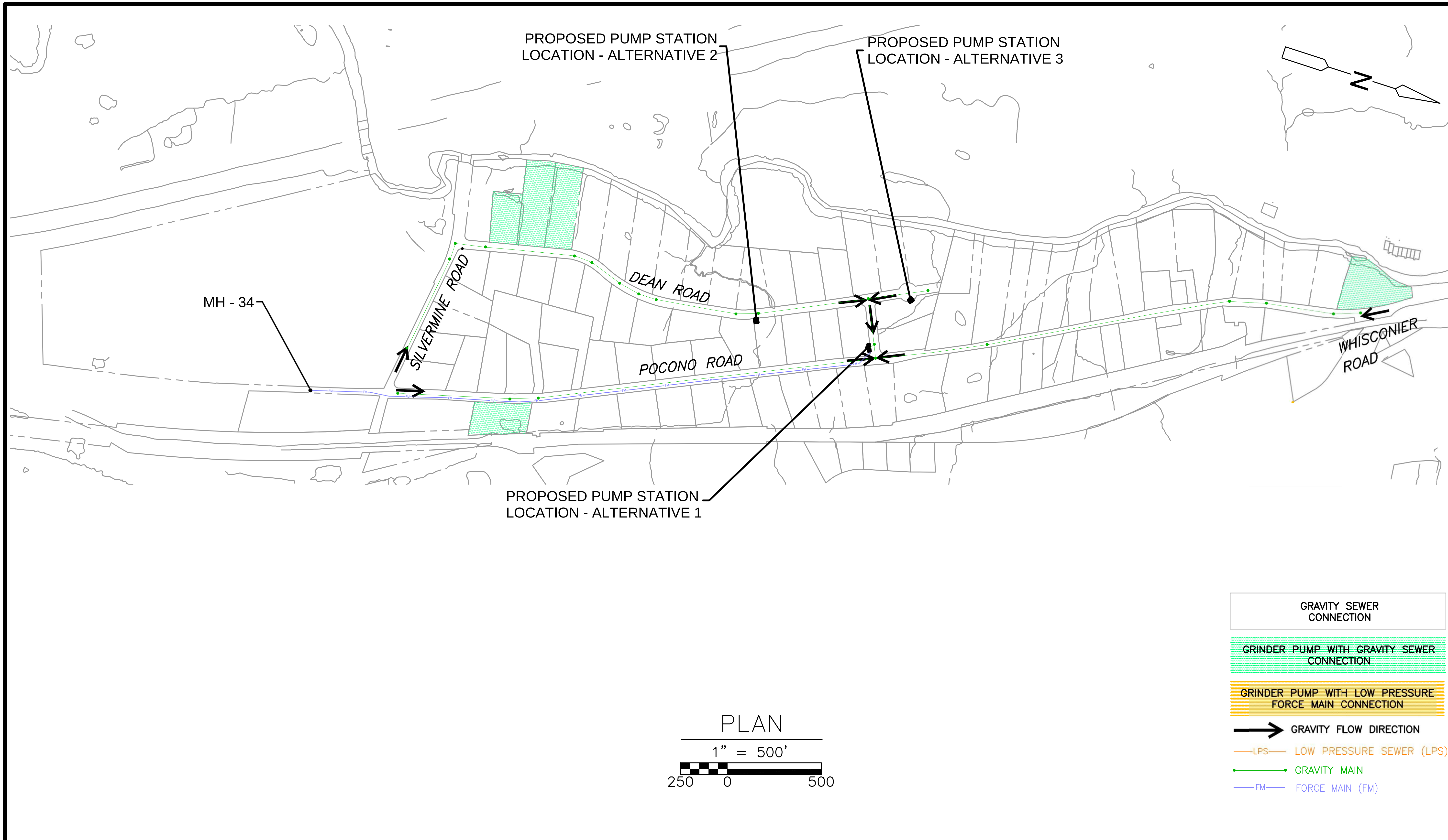
Dean and Pocono Roads Study Area; Proposed Discharge Locations

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023



CDM Smith

BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
DEAN AND POCONO ROADS AREA

FIGURE 4-3
ALTERNATIVE 1 GRAVITY SEWER MAIN WITH LIMITED NUMBER OF PRIVATE GRINDER PUMPS AND ONE BWPCA PUMPING STATION
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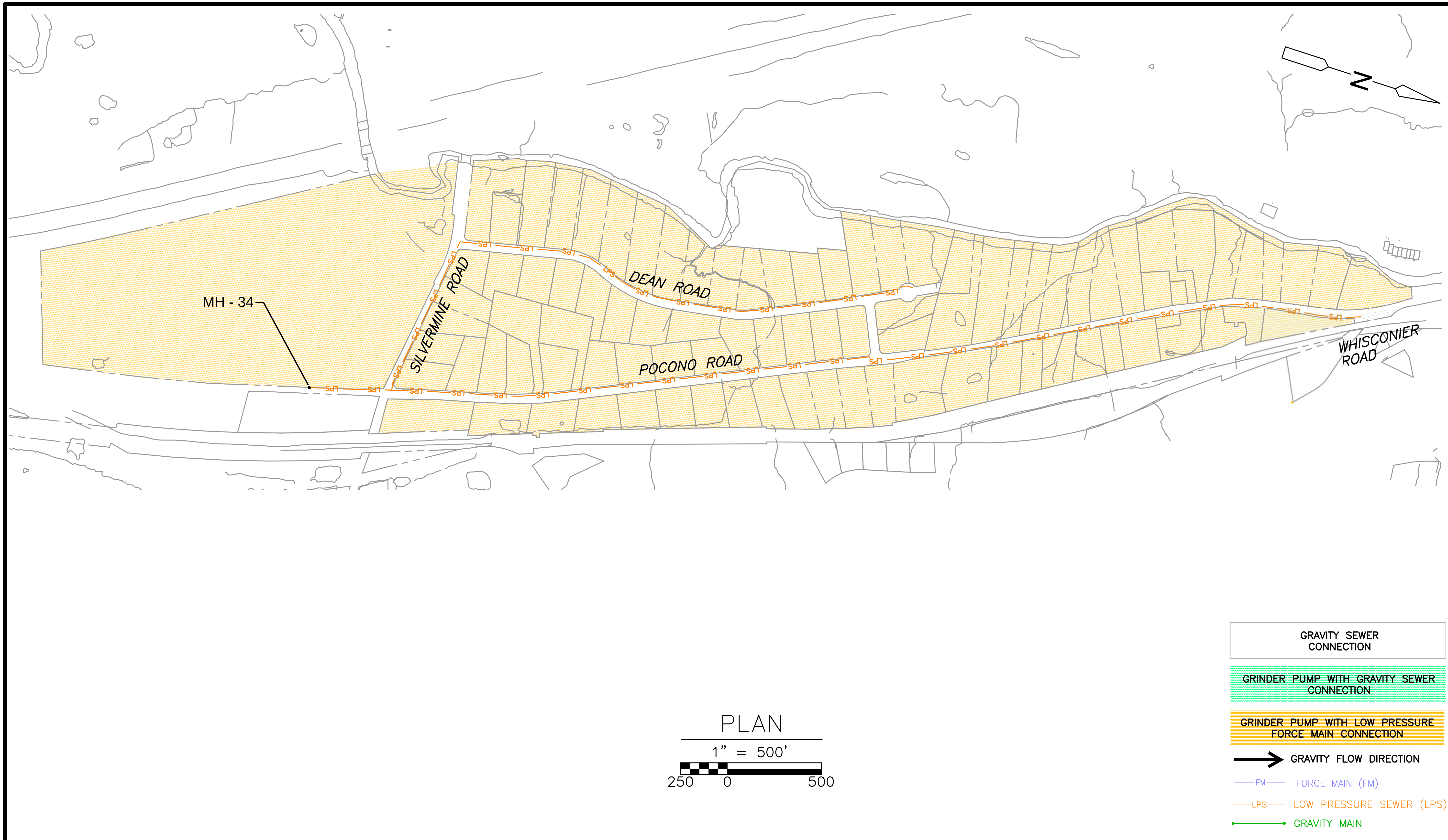

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BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
DEAN AND POCONO ROADS AREA

FIGURE 4-4
ALTERNATIVE 2 LOW-PRESSURE SEWER SYSTEM
WITH PRIVATE GRINDER PUMPS
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Section 5

Candlewood Peninsula and Candlewood Lake Road Areas

CDM Smith

Section 5

Candlewood Peninsula and Candlewood Lake Road Areas

5.1 Study Area Definition

As noted in prior Sections, the Candlewood Peninsula and Candlewood Lake Road Areas include approximately 1,100 residential parcels on the Candlewood Peninsula, in the Candlewood Lake Club area, Pleasant Rise area, and along Candlewood Lake Road. For this study, the area also includes the multi-family residential and commercial properties along Candlewood Lake Road.

5.2 Subsurface Conditions

CDM Smith conducted a preliminary geotechnical investigation program in the project area consisting of 40 drive-and-wash borings and 50 direct-push borings (geoprobes). Geologic-Earth Exploration (Geologic) of Norfolk, Massachusetts, under subcontract to CDM Smith, advanced the geoprobes to depths ranging from about 3 to 20 feet, and the drive-and-wash borings to depths ranging from about 2.5 to 22 feet during April and May 2022. Previously, Terracon of Rocky Hill, Connecticut completed 13 auger borings, to a depth of approximately 5.5 to 8 feet, through LAI in November 2020. The preliminary borings and geoprobes were spaced approximately several hundred feet apart throughout the study area, generally including borings at most intersections and geoprobes in between. Ground-penetrating radar (GPR) and radio detection equipment was used to mark the location of utilities in the vicinity of borings and geoprobes. A summary of the boring locations is included in **Table 5-1**.

Table 5-1 2022 Geotechnical Boring Locations

Study Area	Direct-Push Borings (Geoprobes)	Drive-and-Wash Borings
Candlewood Peninsula	29	30
Candlewood Lake Club	5	6
Northern Candlewood Lake Road Area	5	3
Southern Candlewood Lake Road and Pleasant Rise Area	11	14

The locations of the subsurface investigations are shown on **Figures 5-1 through 5-4** and data obtained is summarized below.

5.2.1 Geotechnical Data

5.2.1.1 Candlewood Peninsula

On the Candlewood Peninsula, 21 drive-and-wash borings and 29 geoprobes were completed in 2022, and 9 auger borings were completed in 2020. **Table 5-2** below summarizes key information from the explorations in the peninsula area, and boring and probe logs are included in **Appendix C.**

Table 5-2 Geotechnical Exploration Summary – Candlewood Peninsula

Exploration ID	Street / Intersection	Total Depth of Exploration (ft)	Approximate Depth to Groundwater	Approximate Depth to Refusal (Possible Bedrock)
B-5 (2020)	Kellogg Street/Lakeview Road	8.0	5.0	--
B-6 (2020)	Hickory Hill Road	8.0	--	--
B-7 (2022)	Chester Street	19.3	--	--
B-8 (2022)	Taylor Street/Willie Lane	13.0	9.0	12.0
B-9 (2022)	Arrowhead Road/Willie Lane	19.8	9.0	--
B-10 (2022)	Taylor Street	16.5	--	15.5
B-11 (2022)	Longview Drive/Berkshire Drive	9.5	--	8.5
B-12 (2022)	Kellogg Street/Bayview Street	15.8	--	14.8
B-14 (2022)	South Lake Shore Drive	20.4	--	--
B-15 (2020)	Beach Boulevard/Longview Drive	7.0	--	7.0
B-16 (2020)	South Lake Shore Drive	8.0	--	--
B-17 (2020)	South Lake Shore Drive	6.5	--	5.5
B-18 (2022)	Longview Drive	15.5	--	14.5
B-19 (2022)	Twilight Lane	5.8	--	4.8
B-20 (2022)	North Lake Shore Drive	21.0	9.0	--
B-21 (2020)	Kellogg Street	8.0	--	--
B-22 (2020)	Bayview Drive	8.0	--	--
B-23 (2020)	Laurel Drive	8.0	--	--
B-24 (2020)	Kellogg Street/Cipolla Lane	8.0	--	--
B-25 (2022)	Clearview Street/Skyline Drive	12.8	--	11.8
B-26 (2022)	Candlewood Shores Drive	21.0	9.0	--
B-27 (2022)	Candlewood Shores Drive	19.9	9.0	--
B-28 (2022)	Candlewood Shores Drive	14.3	--	13.3
B-30 (2022)	Hickory Hill Road/Laurel Drive	20.2	--	--
B-31 (2022)	Hickory Hill Road/Cranberry Lane	19.3	--	--
B-32 (2022)	Kellogg Street	21.0	--	--
B-33 (2022)	Kellogg Street/Lakeview Road	19.9	19.0	--
B-34 (2022)	Lakeview Road	17.5	4.0	16.5
B-58 (2022)	Skyline Drive	11.0	--	10.0
B-59 (2022)	North Lake Shore Drive	21.0	9.0	--
G-1 (2022)	Arrowhead Road	15.0	--	--
G-2 (2022)	Myron Road/Arrowhead Road	13.0	8.0	--
G-3 (2022)	Arrowhead Road	20.0	16.0	--
G-4 (2022)	Arrowhead Road	14.0	--	--
G-5 (2022)	Kellogg Street	20.0	9.0	--
G-6 (2022)	South Lake Shore Drive	10.0	--	10.0
G-7 (2022)	Berkshire Drive	3.0	--	3.0
G-8 (2022)	South Lake Shore Drive	3.0	--	3.0

Exploration ID	Street / Intersection	Total Depth of Exploration (ft)	Approximate Depth to Groundwater	Approximate Depth to Refusal (Possible Bedrock)
G-9 (2022)	Berkshire Drive	10.0	--	10.0
G-10 (2022)	South Lake Shore Drive	20.0	--	--
G-11 (2022)	South Lake Shore Drive	20.0	14.0	--
G-12 (2022)	Berkshire Drive	20.0	--	--
G-13 (2022)	North Lake Shore Drive	15.0	10.0	15.0
G-14 (2022)	North Lake Shore Drive	15.0	8.0	15.0
G-15 (2022)	North Lake Shore Drive	15.0	8.0	15.0
G-16 (2022)	North Lake Shore Drive	15.0	9.0	15.0
G-17 (2022)	North Lake Shore Drive	10.0	7.0	10.0
G-18 (2022)	Skyline Drive	3.0	--	3.0
G-20 (2022)	North Lake Shore Drive	20.0	9.0	--
G-21 (2022)	Skyline Drive	13.0	10.0	13.0
G-23 (2022)	Clearview Drive	20.0	--	--
G-24 (2022)	North Lake Shore Drive	20.0	12.0	--
G-25 (2022)	Clearview Drive	20.0	12.0	--
G-26 (2022)	Candlewood Shores Drive	20.0	10.0	--
G-27 (2022)	Laurel Drive	20.0	10.0	--
G-28 (2022)	Laurel Drive	20.0	9.0	--
G-29 (2022)	Hickory Hill Road/Laurel Drive	20.0	9.0	--
G-30 (2022)	Kellogg Street	20.0	10.0	--
G-31 (2022)	Lakeview Road	13.5	7.0	13.5

Shallow refusal on presumed bedrock was encountered in several borings and geoprobes at depths ranging from 3 to 16 feet below ground surface; refusal was not encountered in some explorations. A roller-bit was advanced 1 foot after refusal in borings B-8, B-10, B-11, B-12, B-18, B-19, B-25, B-28, B-34, and B-58 to verify bedrock, but the possibility remains that the refusal was on a boulder greater than 1 foot in diameter. A possible outcrop was observed in the vicinity of G-7.

Most of the soil samples collected from the geoprobes and borings were visually classified as dense to very dense silty sand and sandy silt with varying amounts of gravel. Groundwater was encountered at depths ranging from 4 feet to 19 below ground surface; groundwater was not encountered in some explorations.

Selected soil samples collected from the geoprobes and borings were sent for grain size analysis testing in accordance with ASTM D6913 at the CDM Smith Geotechnical Testing Laboratory in Chelmsford, Massachusetts. The test results indicated that samples consisted of silty sand, sandy silt, or silt, with some clay and gravel present, which generally confirms the visual classifications.

5.2.1.2 Candlewood Lake Club and Northern Candlewood Lake Road Areas

Six drive-and-wash borings and five geoprobes were completed in the Candlewood Lake Club area and three drive-and-wash borings and five geoprobes were completed in the northern Candlewood Lake Road study area. **Table 5-3** below summarizes key information from the explorations in these areas, and boring and probe logs are included in **Appendix C.**

Table 5-3 Geotechnical Exploration Summary – Candlewood Lake Club and Northern Candlewood Lake Road Area

Exploration ID	Street / Intersection	Total Depth of Exploration (ft)	Approximate Depth to Groundwater	Approximate Depth to Refusal (Possible Bedrock)
B-29 (2022)	Candlewood Lake Road	9.0	--	8.0
B-49 (2022)	Candlewood Lake Road	14.8	4.0	14.8
B-51 (2022)	Candlewood Lake Rd/North Mountain Rd	20.8	9.0	--
B-52 (2022)	Candlewood Lake Road/Indian Trail	21.0	9.0	--
B-53 (2022)	Indian Trail	19.8	--	--
B-54 (2022)	Candlewood Lake Road	22.0	--	--
B-55 (2022)	Indian Trail/Forest Trail	22.0	--	--
B-56 (2022)	Forest Trail	21.0	4.0	--
B-57 (2022)	Indian Trail	13.0	4.0	12.0
G-49 (2022)	Candlewood Lake Road	20.0	14.0	--
G-50 (2022)	Old Prange Road/Allen Road	15.0	8.0	15.0
G-51 (2022)	Prange Road	20.0	10.0	--
G-52 (2022)	Candlewood Lake Road	20.0	9.0	20.0
G-53 (2022)	Prange Road/North Mountain Road	20.0	9.0	--
G-54 (2022)	Indian Trail	20.0	--	--
G-55 (2022)	Candlewood Lake Road	20.0	12.0	--
G-56 (2022)	Indian Trail	20.0	14.0	--
G-57 (2022)	Cotton Tail Lane	20.0	N/A	--
G-58 (2022)	Candlewood Lake Road	20.0	18.0	--

Shallow refusal on presumed bedrock was encountered in several borings and geoprobes at depths ranging from 8 to 20 feet below ground surface; refusal was not encountered in most explorations. A roller-bit was advanced 1 foot after refusal in borings B-29 and B-57 to verify bedrock, but the possibility remains that the refusal was on a boulder greater than 1 foot in diameter.

Most of the soil samples collected from the geoprobes and borings were visually classified as dense to very dense silty sand and sandy silt with varying amounts of gravel. Groundwater was encountered at depths ranging from 4 to 18 feet below ground surface; groundwater was not encountered in some explorations.

Selected soil samples collected from the geoprobes and borings were sent for grain size analysis testing in accordance with ASTM D6913 at the CDM Smith Geotechnical Testing Laboratory in

Chelmsford, Massachusetts. The test results indicated that most samples consisted of silty sand, which generally confirms the visual classifications.

5.2.1.3 Southern Candlewood Lake Road and Pleasant Rise Area

Ten drive-and-wash borings and eleven geoprobes were completed in the Southern Candlewood Lake Road and Pleasant Rise area in 2022, and four auger borings were completed in 2020.

Table 5-4 below summarizes key information obtained from the explorations in the Southern Candlewood Lake Road and Pleasant Rise area, and boring and probe logs are included in **Appendix C.**

Table 5-4 Geotechnical Exploration Summary – Southern Candlewood Lake Road and Pleasant Rise

Exploration ID	Street / Intersection	Total Depth of Exploration (ft)	Approximate Depth to Groundwater	Approximate Depth to Refusal (Possible Bedrock)
B-1 (2020)	Candlewood Lake Road	8.0	--	4.0
B-2 (2020)	Candlewood Lake Road	5.5	--	3.5
B-3 (2020)	Candlewood Lake Road	8.0	6.5	--
B-4 (2020)	Candlewood Lake Road	8.0	--	7.5
B-13 (2022)	Candlewood Lake Road	13.5	4.0	12.5
B-40 (2022)	Candlewood Lake Road	14.7	--	14.7
B-41 (2022)	North Pleasant Rise	2.5	--	2.5
B-42 (2022)	Pleasant Rise Circle	21.0	14.0	--
B-43 (2022)	Pleasant Rise Circle	21.0	9.0	--
B-44 (2022)	Candleview Road	19.4	5.0	--
B-45 (2022)	Candlewood Lake Road/Woodview Drive	20.3	9.0	--
B-46 (2022)	Horseshoe Drive	13.5	--	12.5
B-47 (2022)	Candlewood Lake Road	21.0	--	--
B-48 (2022)	Kellogg Street/Candlewood Lake Road	21.0	4.0	--
G-38 (2022)	Candlewood Lake Road	12.0	10.0	12.0
G-39 (2022)	Candlewood Lake Road	15.0	6.0	15.0
G-40 (2022)	Pleasant Rise Circle	20.0	10.0	--
G-41 (2022)	Pleasant Rise Circle	20.0	8.0	--
G-42 (2022)	Candlewood Lake Road	4.0	--	4.0
G-43 (2022)	North Pleasant Rise	20.0	10.0	--
G-44 (2022)	Woodview Drive	20.0	--	--
G-45 (2022)	Candlewood Lake Road	20.0	N/A	--
G-46 (2022)	Woodview Drive	20.0	9.0	--
G-47 (2022)	Candlewood Lake Road	13.0	N/A	13.0
G-48 (2022)	Candlewood Lake Road	20.0	11.0	--

Shallow refusal on presumed bedrock was encountered in several borings and geoprobes at depths ranging from 4 to 15 feet below ground surface; refusal was not encountered in some explorations. A roller-bit was advanced 1 foot after refusal in borings B-13 and B-46 to verify bedrock, but the possibility remains that the refusal was on a boulder greater than 1 foot in diameter. A possible outcrop was observed in the vicinity of B-41.

Most of the soil samples collected from the geoprobes and borings were visually classified as dense to very dense silty sand with varying amounts of gravel. Groundwater was encountered at depths ranging from 4 to 14 feet below ground surface; it was not encountered in some explorations.

Selected soil samples collected from the geoprobes and borings were sent for grain size analysis testing in accordance with ASTM D6913 at the CDM Smith Geotechnical Testing Laboratory in Chelmsford, Massachusetts. The test results indicated that samples consisted of silty sand, which generally confirms the visual classifications.

5.2.1.4 Corrosion Potential Testing

Four samples were collected and transported to Alpha Analytical of Westborough, Massachusetts for corrosion potential testing (specific conductance, chloride, pH, and sulfates). The samples were taken from G-25 in the Candlewood Peninsula area, G-45 and G-48 in the Southern Candlewood Lake Road area, and G-56 in the Candlewood Lake Club study area. The results, presented in **Table 5-5**, indicate that the soil has low corrosion potential for concrete and reinforcing steel; additional corrosivity testing should be completed during the design phase to determine any protection needs for ductile iron pipe.

Table 5-5 Corrosion Potential Test Results

	G-25 (1-10’)	G-45 (2-10’)	G-48 (2-10’)	G-56 (0-10’)	Units
Specific Conductance @ 25 °C	40	79	48	ND	µmhos/cm
Chloride	ND	ND	18	ND	mg/kg
pH	8.4	8.5	8.8	8.4	SU
Sulfate	ND	ND	ND	ND	mg/kg

ND = Not Detected

Additional geotechnical investigations will be required to fill in data gaps and better define the subsurface conditions if the project moves forward to design.

5.2.2 Environmental Data

As part of the subsurface investigations, a number of soil samples were collected for laboratory analysis to conduct a preliminary evaluation of the environmental site conditions. The results of the soil laboratory data were used to evaluate soil reuse, management, and disposal options during construction. The assessment identified any potential soil contamination and whether soil excavated during project construction can potentially be re-used or if it will have to be transported to an off-site disposal facility.

Several soil samples were screened for evidence of visual or olfactory impacts (e.g. soil staining, sheen, odor, etc.) and screened for volatile organic compounds (VOCs) using a photoionization detector (PID). A total of 18 soil samples were collected for laboratory analyses from 17 boring locations throughout the project area. In addition, for quality assurance purposes, one duplicate soil sample was collected along with two trip blanks.

Samples were generally collected from either the 3-5 or 4-6 ft depth intervals based on the depth expected to be excavated based on proposed pipe elevations. Soil samples were placed on ice and submitted to Pace Analytical Laboratory (formerly Con-Test) in East Longmeadow, Massachusetts for laboratory analysis. Soil samples were analyzed for Metals (6010D and 7471B), Volatile Organic Compounds (VOCs) (8260C-D), Semivolatile Organics (SVOCs) (8270D-E), and Extractable Total Petroleum Hydrocarbons (ETPH) (CT DEP ETPH). Results are summarized in **Appendix C**.

The data was compared to Connecticut Department of Energy & Environmental Protection (CT DEEP) Remediation Standard Regulations (RSRs) soil criteria as defined in Regulation of Connecticut State Agencies (RCSA) Section 22a-133k-1 to 133k-3, which included residential and industrial/commercial (I/C) direct exposure criteria (DEC) and GA pollutant mobility criteria (PMC). The project is not in a state clean-up program and, therefore, not specifically subject to remediation under the RSRs. The soil data are evaluated against the RSR criteria to provide a baseline understanding relative to potential environmental concerns and potential reuse options during construction.

In addition, the soil results were compared to Massachusetts Department of Environmental Protection (MassDEP) Reuse & Disposal of Contaminated Soil at Massachusetts Landfills Criteria (Comm97-001) for lined and unlined landfills to evaluate regional off-site disposal facility options.

5.2.2.1 Environmental Results

Key results are outlined below.

Total Metals

Five metals were each detected in at least one of the soil samples analyzed (arsenic, barium, cadmium, chromium, and lead). The metals detected were all below the RSR direct exposure criteria and the Comm 97-001 unlined and lined landfill criteria.

ETPH

ETPH was detected in 9 of the 18 samples ranging from 13 milligrams per kilogram (mg/kg) to 2,400 mg/kg, with the second highest ETPH concentration of 180 mg/kg.

One sample, B-48 (4-6), located at the intersection of Candlewood Lake Road and Kellogg Street, contained ETPH above RSR residential DEC and GA PMC with a detection of 2,400 mg/kg. ETPH was below both Comm 97-001 unlined (2,500 mg/kg) and lined (5,000 mg/kg) landfill criteria for ETPH.

VOCs

Only two VOC compounds were detected, both at low concentrations below RSR criteria. Naphthalene was detected at one location at a concentration of 0.004 mg/kg. Chloroform was detected at three locations ranging in concentration from 0.0028 mg/kg to 0.0038 mg/kg. No other VOC compounds were detected. Total VOCs ranged from 0.0028 to 0.004 mg/kg, well below the Comm 97-001 unlined and lined landfill criteria of 4 and 10 mg/kg, respectively.

SVOCs

In terms of SVOC analysis, 19 polycyclic aromatic hydrocarbons (PAHs) were detected in just four of the soil samples (B-13, B-42, B-48, and G-11). Detections were at low concentrations, below RSR DEC and PMC criteria, at three of the four samples. At B-48 (4-6), several of the PAH compounds were detected above the residential DEC and the GA PMC, with a few compounds also exceeding the I/C DEC. Total SVOCs of the four soil samples were 0.44 mg/kg (B-42), 3.29 mg/kg (G-11), 4.84 mg/kg (B-13), and 245.28 mg/kg (B-48) compared to the Comm 97-001 unlined and lined landfill criteria of 100 mg/kg.

Quality Control Samples

Quality control samples are collected to verify the accuracy and quality of project data, and to indicate any possible cross-contamination or potentially biased results. The two trip blank results were non-detect indicating that the sample collection process, storage, and transport did not introduce VOC contaminants. The duplicate sample (DUP-1) results closely matched those of its associated parent sample taken at B-12 (4-6), indicating laboratory analysis was consistent.

Summary

From an environmental standpoint, according to the CT DEEP guidance policy to utility companies on the reuse of contaminated soil, soil is acceptable for reuse in the *same excavation* provided that 1) any excess contaminated material that is not reused in the same trench is disposed of in accordance with the appropriate soil and hazardous waste regulations and 2) the upper one foot of the excavation is filled with clean fill or pavement. Reuse of the soil must also meet all geotechnical requirements and specifications.

With the exception of one sample, B-48 located at the intersection of Candlewood Lake Road and Kellogg Street, all soil results were below CT DEEP RSR criteria and Comm 97-001 unlined and lined landfill criteria. Therefore, the majority of soil would be able to be reused as backfill in the same excavation, provided it meets geotechnical requirements, and surplus material would not require special handling or disposal.

The soil encountered at B-48 contained ETPH and several PAH compounds above both CT DEEP RSR criteria as well as Total SVOCs above allowable reuse levels at Massachusetts landfills as outlined in MA DEP Policy No. Comm 97-001. Therefore, material in this vicinity will need to be disposed of at a permitted commercial disposal facility.

This preliminary evaluation is based on the data for samples collected at specific boring locations within the project areas. It is intended to provide an initial characterization of soils in the project area for subsequent handling, reuse, and disposal during construction. Additional environmental sampling and laboratory analyses are necessary if further characterization and environmental soil disposition must be refined. If conditions are encountered such that suspected contaminated material is observed, additional data should be collected to evaluate the suspected contamination and assess allowable reuse and/or off-site disposal.

5.3 Discharge Locations and Downstream Capacity

The alternatives herein were developed assuming that any new sewers from the Study Areas would ultimately flow south along Candlewood Lake Road to BWPCA's Caldor Pump Station located at the intersection of Candlewood Lake Road and Federal Road. This station currently conveys all of Brookfield's flow to the Danbury WPCP.

The Facilities Plan included an analysis of pump station capacity with projected future flows. The Facilities Plan analysis identified a lack of capacity at the Caldor Pump Station in the future if the potential growth in the sewer service area was realized.

Furthermore, the capacity of the 12-inch sewer on South Candlewood Lake Road would need to be examined as part of a sewer extension design project. Available drawings indicate that the existing sewer on Candlewood Lake Road south of the Candlewood Lake Elementary School is PVC pipe at a minimum slope of 0.2 percent, although numerous segments downstream are at higher slopes. Assuming the pipe is in good condition, the estimated capacity of the limiting segments is approximately 1.2 million gallons per day (mgd). Based on the flows outlined in Section 2, flow from the peninsula and surrounding areas off Candlewood Lake Road is estimated to average approximately 215,000 gallons per day (gpd); peak flows would be in the range of 1 mgd. Existing flow in the pipe would need to be reviewed carefully if this project proceeds. It is likely that portions of the existing sewer on Candlewood Lake Road may need to be upsized or that a parallel pipe may be required to provide adequate capacity for the additional flow from this project area.

The current flows and timing of future developments in the sewershed for the Candlewood Lake Road sewer and the Caldor Pump Station need to be evaluated if the peninsula area sewer system project proceeds to final design.

Alternative locations for discharge and treatment are discussed in Section 6; however, the evaluation presented below is based on conveyance to the Caldor Pump Station and the Danbury WPCP.

5.4 Evaluation of Feasible Alternatives

This section describes numerous alternatives for providing sanitary sewer service on the Candlewood Peninsula and the adjacent areas, referred to as the Candlewood Lake Club and Northern Candlewood Lake Road Area (generally north of the peninsula), and the Southern Candlewood Lake Road and Pleasant Rise Area (generally south of the peninsula). A total of six alternatives were analyzed for providing sewer service to the project area including gravity sewer alternatives, grinder pump and low-pressure sewers, hybrid gravity and grinder pump systems, and an alternative to maintain and improve existing septic systems. These six options are discussed further in the following sections.

- Alternative A – Gravity Sewer System with Seven BWPCA Pump Stations
- Alternative B – Shallower Gravity System with Seven BWPCA Pump Stations
- Alternative C – Hybrid Sewer System with Five BWPCA Pump Stations
- Alternative D – Hybrid Sewer System with Three BWPCA Pump Stations
- Alternative E – Low-Pressure Sewer System
- Alternative F – Septic System Maintenance/Upgrades/Replacement

5.4.1 Alternative A – Gravity Sewer System with Limited Number of Private Grinder Pumps and Seven BWPCA Pump Stations

Alternative A (shown on overview **Figure 5-5**) consists of a gravity sanitary sewer system with less than 30 private grinder pumps on properties at the lowest elevations throughout the project areas. The majority of the proposed gravity sanitary sewer route has typical gravity sewer elevations of less than 15 feet deep, but given the elevation changes on the peninsula, this alternative has several areas with gravity sewer at depths greater than 25-feet, up to 35 feet deep. It is acknowledged that with sewers at this depth, constructability is a challenge and this alternative may not be feasible; however, it is included herein to show the extreme scenario maximizing gravity sewer connections, for comparison to other alternatives.

Conveyance out of the project area by gravity is not feasible, and pump stations will be required. The pump stations will receive gravity sanitary flow from the project area and ultimately flow to the existing Caldor Pump Station. A Summary of the pumps and piping is included in **Table 5-6** and the estimated costs are shown in Section 5.5.

Table 5-6 Sanitary Sewer Pipe and Pump Summary for Alternative A

Item	Total (Rounded)
Total Gravity Sewer Main (LF)	78,000
8-inch Gravity Sewer <10' Depth	*28,000*
8-inch Gravity Sewer 10'-15' Depth	*19,000*
8-inch Gravity Sewer 15'-20' Depth	*13,000*
8-inch Gravity Sewer 20'-25' Depth	*11,000*
8-inch Gravity Sewer >25' Depth	*7,000*
BWPCA Pump Stations (each)	7
± 4-inch Pump Station Force Main (LF)	18,000
Private Grinder Pumps (each)	30
± 2-inch Low Pressure Sewer Main (LF)	1,100

The layout of this alternative and the proposed location of the BWPCA pump stations and grinder pumps is shown on the concept design drawings included in **Appendix D**. Paragraphs 5.4.1.1 through 5.4.1.3 provide more detail on Gravity Sewer Alternative A for the different areas of the project.

5.4.1.1 Candlewood Peninsula

The topography of the peninsula is variable but generally slopes away from the center and downhill towards the Lake on all sides. There are several low elevation areas on the peninsula that control the depth of the gravity sewers. On the Candlewood Peninsula, Gravity Sewer Alternative A would require approximately 44,000 linear feet (LF) of 8-inch gravity sanitary sewer, four BWPCA pump stations, approximately 11,000 LF of 4-inch force main, an estimated 26 grinder pumps, and 1,100 LF of low-pressure sewers. The proposed gravity sewers on the peninsula range from approximately 8-35 feet deep in this Alternative. Preliminary locations for the proposed pump station have been sited around the low points to maximize the extent of gravity sewers and utilize the topography of the peninsula.

5.4.1.1.1 Candlewood Peninsula Pump Stations

Alternative A would require four BWPCA pump stations on the peninsula. The potential locations for the BWPCA pump stations have been preliminarily identified and are described below.

West Pump Station

In Alternative A, the West Pump Station would be located in the vicinity of 157 North Lake Shore Drive, near the intersection with South Lake Shore Drive and Beach Boulevard. This pump station would serve much of the northwestern portion of the peninsula, including portions of North Lake Shore Drive, South Lake Shore Drive, Mountain View Drive, Twilight View Drive, Skyline Drive, Dogwood Lane, Lilac Lane, Longview Drive, Berkshire Drive, and Bayview Drive. The parcel is a green space park property owned by the Candlewood Shores Tax District. It is at a relative low point in the system. The pump station would be located on the southwest corner of the property, away from the park amenities and the residents in an area that would be easily accessible for the BWPCA and the least disruptive to the residents.

South Pump Station

The South Pump Station on the peninsula would be in the Arrowhead Point neighborhood on the southern end of the peninsula. This would be a small pump station and would serve several streets in the southwestern corner of the peninsula, including portions of Arrowhead Road, Chester Street, Taylor Street, Willie Lane and Kellogg Street in Arrowhead Point. This pump station is proposed to be located on or near the tennis court parcel, which is owned by the Arrowhead Point Tennis Association. The pump station would be located close to the road in an area that would be easily accessible for the BWPCA and would not displace the tennis facilities.

Kellogg Pump Station

The Kellogg Pump Station is centrally located on the peninsula and would be located near the parcel at 3 Laurel Drive near the intersection with Kellogg Street. This pump station would be similar in size to the south pump station and serve much of the southwestern portion of the peninsula, including portions of Kellogg Street, Laurel Drive, Hickory Hill Road, Cipolla Lane, Cranberry Lane, and Lakeview Road. 3 Laurel Drive is a vacant property owned by the Aquarion Water Company of Connecticut. The property is at a relative low point in the system and is adjacent to 5 Berkshire Drive which is owned by the Candlewood Shores Tax District. The proposed Kellogg Pump Station is centrally located and as far away from residences as possible. This location would allow easy access for the BWPCA and maintenance staff.

Peninsula Pump Station

The proposed Peninsula Pump Station, the largest of the stations on the peninsula, would be located in the vicinity of 16 North Lake Shore Drive, on the east side of North Lake Shore Drive and north of the intersection with Candlewood Shores Road. This currently-undeveloped parcel is owned by the Candlewood Shores Tax District and is at a relative low point in the system. The parcel has area near the 440-foot elevation line on the south edge of the property that would reduce the overall depth of the proposed pump station, provide easy maintenance access from Candlewood Shores Road, and utilize a minimal amount of the parcel. This pump station would serve the northeastern portion of the peninsula, including portions of North Lake Shore Drive, Clearview Drive, Skyline Drive and Candlewood Shores Road. This pump station would also receive flow from the other pump stations on the peninsula before discharging to the gravity sewer system along Candlewood Lake Road. The pump station would be located close to the road in an area that would be easily accessible for the BWPCA and the least disruptive to the residents.

5.4.1.2 Candlewood Lake Club and Northern Candlewood Lake Road Area

The topography of the Candlewood Lake Club area slopes downhill west towards Candlewood Lake Road and south towards Cadigan Park. The areas south and west of Cadigan Park also slope downhill towards the park. This topography allows the Candlewood Lake Club area to be served by gravity sewers that are typically less than 15 feet deep with a short section of sewer that is between 15 feet and 20 feet deep. In the Candlewood Lake Club Area, Gravity Sewer Alternative A will require approximately 17,000 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, and approximately 3,700 LF of 4-inch force main.

5.4.1.2.1 Northern Candlewood Lake Area Pump Station

Alternative A would require one BWPCA pump station for the Candlewood Lake Club and Northern Candlewood Lake Road Area. The potential location for the BWPCA pump station has been preliminarily identified and is described below.

North Mountain Road Pump Station

The North Mountain Road pump station location would be near the intersection of North Mountain Road and Candlewood Lake Road, in the vicinity of Cadigan Park at 501 Candlewood Road. The property is currently owned by the Town of Brookfield and has several maintenance buildings and sports fields. This pump station would serve the Candlewood Lake Club area, the Town-owned buildings near the park, and the multi-family residential properties nearby. It can be located on the municipal property away from existing buildings and in an area that allows maintenance staff access to the pump station.

5.4.1.3 Southern Candlewood Lake Road and Pleasant Rise Area

The Pleasant Rise residential area has a high elevation ridge that runs north and south through the area of North Pleasant Rise, Candleview Road, Pleasant Rise, and Pleasant Rise Circle. There is a low elevation area on the cul-de-sac at the east end of Pleasant Rise that controls the depth of the gravity sewer. The intersection of Candlewood Lake Road and Main Street is the lowest point on Candlewood Lake Road south of the Peninsula and north of the Pleasant Rise area. In the Southern Candlewood Lake Road and Pleasant Rise Area, Gravity Sewer Alternative A will require approximately 17,000 LF of 8-inch gravity sanitary sewer, two BWPCA pump stations, and approximately 4,000 LF of 4-inch force main.

5.4.1.3.1 Southern Candlewood Lake Road and Pleasant Rise Area Pump Stations

Alternative A would require two BWPCA pump stations for the Southern Candlewood Lake Road and Pleasant Rise Area. The potential locations for the BWPCA pump stations have been preliminarily identified and are described below.

Candlewood Lake Road Pump Station

The central proposed Candlewood Lake Road pump station is in the vicinity of 263 Candlewood Lake Road. This property is at a low point of Candlewood Lake Road and would collect flows from the areas around the pump station and the flows from the pump stations on the peninsula. The currently vacant property is owned by the Town of Brookfield.

North Pleasant Rise Pump Station

The pleasant rise residential area has a proposed pump station that would be in the vicinity of 46 North Pleasant Rise near the dead-end road. The property is at a low point on the east side of the ridge that runs the length of the Pleasant Rise Community. The Town of Brookfield currently owns the parcel at 45 North Pleasant Rise on the dead-end road. The pump station would discharge to the gravity sewer on the west side of the ridge in Pleasant Rise.

5.4.2 Alternative B – Shallower Gravity Sewer System with Seven BWPCA Pump Stations

Alternative B (shown on overview **Figure 5-6**) replaces the gravity lateral connection for numerous lower-elevation homes with grinder pumps to reduce the overall depth of the gravity sewers in the project areas. This alternative would have approximately 200 grinder pumps to accomplish this depth reduction. The majority of the added grinder pumps are along the shores of the Peninsula for low-lying properties along North Lake Shore Drive, South Lake Shore Drive, and Lakeview Road; much of the remaining gravity sanitary sewer route is maintained and includes grinder pumps at intermittent low points to raise the elevation of the sewer by 10 to 15 feet in areas to increase the constructability of the project and reduce the overall construction costs, although portions of sewer greater than 25 deep remain. Alternative B includes seven pump stations in the same locations as Alternative A; the stations will receive gravity sanitary flow from the project area and ultimately flow to the existing Caldor Pump Station. A Summary of the pumps and piping is included in **Table 5-7** and the estimated costs are presented in Section 5.5.

Table 5-7 Sanitary Sewer Pipe and Pump Summary for Alternative B

Item	Total (Rounded)
Total Gravity Sewer Main (LF)	78,000
8-inch Gravity Sewer <10' Depth	*28,000*
8-inch Gravity Sewer 10'-15' Depth	*19,000*
8-inch Gravity Sewer 15'-20' Depth	*29,000*
8-inch Gravity Sewer 20'-25' Depth	*2,000*
8-inch Gravity Sewer >25' Depth	*0*
BWPCA Pump Stations (each)	7
± 4-inch Pump Station Force Main (LF)	18,000
Private Grinder Pumps (each)	200
± 2-inch Low Pressure Sewer Main (LF)	1,200

Paragraphs 5.4.2.1 through 5.4.2.3 provide more detail on Gravity Sewer Alternative B for the different areas of the project.

5.4.2.1 Candlewood Peninsula

As noted above, the topography of the peninsula is variable but generally slopes away from the center and downhill towards the Lake on all sides; low elevation areas control the depth of the gravity sewers. On the Candlewood Peninsula, Gravity Sewer Alternative B will require approximately 43,000 LF of 8-inch gravity sanitary sewer, four BWPCA pump stations, approximately 10,000 LF of 4-inch force main, an estimated 200 grinder pumps, and 1,200 LF of 2-inch low pressure sewers.

The proposed gravity sewers on the peninsula range from approximately 8-25 feet deep in this Alternative.

5.4.2.1.1 Candlewood Peninsula Pump Stations

Alternative B would require the same four BWPCA pump stations on the peninsula as Alternative A – the West Pump Station on North Lake Shore Drive, South Pump Station in Arrowhead Point, Kellogg Pump Station on Laurel Drive, and the larger Peninsula Pump Station on North Lake Shore Drive. Refer to Section 5.4.1.1.1 above for more detail on each station.

5.4.2.2 Candlewood Lake Club and Northern Candlewood Lake Road Area

As noted above, the topography of Candlewood Lake Club and Northern Candlewood Lake Road Area slopes downhill west towards Candlewood Lake Road and south towards Cadigan Park. The areas south and west of Cadigan Park also slope downhill towards the park. This topography allows the Candlewood Lake Club area to be served by gravity sewers that are typically less than 15 feet deep with a short section of sewer that is between 15 feet and 20 feet deep. In the Candlewood Lake Club Area, Gravity Sewer Alternative B is the same as for Alternative A, requiring approximately 17,000 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, and approximately 3,700 LF of 4-inch force main.

5.4.2.2.1 Northern Candlewood Lake Area Pump Station

Alternative B would require the North Mountain Road Pump Station to serve the Candlewood Lake Club and the surrounding areas, as with Alternative A. Refer to Section 5.4.1.2.1 above for more detail on the station.

5.4.2.3 Southern Candlewood Lake Road and Pleasant Rise Area

As noted above, the Pleasant Rise residential area has a high elevation ridge that runs north-south through the area of North Pleasant Rise, Horseshoe Drive, Candleview Road, Pleasant Rise, and Pleasant Rise Circle. There is a low elevation area on the cul-de-sac at the east end of Pleasant Rise that controls the depth of the gravity sewer. The intersection of Candlewood Lake Road and Main Street is the lowest point on Candlewood Lake Road south of the Peninsula and north of the Pleasant Rise area. In the Southern Candlewood Lake Road and Pleasant Rise Area, Gravity Sewer Alternative B is the same as Alternative A, and would require approximately 17,000 LF of 8-inch gravity sanitary sewer, two BWPCA pump stations, and approximately 4,000 LF of 4-inch force main.

5.4.2.3.1 Southern Candlewood Lake Road and Pleasant Rise Area Pump Stations

Alternative B would require the same two BWPCA pump stations for the Southern Candlewood Lake Road and Pleasant Rise Area as Alternative A, the Candlewood Lake Road Pump Station in the vicinity of 263 Candlewood Lake Road and the North Pleasant Rise Pump Station in the vicinity of 46 North Pleasant Rise. Refer to Section 5.4.1.3.1 above for more detail on each station.

5.4.3 Alternative C – Hybrid Collection System with Five BWPCA Pump Stations

Alternative C (shown on overview **Figure 5-7**) replaces sections of deep gravity sewer with low-pressure sewer and approximately 370 grinder pumps. The increase in grinder pumps would also eliminate two pump stations in this alternative. This results in gravity sewer depths generally less than 15 feet. The low-pressure sewer system would be installed at approximately 5 feet below ground surface. The pump stations will receive gravity sanitary flow from the system and pump to the existing sewer system and the Caldor Road Pump Station. A Summary of the pumps and piping is included in **Table 5-8** and the estimated costs are shown in Section 5.5.

Table 5-8 Sanitary Sewer Pipe and Pump Summary for Alternative C

Item	Total (Rounded)
Total Gravity Sewer Main (LF)	55,000
8-inch Gravity Sewer <10' Depth	*38,000*
8-inch Gravity Sewer 10'-15' Depth	*11,000*
8-inch Gravity Sewer 15'-20' Depth	*4,000*
8-inch Gravity Sewer 20'-25' Depth	*2,000*
8-inch Gravity Sewer >25' Depth	*0*
BWPCA Pump Stations (each)	5
± 4-inch Pump Station Force Main (LF)	17,000
Private Grinder Pumps (each)	370
± 2-inch Low Pressure Sewer Main (LF)	25,000

Paragraphs 5.4.3.1 through 5.4.3.3 provide more detail on Hybrid Alternative C for the different areas of the project.

5.4.3.1 Candlewood Peninsula

On the Candlewood Peninsula, Gravity Sewer Alternative C will require approximately 33,000 LF of 8-inch gravity sanitary sewer, three BWPCA pump stations, approximately 10,000 LF of 4-inch force main, 285 grinder pumps, and 14,000 LF of low-pressure sewers. Alternative C eliminates the South Pump Station on the Peninsula (that was required in Alternatives A and B), and most of the Arrowhead Point area would be served with private grinder pumps and low-pressure sewers.

5.4.3.1.1 Candlewood Peninsula Pump Stations

Alternative C would require three BWPCA pump stations on the peninsula– the West Pump Station on North Lake Shore Drive, Kellogg Pump Station on Laurel Drive, and the larger Peninsula Pump Station on North Lake Shore Drive. Refer to Section 5.4.1.1.1 above for more detail on each station.

5.4.3.2 Candlewood Lake Club and Northern Candlewood Lake Road Area

As noted above, the topography of Candlewood Lake Club and Northern Candlewood Lake Road Area slopes downhill west towards Candlewood Lake Road and south towards Cadigan Park. The areas south and west of Cadigan Park also slope downhill towards the park. This topography allows the Candlewood Lake Club area to be served by gravity sewers that are typically less than 15 feet deep with a short section of sewer that is between 15 feet and 20 feet deep. In the Candlewood Lake Club Area, Gravity Sewer Alternative C is the same as for Alternatives A and B, requiring approximately 17,000 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, and approximately 3,700 LF of 4-inch force main.

5.4.3.2.1 Northern Candlewood Lake Area Pump Station

Alternative C would require the North Mountain Road Pump Station to serve the Candlewood Lake Club and the surrounding areas, as with Alternatives A and B. Refer to Section 5.4.1.2.1 above for more detail on the station.

5.4.3.3 Southern Candlewood Lake Road and Pleasant Rise Area

As noted above, the Pleasant Rise residential area has a high elevation ridge that runs north-south through the area of North Pleasant Rise, Horseshoe Drive, Candleview Road, Pleasant Rise, and Pleasant Rise Circle. There is a low elevation area on the cul-de-sac at the east end of Pleasant Rise. The intersection of Candlewood Lake Road and Main Street is the lowest point on Candlewood Lake Road south of the Peninsula and north of the Pleasant Rise area. In the Southern Candlewood Lake Road and Pleasant Rise Area, Alternative C will require approximately 5,400 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, approximately 3,000 LF of 4-inch force main, 85 grinder pumps, and 12,000 LF of low-pressure sewer. This alternative eliminates the need for the North Pleasant Rise Pump Station by replacing the properties east of the high-elevation ridge that divides the area with grinder pumps and low-pressure sewer that would discharge into the gravity sanitary sewer system that flows west towards Candlewood Lake Road.

5.4.2.3.1 Southern Candlewood Lake Road and Pleasant Rise Area Pump Station

Alternative C would require one BWPCA pump station, the Candlewood Lake Road Pump Station in the vicinity of 263 Candlewood Lake Road, discussed in Section 5.4.1.3.1 above.

5.4.4 Alternative D – Hybrid Collection System with Three BWPCA Pump Stations

Alternative D further reduces the total number of BWPCA pump stations required with the addition of approximately 180 more grinder pumps and areas of low-pressure sewer. In this alternative, the vast majority of gravity sewer would be less than 15 feet deep. The low-pressure sewer system would be installed at approximately 5 feet below ground surface. This alternative would eliminate or combine the remaining pump stations into three regional pump stations: one on the peninsula, one at North Mountain Road south of Candlewood Lake Club, and one on Candlewood Lake Road north of Pleasant Rise. The pump stations would receive gravity sanitary flow from the system and pump to the existing sewer system and the Caldor Road Pump Station. A Summary of the pumps and piping is included in **Table 5-9** and the estimated costs are presented in Section 5.5.

Table 5-9 Sanitary Sewer Pipe and Pump Summary for Alternative D

Item	Total (Rounded)
Total Gravity Sewer Main (LF)	40,000
8-inch Gravity Sewer <10' Depth	*28,000*
8-inch Gravity Sewer 10'-15' Depth	*6,000*
8-inch Gravity Sewer 15'-20' Depth	*4,000*
8-inch Gravity Sewer 20'-25' Depth	*2,000*
8-inch Gravity Sewer >25' Depth	*0*
BWPCA Pump Stations (each)	3
± 4-inch Pump Station Force Main (LF)	12,000
Private Grinder Pumps (each)	550
± 2-inch Low Pressure Sewer Main (LF)	39,000

Paragraphs 5.4.4.1 through 5.4.4.3 provide more detail on Hybrid Alternative D for the different areas of the project.

5.4.4.1 Candlewood Peninsula

On the Candlewood Peninsula, Gravity Sewer Alternative D will require approximately 18,000 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, approximately 5,600 LF of 4-inch force main, 460 grinder pumps, and 27,000 LF of low-pressure sewer. Alternative D eliminates the South Pump Station, Kellogg Pump Station, and Peninsula Pump Station that were required in earlier Alternatives. Most of the Arrowhead Point area, Hickory Hill, Candlewood Orchards, and the northeastern portion of the peninsula would be served with private grinder pumps and low-pressure sewers. The remaining gravity sewer areas on the peninsula are in the central and western portion of the peninsula, west and north of The Kellogg Street and Bayview Drive intersection and west of Clearview Drive. South Lake Shore Drive has a low point at the southern end that controls the depth of the gravity sewer, but all gravity sewers on the peninsula would be less than 15 feet deep in Alternative D.

5.4.4.1.1 Candlewood Peninsula Pump Station

Alternative D would require only one pump station on the peninsula- the West Pump Station as described in Section 5.4.1.1.1 above. This station would serve all gravity sewers on the peninsula.

5.4.4.2 Candlewood Lake Club and Northern Candlewood Lake Road Area

In the Candlewood Lake Club Area and northern Candlewood Lake Road area, Gravity Sewer Alternative D will require approximately 17,000 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, and approximately 3,700 LF of 4-inch force main. The gravity sewer for the Candlewood Lake Club and Northern Candlewood Lake Road Areas are the same as the previous Alternatives, with the addition of approximately 12 grinder pumps on the west side of Candlewood Lake Road to reduce the depth of gravity sewer in this area.

5.4.4.2.1 Northern Candlewood Lake Area Pump Station

Alternative D would require the North Mountain Road Pump Station to serve the Candlewood Lake Club and the surrounding areas, as with prior Alternatives. Refer to Section 5.4.1.2.1 above for more detail on the station.

5.4.4.3 Southern Candlewood Lake Road and Pleasant Rise Area

As noted above, the Pleasant Rise residential area has a high elevation ridge that runs north-south through the area of North Pleasant Rise, Horseshoe Drive, Candleview Road, Pleasant Rise, and Pleasant Rise Circle. There is a low elevation area on the cul-de-sac at the east end of Pleasant Rise. The intersection of Candlewood Lake Road and Main Street is the lowest point on Candlewood Lake Road south of the Peninsula and north of the Pleasant Rise area. In the Southern Candlewood Lake Road and Pleasant Rise Area, Alternative D is the same as Alternative C, eliminating the need for the North Pleasant Rise Pump Station by replacing the properties east of the high-elevation ridge that divides the area with grinder pumps and low-pressure sewer that would discharge into the gravity sanitary sewer system that flows west towards Candlewood Lake Road. In the Pleasant Rise area, Alternative D will require approximately 5,400 LF of 8-inch gravity sanitary sewer, one BWPCA pump station, approximately 3,000 LF of 4-inch force main, 87 grinder pumps, and 12,000 LF of low-pressure sewer.

5.4.4.3.1 Southern Candlewood Lake Road and Pleasant Rise Area Pump Station

As with Alternative C, Alternative D would require one BWPCA pump station in the Southern Candlewood Lake Road Area. This is the Candlewood Lake Road Pump Station in the vicinity of 263 Candlewood Lake Road, discussed in Section 5.4.1.3.1 above.

5.4.5 Alternative E – Low Pressure Sewer System with Private Grinder Pumps

Alternative E would serve the entire project area with private grinder pumps and low-pressure sewers. The low-pressure sewer system would be installed at approximately 5 feet below ground surface and would ultimately discharge to the existing gravity sewer system and the Caldor Road Pump Station.

The furthest property is approximately three miles away from the existing gravity sewer south of the Pleasant Rise area. As such, the low-pressure sewer alternative would require one BWPA booster pump station to collect the combined flow from the low-pressure sewers in the peninsula and northern Candlewood Lake Road area to convey it to the existing gravity sanitary sewer. The properties in Pleasant Rise and near the existing gravity sewer would be routed in a low-pressure sewer directly to the existing gravity sewer.

This alternative would include approximately 1,000 to 1,100 grinder pumps (one on each developed property), 79,000 LF of 2- to 4-inch low-pressure force main, one BWPCA pumping station, and 9,100 LF of 4-inch force main. The full pressure sewer alternative is shown on the concept design drawings included in **Appendix D.** A Summary of the pumps and piping is included in **Table 5-10** and the estimated costs are presented in Section 5.5.

Table 5-10 Sanitary Sewer Pipe and Pump Summary for Alternative E

Item	Total (Rounded)
Total Gravity Sewer Main (LF)	0
8-inch Gravity Sewer <10' Depth	*0*
8-inch Gravity Sewer 10'-15' Depth	*0*
8-inch Gravity Sewer 15'-20' Depth	*0*
8-inch Gravity Sewer 20'-25' Depth	*0*
8-inch Gravity Sewer >25' Depth	*0*
BWPCA Pump Stations (each)	1
± 4-inch Pump Station Force Main (LF)	9,100
Private Grinder Pumps (each)	1,100
± 2- to 4-inch Low Pressure Sewer Main (LF)	79,000

The layout of this alternative and the proposed location of the BWPCA pump station and grinder pumps are shown on the concept design drawings included in **Appendix D**. Paragraphs 5.4.5.1 through 5.4.5.3 provide more detail on the Low Pressure Sewer and Grinder Pumps for the different areas of the project.

5.4.5.1 Candlewood Peninsula

On the peninsula, Alternative E will require approximately 800 grinder pumps, 45,000 LF of low-pressure sewer, one BWPCA pump station, and approximately 9,100 LF of 4-inch force main.

5.4.5.1.1 Candlewood Peninsula Pump Stations

Alternative E would require a regional BWPCA pump station on the peninsula. The Peninsula Pump Station is preliminarily sited in the vicinity of 16 North Lake Shore Drive, on the east side of North Lake Shore Drive and north of the intersection with Candlewood Shores Road. This currently undeveloped parcel is owned by the Candlewood Shores Tax District and is the same location as proposed in some prior Alternatives.

5.4.5.2 Candlewood Lake Club and Northern Candlewood Lake Road Area

In the Candlewood Lake Club Area, low-pressure sewer Alternative E will require approximately 150 grinder pumps and 17,000 LF of low-pressure sewer; no pump station would be required in the Northern Candlewood Lake Road area.

5.4.5.3 Southern Candlewood Lake Road and Pleasant Rise Area

In the Southern Candlewood Lake Road and Pleasant Rise Area, low-pressure sewer Alternative E will require approximately 150 grinder pump stations and approximately 17,000 LF of low-pressure sewer; no pump station would be required in the Southern Candlewood Lake Road area.

5.4.6 Alternative F – Septic System Rehabilitation/Replacement

The project area faces many challenges for septic systems. Portions of some parcels are within the 500-year floodplain and/or the 100-year floodplain according to FEMA mapping. Many parcels also face issues due to small lot sizes and the presence of wetlands. Furthermore, community wells provide water supply for portions of the peninsula.

The National Resources Conservation Service (NRCS) characterizes soils by slope, percolation, depth to groundwater, depth to bedrock, and flooding. These criteria are combined to assess the ability to support a typical subsurface disposal system, defined as being for a single family, 4-bedroom home on a 1-acre lot with a private well, or a ½-acre lot with public water supply. Portions of the Candlewood Peninsula and Candlewood Lake Road project areas are rated by NRCS as having low, very low, or extremely low potential for subsurface sewage disposal; large portions are not rated. Based on the Connecticut Environmental Conditions Online (accessed through www.cteco.uconn.edu):

- Low potential soils are defined as having "one or more limitations, such as low percolation rate and depth to seasonal highwater table, that require extensive design and site preparation to overcome".
- Very low potential soils are defined as having "major soil limitations, such as depth to bedrock, that require extensive design and site preparation. A permit for a Subsurface Disposal System (SSDS) may not be issued unless the naturally occurring soils meet the minimal requirements outlined in the state health code. It is unlikely that these soils can be improved sufficiently to meet state health code regulations."
- Extremely low potential soils are defined as having "multiple major limitations, such as flooding and depth to seasonal high water table, which are extremely difficult to overcome. A permit for a Subsurface Disposal System (SSDS) may not be issued unless the naturally occurring soils meet the minimal requirements outlined in the state health code. It is unlikely that these soils can be improved sufficiently to meet state health code regulations."
- Soils that are not rated "have characteristics that show extreme variability from one location to another. The work required to overcome adverse soil properties cannot be estimated. Often these areas are urban land complexes… onsite investigation is required to determine soil conditions present at the site."

Portions of the Candlewood Peninsula and Candlewood Lake Road Areas are mapped as having soils of concern in relation to continued use of onsite subsurface sewage disposal systems.

Furthermore, as noted in Section 5.2 above, during the geotechnical exploration program in 2022, groundwater and rock were encountered in some locations at less than 5 feet below grade, and at numerous locations at less than 10 feet below grade. Shallow groundwater and rock with minimal unsaturated soil hinder natural wastewater renovation from septic systems and is consistent with the low potential soil descriptions above.

Throughout the study areas, properties average approximately 3 bedrooms per home. The average lot size on the peninsula is 0.3 acres. Properties in the Candlewood Lake Club average 0.4 acres, and properties average greater than 0.5 acres in the Pleasant Rise and Candlewood Lake Roads area. As noted in Section 1, a density of greater than 6 bedrooms per acre (or 3 bedrooms in areas where lots are smaller than 0.5 acres) is of concern to CT DPH for potentially adversely affecting groundwater quality. As such, density is of particular concern on the Peninsula and in the Candlewood Lake Club areas.

Additionally, as noted in Section 1, based on a review of the Brookfield Board of Health septic system data online, there is information on approximately 58 percent of properties in the Candlewood Peninsula and Candlewood Lake Road Area, and approximately 35 percent have septic age information available. Of the properties with information available:

- Average system age is 25 years
- 60 percent have septic systems greater than 20 years old, 30 percent have septic systems greater than 30 years old, and 13 percent have septic systems greater than 40 years old

Additionally, the greater than 60 percent of the properties in the two areas with no age information available may be of concern. It appears that numerous properties in the area, that were generally constructed in the 1950s and 1960s, may still have their original septic systems; those systems are well beyond their expected useful life and are likely to require replacement in the near future.

5.4.6.1 Septic Inspection Program

As noted in Section 3, for this alternative to be successful, additional research on the existing septic systems, soil conditions and groundwater would be required. If this alternative is pursued, it is recommended that a systematic program of septic system inspections and improvements is undertaken to ensure that septic systems are properly maintained and functioning as well as possible on each property.

This program would include a complete physical inspection of all septic systems and more comprehensive geotechnical analysis of the soils on each lot. Alternative F would require an initial inspection and review of all septic systems to get a baseline of the area's septic systems. Each septic system will also require routine inspection every five years that would entail a review of the existing records with a certified inspector. The review would include the following at a minimum:

- Visual confirmation that the septic system is functioning properly
- Visual inspection of the septic system and installation area for damage and breakouts
- Review of the existing septic system records and size for compliance with current Public Health Code regulations.

Residences that have lot sizes large enough for code compliant septic with appropriate soil conditions can replace damaged or failed septic systems, including tanks and leaching fields. Residences that have poor soil conditions would require mounded, elevated above the groundwater, or advanced treatment solutions (though it is noted that advanced treatment solutions may not be permissible for private residential parcels per CT DEEP). Individual homeowners would be responsible for the costs of improvements. It is expected that an inspection program would trigger replacement of some systems earlier than homeowners would make this investment in the absence of a program.

It is estimated that approximately 3 percent of septic systems in the project area may require replacement each year; this is consistent with typical industry expectations that a reasonable septic system life is in the range of 30 years.

This program would have to be defined by the Town Board of Health in conjunction with the BWPCA, but a reasonable starting point would be to have each system professionally inspected every five years. The cost of a program would likely be borne by each individual homeowner.

5.5 Summary of Alternatives and Cost Analysis

Capital and life cycle costs have been developed for each of the six alternatives described above.

5.5.1 Capital Cost Summary of Feasible Alternatives

Using the concept design drawings and figures for the various alternatives, approximate quantities of major system components were determined. The approximated quantities for all alternatives were used in combination with unit prices provided by CDM Smith’s professional cost estimators to create an Opinion of Probable Construction Cost (OPCC). The OPCC includes contractor general conditions of the contract, overhead and profit, and construction estimating contingency. Additionally, to arrive at an overall Project Cost overall project costs that need to be budgeted for by the BWPCA including escalation, engineering and implementation costs, and project contingency are included in the total planning-level figures presented below. **Table 5-11** summarizes the key features and Total Estimated Project Costs for both sewer extension alternatives.

Table 5-11 Candlewood Area - Sewering Alternatives Project Cost Summary

Summary of Alternative		Total Estimated Project Cost (rounded) [1]
Alternative A – Gravity Sewer System with Seven BWPCA Pump Stations		$90 - $95+ million
± 8-inch Gravity Sewer Main	78,000 LF	
BWPCA Pump Stations	7	
± 4-inch Pump Station Force Main	18,000 LF	
Private Grinder Pumps	30	
± 2-inch Low Pressure Sewer Main	1,100	
Alternative B – Shallower Gravity System with Seven BWPCA Pump Stations		$85 - $90 million
± 8-inch Gravity Sewer Main	78,000 LF	
BWPCA Pump Stations	7	
± 4-inch Pump Station Force Main	18,000 LF	
Individual Grinder Pumps	200	
± 2-inch Low Pressure Sewer Main	1,200	
Alternative C – Hybrid Sewer System with Five BWPCA Pump Stations		$ 65 - $70 million
± 8-inch Gravity Sewer Main	55,000 LF	
BWPCA Pump Stations	5	
± 4-inch Pump Station Force Main	17,000 LF	
Individual Grinder Pumps	370	
± 2-inch Low Pressure Sewer Main	25,000	
Alternative D – Hybrid Sewer System with Three BWPCA Pump Stations		$60 - $65 million
± 8-inch Gravity Sewer Main	40,000 LF	
BWPCA Pump Stations	3	
± 4-inch Pump Station Force Main	12,000 LF	
Individual Grinder Pumps	550	
± 2-inch Low Pressure Sewer Main	39,000	
Alternative E – Low-Pressure Sewer System		$55 - $60 million
± 8-inch Gravity Sewer Main	0 LF	
BWPCA Pump Stations	1	
± 4-inch Pump Station Force Main	9,100 LF	
Individual Grinder Pumps	1,100	
± 2-inch Low Pressure Sewer Main	79,000	

Project cost estimating notes are detailed further in **Appendix E** and summary of major items are below:

- Total Project Costs for all Items include Engineer's Opinion of Probable Construction Cost including contractor labor, equipment, materials, general conditions, overhead & profit, construction contingency, plus Project Costs including engineering and implementation, project contingency, and escalation to 2026.
- Costs include service connections from the gravity sewer main to the property line. Service connection work on private property is not included in the project costs and would be the responsibility of the individual homeowners.

- Grinder pump costs include purchase of one pump per residence; installation and work on private property is not included.
- Pavement restoration is assumed to be an average of 8 feet wide for all gravity sewer and force main work, with force main in the same trench for the gravity sewer option. For low-pressure sewer, pavement is assumed to be 4 feet wide. For the full low-pressure sewer option in the Candlewood area, particularly on the peninsula, the low-pressure sewer may also be located in the pavement and an 8-foot-wide trench is also assumed. For smaller areas of low-pressure sewer, paving will be required where service connections need to cross the street to the opposite property line.

For Alternative F, Septic System Rehabilitation/Replacement, all costs would be borne by homeowners and there would not be a capital project undertaken by the BWPCA, so that option is not included in Table 5-11. However, this option has significant long-term costs to be borne by homeowners, and those are further explored in the life cycle cost analysis presented in Section 5.5.2 below.

5.5.2 Life Cycle Cost Effectiveness

To compare the full cost of the three alternatives, a 50-year life cycle cost analysis calculation was performed. This interval was chosen based on the varied equipment life of the proposed alternatives.

The life cycle costs for the system includes the capital construction project costs, periodic replacement of equipment, and recurring costs such as electrical usage, septic tank pumping costs and sewer user fees over a 50-year period. A present worth analysis was conducted to compare the alternatives presented above. This is a relative analysis designed to present the equalized costs over the life of the alternatives. This analysis was intended to compare the major capital and equipment costs and may not include all minor maintenance costs.

The life cycle analysis costs include both the residents' costs and the BWPCA costs combined. A summary of the life cycle cost analysis is included in **Table 5-12** and includes the following assumptions:

1. The gravity sewer system has an expected life cycle of greater than 50 years for pipes, manholes and force mains, with major pump station equipment replacements every 20 years. Pipes will have some remaining life at the end of this analysis period, but this salvage value is not quantified as a credit herein.
2. The grinder pumps have a shorter life cycle with grinder pump replacement approximately every 15 years. Low pressure sewer main pipes are expected to have a life cycle of greater than 50 years, similar to gravity sewers; the pipes will have some remaining life at the end of this life cycle analysis, but this salvage value is not quantified as a credit herein.
3. The available data and typical industry expectations suggest that septic systems in this area have a typical life cycle between 30 and 40 years; this equates to approximately 3

percent of systems requiring replacement each year. With the shallow groundwater throughout much of the project area, it is expected that many systems may require mounding to improve performance and reliability. An estimated cost of $35,000 (in today's dollars) is assumed for each septic system replacement.

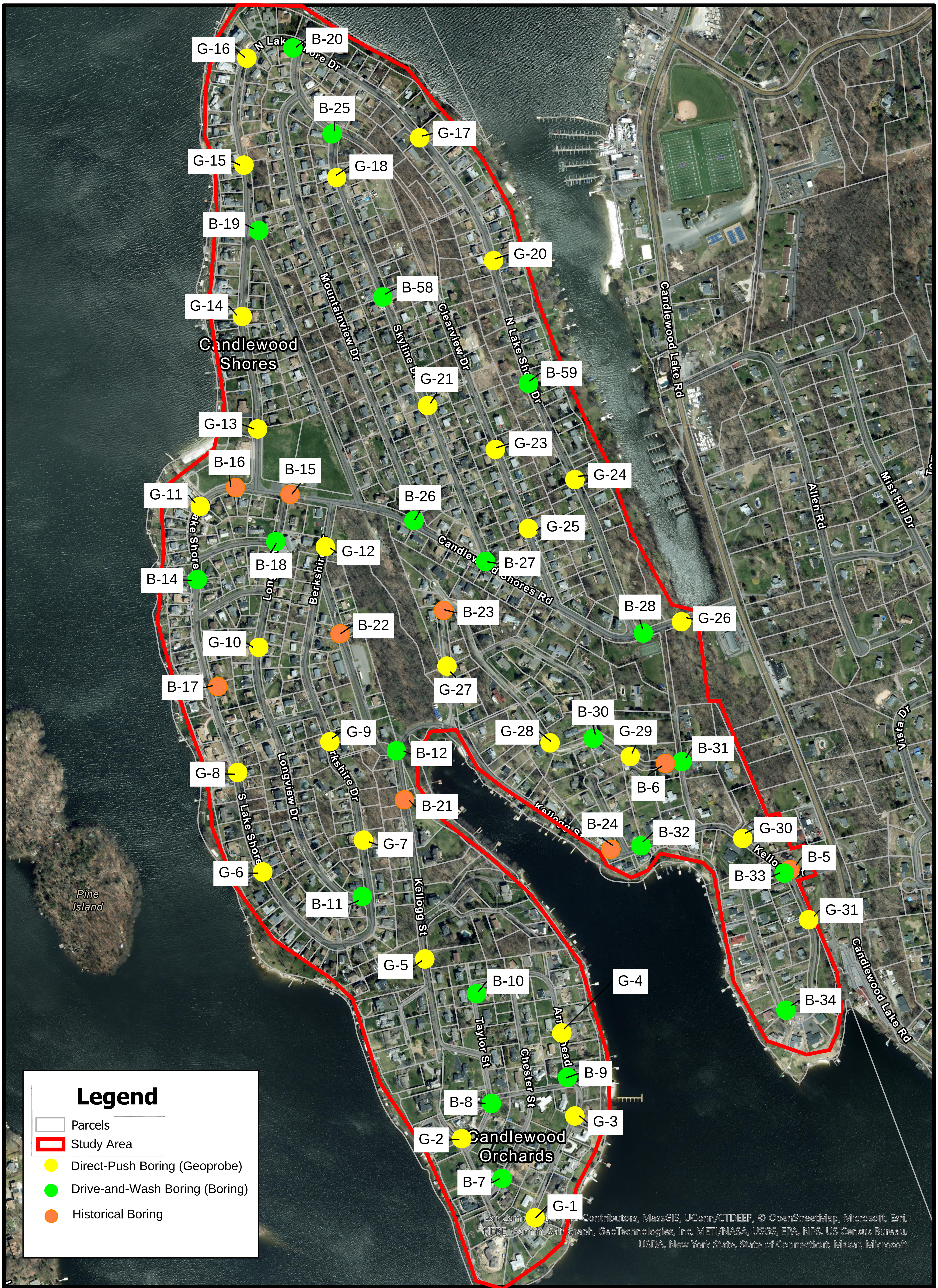
4. Annual escalation of 4 percent over the planning period is assumed;
5. The USEPA 2023 discount rate of 2.5-percent was used;
6. Salvage values of equipment are assumed to be zero;
7. For the septic option, an estimated $400 every three years for septic tank pumping and $600 every five years for the septic inspection program is carried;
8. For the sewer options, a sewer user bill of $520 per year is carried, as is an average allowance of $10,000 per property for each homeowner to connect to the system;
9. Utility Power Costs are estimated at $0.25/kWh;
10. A sewer extension project would be eligible for a 20 percent grant through the Connecticut Clean Water Fund; septic tank replacement would not be.

Table 5-12 Candlewood Area - 50-Year Life Cycle Cost Summary of Alternatives

Alternative	Estimated Initial Project Capital Cost ($) (after 20% CWF Grant)	50 Year Estimated Life Cycle Cost	Approximate Annual Cost, $/year per property
Alternative A – Gravity Sewer System with Seven BWPCA Pump Stations	$75 million	$130 million	$2,400
Alternative B – Shallower Gravity System with Seven BWPCA Pump Stations	$69 million	$130 million	$2,400
Alternative C – Hybrid Sewer System with Five BWPCA Pump Stations	$55 million	$120 million	$2,200
Alternative D – Hybrid Sewer System with Three BWPCA Pump Stations	$49 million	$120 million	$2,200
Alternative E – Low-Pressure Sewer System	$45 million	$130 million	$2,400
Alternative F – Septic System Replacement	n/a	$110 million	$2,000

This life cycle cost analysis shows that gravity options with the highest initial capital costs ultimately have similar life-cycle costs to the hybrid and low-pressure options due to the higher operational costs of pressure sewers. The 50-year life cycle cost of all sewering options are within less than 10 percent of each other. The septic system replacement alternative has no initial capital project cost for the BWPCA and appears to have the lowest life cycle cost for these project areas. However, the actual costs to each homeowner would be variable depending on actual septic system replacement costs on each property; as discussed herein, physical limitations such as poor soils and density of development would not be easily solved with the septic system replacement option.

This analysis assumes a 20 percent CWF grant on the initial project construction costs. Any additional grants, such as a higher CWF grant percentage or other funding sources that can be applied to the project would further improve the life cycle cost analysis in favor of the sewering options because grants would be applied to the initial capital costs. Long-term operational costs and septic programs are not likely to be reduced with grant funding. Funding and implementation considerations are discussed further in Section 7.



0 500 1,000
Feet

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CDM Smith

Figure 5-1

Candlewood Peninsula Study Area; Subsurface Investigation Locations

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023

0 500 1,000 Feet

N

CDM Smith

Figure 5-2

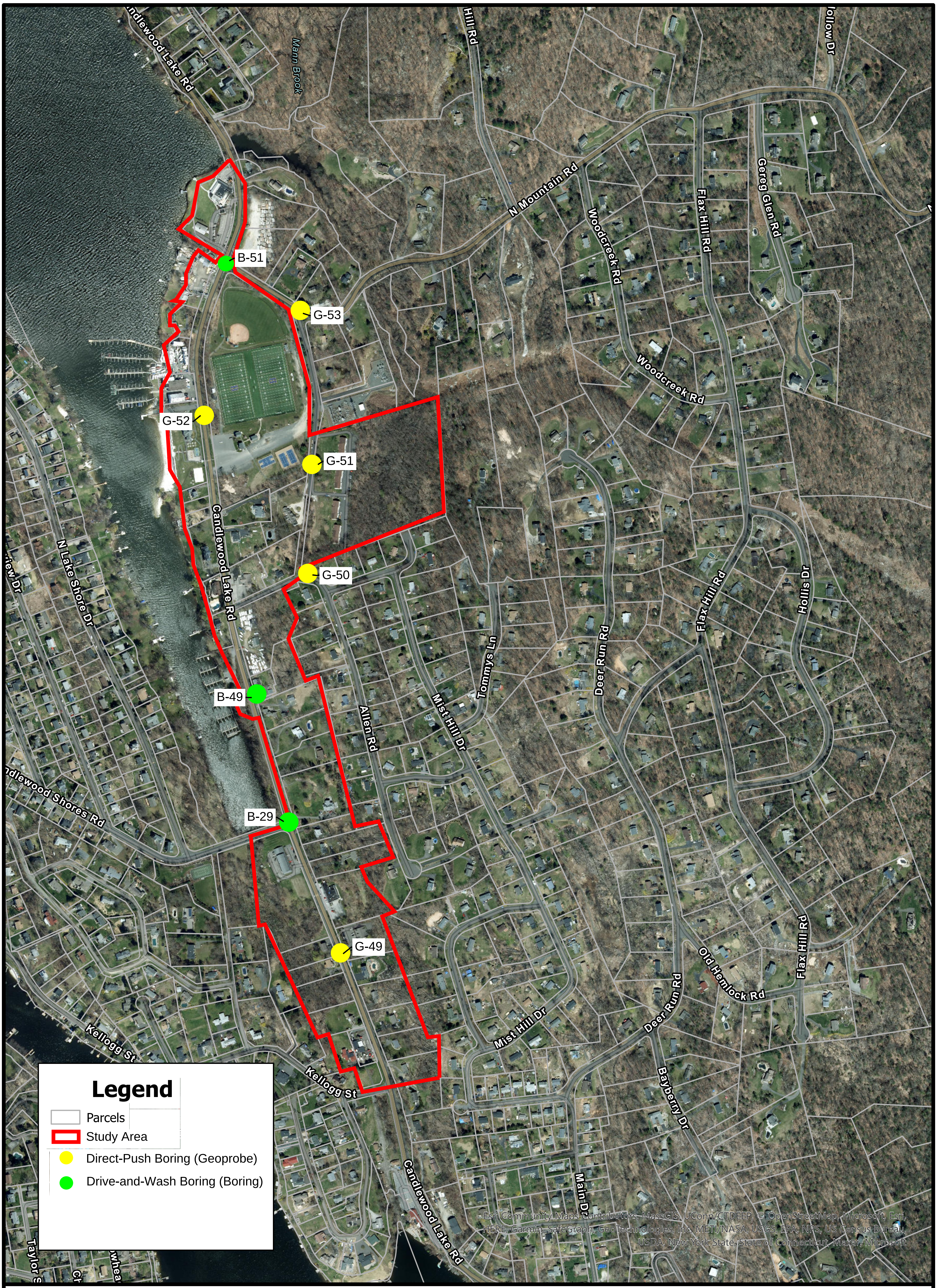
Candlewood Lake Club Study Area; Subsurface Investigation Locations

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023



0 500 1,000 Feet

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Figure 5-3

Northern Candlewood Lake Road Study Area; Subsurface Investigation Locations

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023

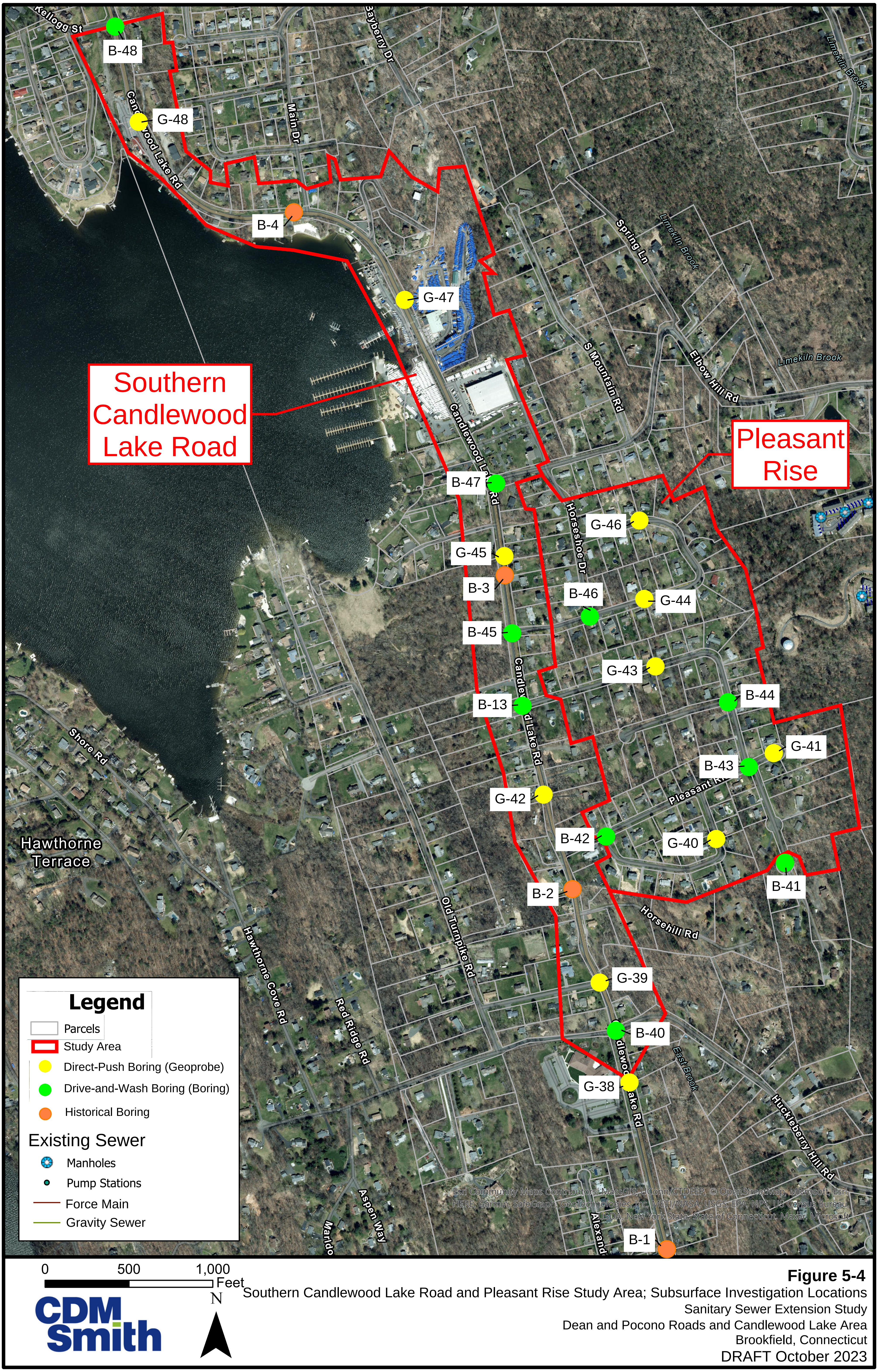

Figure 5-4

Southern Candlewood Lake Road and Pleasant Rise Study Area; Subsurface Investigation Locations

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

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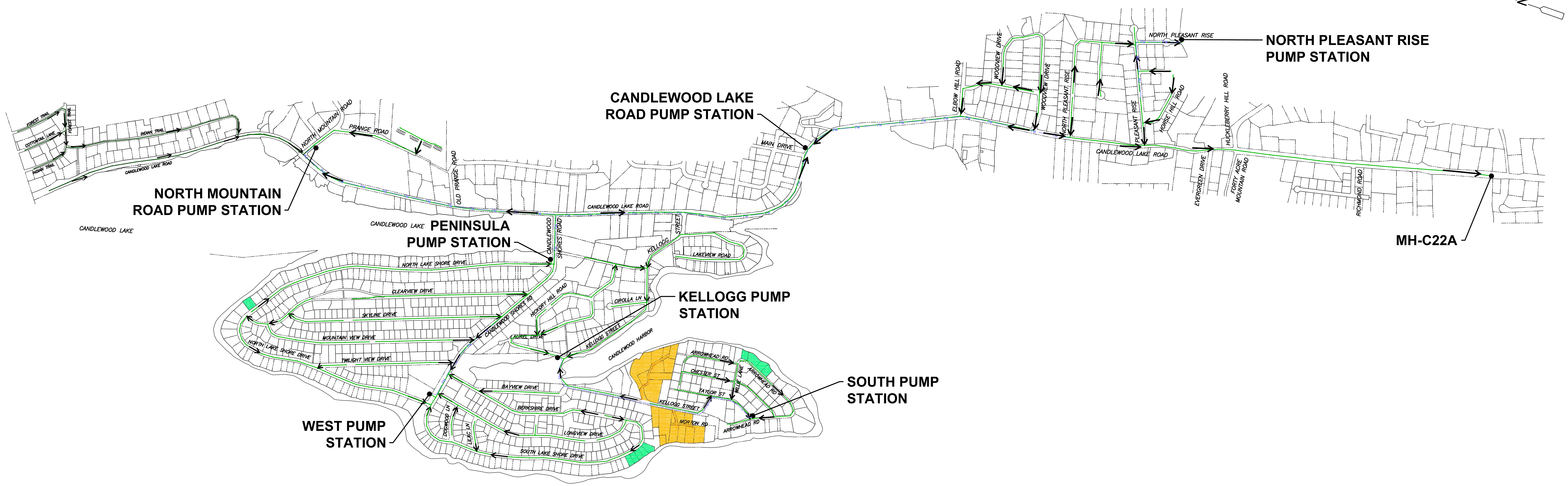

PLAN
1"=600'

GRAVITY SEWER CONNECTION
GRINDER PUMP WITH GRAVITY SEWER CONNECTION
GRINDER PUMP WITH LOW PRESSURE FORCE MAIN CONNECTION

GRAVITY FLOW DIRECTION
—FM— FORCE MAIN (FM)
—LPS— LOW PRESSURE SEWER (LP)
GRAVITY MAIN

1" = 600'
300 0 600

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: T. REESER
DRAWN BY: S. ENGEL/J. CABRERA
SHEET CHK'D BY: D. MURPHY
CROSS CHK'D BY: K. WAGNER
APPROVED BY:
DATE: OCTOBER 2023

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BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
CANDLEWOOD PENINSULA AND
CANDLEWOOD LAKE ROAD AREA

ALTERNATIVE A
GRAVITY SEWER SYSTEM WITH LIMITED NUMBER OF
GRINDER PUMPS AND SEVEN BWPCA PUMP STATIONS

PROJECT NO. 261865-269061
FILE NAME: ALTERNATIVE A

FIGURE 5-5

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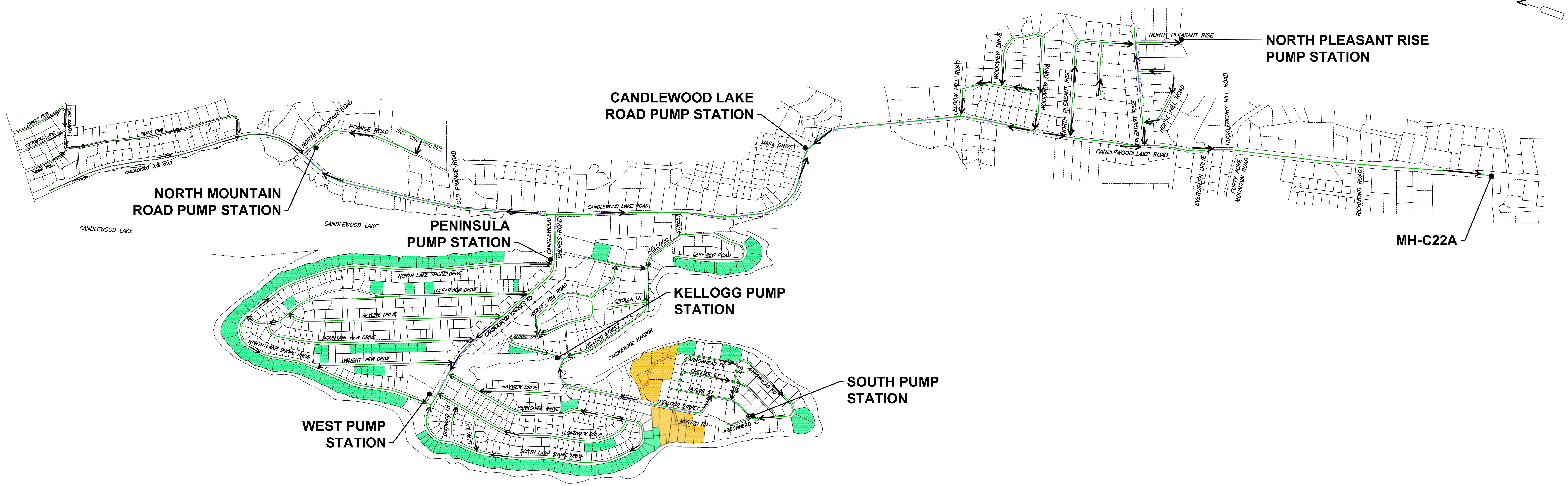

PLAN
1"=600'

GRAVITY SEWER CONNECTION
GRINDER PUMP WITH GRAVITY SEWER CONNECTION
GRINDER PUMP WITH LOW PRESSURE FORCE MAIN CONNECTION

GRAVITY FLOW DIRECTION
FORCE MAIN (FM)
LOW PRESSURE SEWER (LP)
GRAVITY MAIN

1" = 600'
300 0 600

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BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
CANDLEWOOD PENINSULA AND
CANDLEWOOD LAKE ROAD AREA

ALTERNATIVE B
SHALLOWER GRAVITY SEWER SYSTEM WITH
SEVEN BWPCA PUMP STATIONS

PROJECT NO. 261865-269061
FILE NAME: ALTERNATIVE B

FIGURE 5-6

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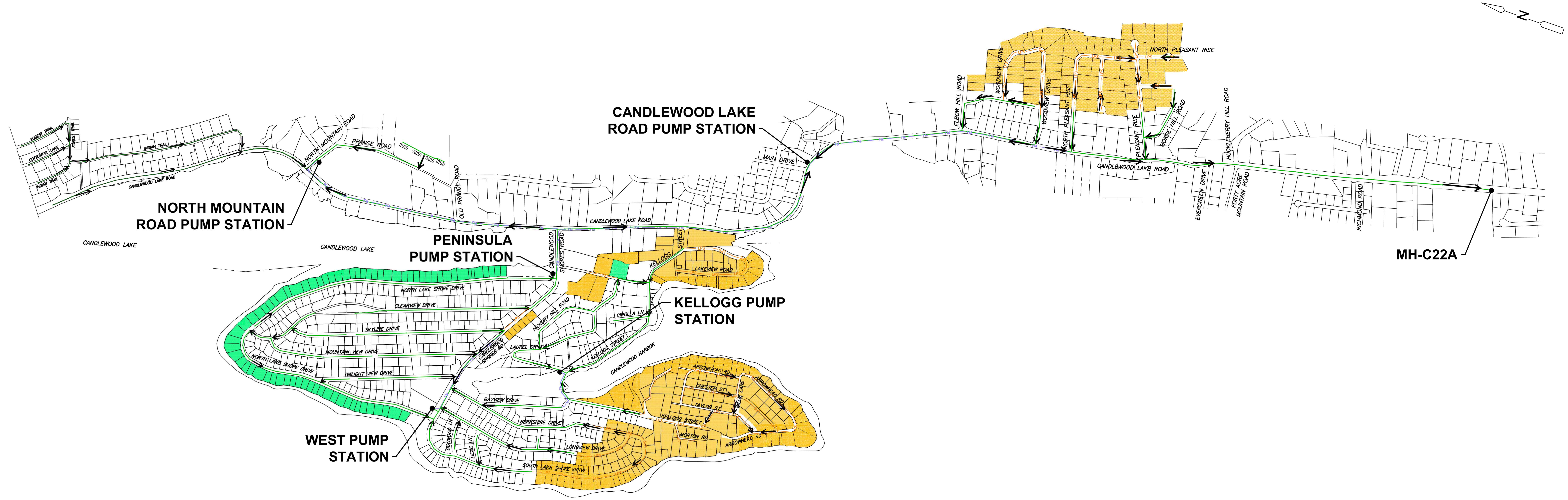

PLAN
1"=600'

GRAVITY SEWER CONNECTION

GRINDER PUMP WITH GRAVITY SEWER CONNECTION

GRINDER PUMP WITH LOW PRESSURE FORCE MAIN CONNECTION

GRAVITY FLOW DIRECTION

—FM— FORCE MAIN (FM)

—LPS— LOW PRESSURE SEWER (LP)

GRAVITY MAIN

1" = 600'
300 0 600

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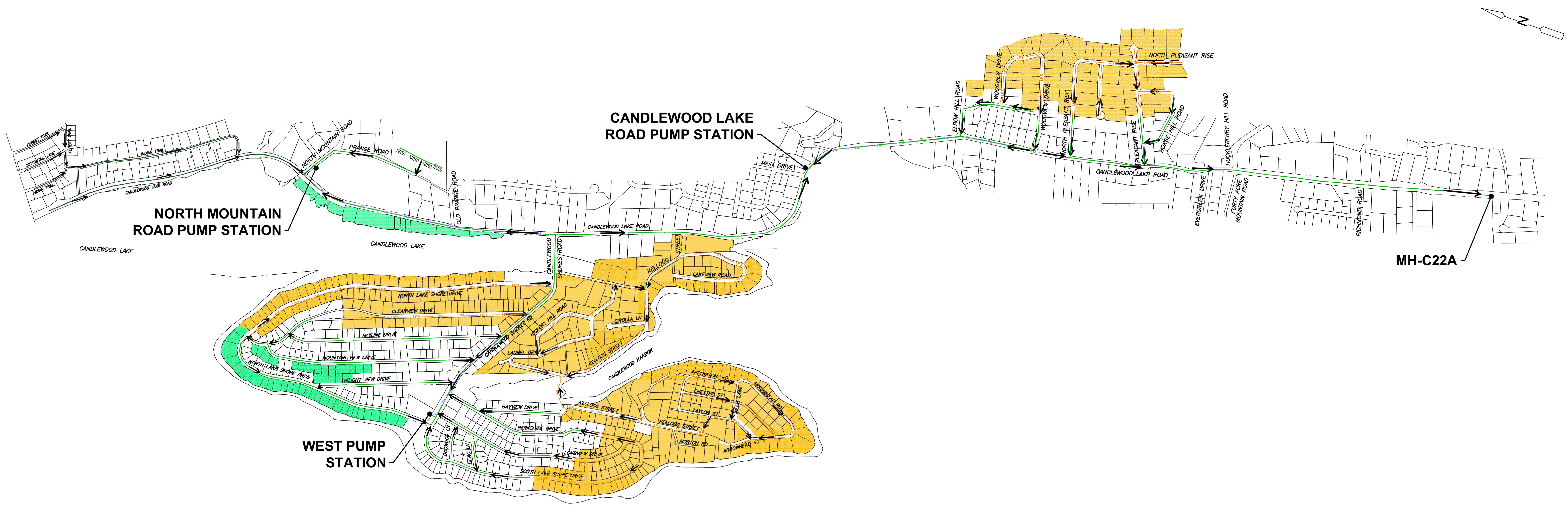
BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
CANDLEWOOD PENINSULA AND
CANDLEWOOD LAKE ROAD AREA

ALTERNATIVE C
HYBRID COLLECTION SYSTEM WITH FIVE BWPCA PUMPING STATIONS

PROJECT NO. 261865-269061
FILE NAME: ALTERNATIVE C

FIGURE 5-7

DRAFT - OCTOBER 2023



PLAN
1"=600'

GRAVITY SEWER CONNECTION

GRINDER PUMP WITH GRAVITY SEWER CONNECTION

GRINDER PUMP WITH LOW PRESSURE FORCE MAIN CONNECTION

GRAVITY FLOW DIRECTION
—FM— FORCE MAIN (FM)
—LPS— LOW PRESSURE SEWER (LP)
GRAVITY MAIN

1" = 600'
300 0 600

REV. NO.	DATE	DRWN	CHKD	REMARKS

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SHEET CHK'D BY: D. MURPHY
CROSS CHK'D BY: K. WAGNER
APPROVED BY:
DATE: OCTOBER 2023

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BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
CANDLEWOOD PENINSULA AND
CANDLEWOOD LAKE ROAD AREA

ALTERNATIVE D
HYBRID COLLECTION SYSTEM WITH THREE BWPCA
PUMPING STATIONS

PROJECT NO. 261865-269061
FILE NAME: ALTERNATIVE D

FIGURE 5-8

DRAFT - OCTOBER 2023

PLAN
1"=600'

GRAVITY SEWER CONNECTION

GRINDER PUMP WITH GRAVITY SEWER CONNECTION

GRINDER PUMP WITH LOW PRESSURE FORCE MAIN CONNECTION

GRAVITY FLOW DIRECTION

—FM— FORCE MAIN (FM)

—LPS— LOW PRESSURE SEWER (LP)

GRAVITY MAIN

1" = 600'
300 0 600

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BROOKFIELD, CONNECTICUT
POTENTIAL SEWER EXTENSION CONCEPT DESIGN
CANDLEWOOD PENINSULA AND
CANDLEWOOD LAKE ROAD AREA

ALTERNATIVE E
LOW-PRESSURE SEWER SYSTEM WITH PRIVATE
GRINDER PUMPS

PROJECT NO. 261865-269061
FILE NAME: ALTERNATIVE E

FIGURE 5-9

DRAFT - OCTOBER 2023

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Section 6

Discharge Locations and In-Town Wastewater Treatment Evaluation

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Section 6

Discharge Locations and In-Town Wastewater Treatment Evaluation

6.1 Projected Wastewater Flows and Discharge Limitations

As outlined in **Section 2**, future sanitary sewer flows in Brookfield may reach 900,000 gpd to 1 mgd. Brookfield's agreement with Danbury allowed Brookfield to discharge approximately 500,000 gpd to the Danbury treatment plant, but in 2000 that allotment was reduced to 380,000 gpd. Negotiations are currently ongoing to restore the initial allotment plus an additional 80,000 gpd – which would bring Brookfield's allocation at the Danbury plant to 580,000 gpd.

At the time of this Report, negotiations with Danbury for additional capacity are ongoing. However, depending on the results of those negotiations and implementation of any sewer extensions, it is possible that 400,000 to 500,000 gpd would have to be treated and discharged elsewhere. This Section analyzes possible alternatives including conveyance to the New Milford Water Pollution Control Facility (WPCF), or construction of a Brookfield treatment facility with discharge to either groundwater or surface water.

6.2 Conveyance and Treatment at New Milford

6.2.1 New Milford Collection System Capacity

One option to supplement Brookfield's current Danbury allotment would be to redirect a portion of the collection system to send some flow to a different town for treatment. The Town of New Milford sewer system currently extends to Route 7 (Federal Road) to a manhole approximately 1,300 feet north of the New Milford and Brookfield town line. That portion of New Milford's sewer system was constructed circa 2013, and capacity needs were based on a 2001 New Milford Facilities Plan prepared by Earth Tech. Subsequently, in 2017, New Milford retained Wright-Pierce to prepare a memorandum entitled "Evaluation of Downstream Impacts from Brookfield Wastewater Flows." This memorandum estimated the available sanitary sewer capacity of the New Milford gravity sewer system and included flow projections and capacity estimates for relevant pump stations. It is noted that for that memorandum, New Milford assumed that Brookfield may request between 80,000 and 120,000 gpd of capacity. This is only a portion of the capacity that may be needed by Brookfield if all sewer extensions noted in **Section 2** are constructed.

If Brookfield flow is redirected to New Milford, it would have to be pumped through five New Milford pump stations that are constructed in series (Pump Station No. 4, Danbury Road Pump Station No. 3, Pump Station No. 2, the Still River Pump Station, and the West Side Pump Station) to convey flow to the New Milford WPCF. The potentially-available capacity in the New Milford system is shown in **Table 6-1** below.

Table 6-1 Potentially Available Capacity in New Milford Sewer System

	Current Available Average Daily Flow Capacity (gpd) [(1)]	Current Available Peak Daily Flow Capacity (gpd) [(1)]	Estimated Future Available Average Daily Flow Capacity (gpd) [(1)]	Estimated Future Available Peak Daily Flow Capacity (gpd) [(1)]
Gravity Sanitary Sewers	481,500	454,500	309,000	0
Sanitary Pump Stations[(2)]	276,000	235,000	91,000	0

Notes:

1. Flow estimates obtained from the Wright-Pierce memorandum “Evaluation of Downstream Impacts from Brookfield Wastewater Flows” dated February 14, 2017.
2. Pump Station No. 4 is the limiting factor for the sanitary pumping capacity.

The 2017 memorandum estimates that the gravity sewer and pump stations have some excess capacity that could be available to Brookfield currently, but not the full 400,000 to 500,000 gpd that may be needed in the future. Furthermore, the estimates show that New Milford will not have any available capacity at future peak conditions in either the collection system or pump stations, based on anticipated buildout and connections within New Milford. The memorandum also notes that there is some capacity available at the New Milford WPCF, but that was based on a potential request of 80,000 to 120,000 gpd by Brookfield in 2017.

If the BWPCA would like to pursue this option further, current and anticipated flows would have to be reviewed with the Town of New Milford. It is possible that conveyance of a substantial amount of flow to New Milford may require substantial upgrades to New Milford’s gravity sewers and some pump stations, particularly New Milford Pump Station No. 4.

6.2.2 Conveyance to New Milford

One of the potential new pump stations, located at 501 Candlewood Lake Road near North Mountain Road, is the closest proposed pump station to New Milford. This pump station would receive approximately 23,000 gpd of gravity sanitary flow from Candlewood Lake Club and some areas of Northern Candlewood Lake Road, and flow from other parts of the project area could also be pumped to it. It would be possible to construct this pump station to convey flow towards New Milford by constructing an approximately 12,700-foot (2.4-mile) force main along North Mountain Road and Route 7 to the New Milford terminal manhole north of the Brookfield town line. The proposed force main and New Milford gravity sewer connection is shown on **Figure 6-1.** The section of Route 7 between North Mountain Rd and the New Milford manhole has several areas that will make force main construction difficult:

- Route 7 is elevated above North Mountain Road
- Route 7 north of North Mountain Road is cut into bedrock
- Route 7 has several elevated sections and rock faces on the west side of the road
- Towards New Milford, Route 7 is largely developed with commercial properties
- There are several wetlands areas around Route 7 within Brookfield

It may be possible to reroute the force main to Laurel Hill Road and Route 202 to avoid some of the bedrock and elevated sections of Route 7, but this route would add 1,500 feet to the force main and both roads have existing gravity sewer and force mains that would add to the complexity of construction.

The difficulty of construction and cost to install 2.4 miles of force main between Brookfield and New Milford make this alternative economically challenging. A summary of the required infrastructure and costs is shown in **Table 6-2**.

Table 6-2 New Milford Conveyance Alternative – Summary

Force Main from Potential North Mountain Road Pump Station to New Milford	Total Estimated Project Cost (rounded)
± 4-inch Pump Station Force Main Including Rock Trenching and State Road Restoration	$10,000,000 to $12,000,000

The estimated project costs are in addition to the proposed collection system costs presented in **Section 5**. The estimated costs in Table 6.2 are for the force main to New Milford and do not include the design and construction costs for the pumping station and gravity sewer.

Total Project Costs for all Items in Table 6-2 include Engineer's Opinion of Probable Construction Cost including contractor labor, equipment, materials, general conditions, overhead & profit, construction contingency, plus Project Costs including engineering and implementation, project contingency, and escalation to 2025.

It also may be feasible to re-route a portion of the existing Brookfield collection system to the north to New Milford, to allow capacity for some of the flow from new expansion areas to be treated at Danbury. If the flow from the northern portion of the existing collection system, including the area tributary to the Federal Road Pump Station, is re-routed to New Milford, it may reduce current flows to the Danbury plant by approximately 67,000 gpd. However, construction of a force main from the Federal Road Pump Station to the New Milford system would require a similar route to that described above, and have similar costs and challenges. Additionally, the costs estimated above do not include any work required in New Milford to provide additional capacity nor do they include a connection fee or "buy-in" fee that is often included in new intermunicipal agreements.

Given the challenges and expenses associated with this route, it is not recommended that this alternative be pursued unless other options are less feasible.

6.3 Potential Brookfield Water Pollution Control Facility

6.3.1 WPCF Requirements

It may be feasible to construct a new WPCF in Brookfield to treat up to the required 400,000 to 500,000 gpd. WPCFs must remove particulate matter as well as chemical and biological contaminants. Large particulate matter is removed in the preliminary treatment process by screening, grinding, or rapid settling methods. Fine particles and floating scum are typically removed during primary treatment. Chemical and biological contaminants are removed during secondary treatment through processes such as suspended-growth biological treatment (aka activated sludge), attached growth and dual biological treatment, or natural systems. Treated water is then disinfected to prevent the spread of disease-causing organisms, protecting both the environment and public health.

WPCFs can vary in size from a small neighborhood system to a city-wide centralized WPCF; a 400,000 to 500,000 gpd facility for Brookfield would fall between these extremes. For the flows required in Brookfield, numerous manufacturers offer “packaged” treatment systems, which include most of the treatment equipment. Some package systems are available pre-assembled shipped in containers, and others require on-site construction of tanks. Many manufacturers recommend buildings for control equipment, or they may be optional to camouflage the treatment facility. Building architecture can be designed to match the surrounding community.

The space required for a new treatment facility can vary; the individual components of vendor-packaged systems are quite compact. However, the need for ancillary structures, pumping and equalization facilities, flow channels and provisions for isolation, and administrative/monitoring facilities all require space. A reasonable footprint for a 400,000 to 500,000 gpd facility is approximately 1 to 2 acres in size, exclusive of any subsurface leaching field facilities that may be required for effluent discharge.

A discussion of some of the most widely used and cost-effective treatment process alternatives is presented in this Section. The purpose of this discussion is to provide an introduction to the required treatment processes and to present adequate information for development of a planning-level cost estimate. A detailed evaluation and final selection of treatment processes should be the first step of a preliminary design effort should a new WPCF be pursued.

Potential permit effluent limits are as follows:

- BOD – 20 mg/L
- TSS – 20 mg/L
- TN – 10 mg/L; possibly as low as 4 mg/L if adjacent to environmentally sensitive area
- TP – Phosphorus treatment as required to ensure no increase above background TP concentration levels at point of environmental concern, likely less than 1 mg/L and potentially as low as 0.2 mg/L
- pH – 6-9
- Fecal coliform- 126 count/100mL sample

These limits are based on guidance from CT DEEP to be consistent with other currently active permits for similar facilities. For a groundwater discharge (“UI” or Underground Injection permit), it is possible that the permit will not include a fecal coliform limit due to the natural attenuation that occurs in the 21-day travel time before reaching adjacent properties. However, disinfection may be included due to the potential public concerns associated with lack of disinfection at a municipal facility.

Treatment facilities could potentially be located at the groundwater or surface water discharge sites discussed in Section 6.3.2 below. Pumping would be required to the selected treatment facility site if a new WPCF is pursued.

6.3.1.1 Wastewater Treatment Processes

Preliminary treatment includes the initial treatment processes to remove coarse matter from the waste stream to prevent damage to downstream equipment. This generally includes screening and grit removal.

Screens are located at the head of the plant and remove large, solid material from the flow stream that could become clogged or damage downstream equipment. The screenings can be dewatered and bagged for disposal. To minimize wear on downstream equipment, abrasive gritty material such as sand can be removed in a grit chamber.

Primary treatment, which is not required by all manufacturers, is a physical process of settling out solids prior to biological treatment. It is accomplished in quiescent tanks when the influent flow is given the opportunity to slow down allowing the heavier solids to settle to the bottom of the tanks where they are collected and removed.

Secondary treatment is a biological process of using microscopic organisms (bacteria) and oxygen to consume organic material present in the wastewater. A multitude of process variations exist, and they can differ in the manner in which the organisms are allowed to come into contact with the wastewater and how oxygen is provided, but they all achieve the same objective.

Sequencing Batch Reactors (SBRs)

SBRs treat wastewater in the same way as conventional activated sludge but accomplish the process batch by batch in a single tank. Wastewater is fed into a tank and undergoes mixing, anoxic, and aeration stages to metabolize the waste. Once these stages are complete, all air is shut off and settling is completed in the same tank. Sludge is drawn off of the bottom and removed as waste. The clarified liquid is then decanted near the surface. An SBR process requires a minimum of two tanks to allow filling of one tank while the second is processing the waste. SBRs generally require flow equalization following the process because the rate of decant in SBRs is generally much faster than the incoming wastewater flow. Flow equalization is relatively inexpensive and is included to eliminate the need to size downstream treatment processes for this high decant rate.

Membrane Bioreactors (MBRs)

Membrane treatment is a variation of activated sludge treatment that uses membranes for solids separation in lieu of traditional settling tanks. MBR distinguishes itself from other activated sludge processes by using membranes in place of final clarifiers. This eliminates many of the common problems associated with achieving a properly settling biomass, along with problems associated with continuing biological activity in the final clarifiers, such as rising sludge.

One commonality of all MBR systems is that the activated sludge process can operate at a higher concentration of bacteria than traditional systems thus requiring a smaller “footprint”. There are several types of MBR processes including hollow fiber suction membranes, flat panel suction membranes, and pressure membranes, and different configurations are offered by several manufacturers. MBRs typically operate at 2-3 times the bacteria concentration of a conventional plant, significantly reducing process tank volume. When designing MBRs for nutrient removal, process configurations are similar to the conventional activated sludge process, except that the secondary clarifier is replaced by the membrane tank. MBRs typically have small footprints and excellent effluent quality but can have high capital and operational costs.

Disinfection

Following biological treatment, effluent is typically disinfected using either ultraviolet (UV) light or through addition of a chlorine solution such as sodium hypochlorite. If sodium hypochlorite is used, a contact tank is required to ensure adequate detention time is achieved prior to discharge. The addition of a chlorine solution can require addition of a dechlorinating solution such as sodium bisulfite to ensure the effluent is not toxic to aquatic life in the receiving stream. UV disinfection can utilize a smaller plant footprint as the disinfection is instantaneous, requires no tanks for chlorine contact time, requires no additional chemical feed systems, and does not require dechlorination; however, the power consumption can be significant compared to sodium hypochlorite disinfection.

Ancillary Processes and Equipment

In addition to the above treatment processes and the related equipment requirements, other ancillary equipment and processes will be needed. The following features must be evaluated during the design of each facility.

- Administrative and laboratory space
- Sludge holding and/or thickening facilities
- Odor control facilities
- Chemical feed systems
- Electrical, control and instrumentation systems
- Backup power such as an onsite generator

6.3.2 Effluent Discharge Options

Treatment facility effluent must be discharged in a manner that minimizes impact to the groundwater, nearby surface waters, and all environmentally sensitive areas. There are two options for effluent discharge available to the Town that would be permitted by DEEP – discharge or recharge to groundwater, and discharge to surface water.

6.3.2.1 Discharge to Groundwater

The first alternative for wastewater treatment discharge is discharging to groundwater. A desktop assessment of vacant, available parcels around Brookfield was conducted to determine if groundwater discharge can be accommodated within town. Parcels with appropriate subsurface conditions for accepting groundwater recharge have been identified via a multi-step screening process. The steps are summarized below.

6.3.2.1.1 Initial Desktop Screening

The first step in the parcel screening process included screening numerous parcels in town, including several identified in the 2020 *Candlewood Lake Brookfield Study Area Wastewater*

Management Plan by LAI, and an additional large parcel in the vicinity of the Candlewood Lake Road project area, that appear undeveloped.

These parcels include:

- 1044 and 1055 Federal Road
- 6 Production Drive
- 98 Laurel Hill Road
- 20 North Mountain Road
- 19A, 20, 21, and 23 Elbow Hill Road
  - 23 Elbow Hill Road, previously identified in the 2020 *Candlewood Lake Brookfield Study Area Wastewater Management Plan,* has an existing residence and has been eliminated from further consideration herein.
- 535 Candlewood Lake Road

These parcels were screened for areas with characteristics suitable for accepting groundwater discharge. Relevant data were obtained from the FEMA Flood Map Service Center and the Connecticut Department of Energy & Environmental Protection (DEEP) Geographic Information Systems (GIS) Open Data Website. Areas not considered suitable for subsurface disposal were then removed from the total usable acreage. The steps included in the initial screening process are described below.

- Wetlands, Water Bodies, and Floodplain: The presence of wetlands and water bodies detracts from the usability of a parcel. For each parcel, area within 100-year FEMA floodplain boundaries and area considered by CT DEEP to be inland wetland soils were removed from the total useable area.
- Potential for Subsurface Sewage Disposal: The National Resources Conservation Service (NRCS) characterizes soils by slope, percolation, depth to groundwater, depth to bedrock, and flooding. Based on the Connecticut Environmental Conditions Online (accessed through www.cteco.uconn.edu): soils with medium or high potential for subsurface sewage disposal systems have limitations that can be easily or generally overcome. Soils with low potential would need extensive efforts to overcome their limitations. Soils with very low or extremely low potential would not likely be able to be improved enough to meet stead health code regulations. Areas classified on the CT DEEP open data website as having low, very low, or extremely low potential for subsurface sewage disposal were removed from the total useable area. Areas with medium, or high potential were kept, as well as areas that were not rated.
- Hydric Soil: Hydric soils are permanently or seasonally saturated, making them anaerobic. High water levels would inhibit the treatment of subsurface sewage. It was confirmed that no remaining areas contained hydric soils, as determined by CT DEEP, since hydric soils have an extremely low potential for subsurface sewage disposal.

- Groundwater Quality: Connecticut DEEP classifies surface and groundwaters as part of the State's Clean Water Program. CT DEEP does not allow new discharges from treatment facilities to Class GC groundwaters. Additionally, treatment facility discharges into an area designated as GAAs (water tributary to a public water supply surface reservoir) may be permitted if related to abatement of an existing pollution problem, but parcels outside of GAAs areas are preferred. All areas under consideration are classified as Class GA Groundwater Areas. Furthermore, none are on the List of Contaminated or Potentially Contaminated Sites in Connecticut from CT DEEP. Allowable Class GA discharges include discharges from septage treatment facilities subject to stringent treatment and discharge requirements, and other wastes of natural origin that easily biodegrade and present no threat to groundwater.
- Aquifer Protection Areas (APAs): Treated domestic wastewater discharge is permitted in APAs but parcels outside of APAs are preferred. It was confirmed that none of the remaining candidate parcels are within mapped APAs on the 2018 CT DEEP Water Quality Classifications Map for Brookfield.

6.3.2.1.2 Screening Results and Groundwater Discharge Capacity Estimates

After removal of unsuitable areas as described above, parcels (or portions of parcels) that appeared favorable were further reviewed to develop an estimate of potential capacity to accept groundwater discharge.

According to the CT DEEP's 2006 *Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems*, a groundwater travel time of 56 days is needed between a Subsurface Wastewater Absorption System (SWAS) and "the outer limit of the cone of depression of a public (community) drinking water supply well." A groundwater travel time of 21 days is also needed between a SWAS and other points of concern (typically considered to be the property line). It is noted that these travel times are based on on-site wastewater renovation systems (septic systems) without treatment; a new facility would provide treatment and disinfection as described above and the travel times may not be enforced. However, CT DEEP guidance on this issue is limited and the travel times are conservatively assumed to be required for purposes of this analysis.

To determine the required distance between the SWAS and points of concern, the velocity of the groundwater in the area is needed. According to the United States Geological Survey (USGS), a high ground-water velocity is 1 foot/day or more. However, CDM Smith has seen higher velocities in some portions of the state; as such, a groundwater velocity value of 2 feet/day was used in the following calculations to be conservative. Site specific tests will need to be conducted to determine site-specific soil velocities and to refine the boundaries of subsurface disposal.

The usable area in each candidate parcel was therefore reduced to allow for 42 feet (21 days at 2 feet/day) to any property line; however, if two areas were contiguous to one another, it was assumed that both parcels would be obtained for the project, so this buffer was not subtracted from the shared property lines and the usable areas were merged into one. It is noted that this is a conservative estimate, as groundwater flows generally in one direction, and it is likely that this buffer may not be needed on all sides of the property. It is also noted that one parcel (535

Candlewood Lake Road) is in the vicinity of an area of contribution to a public water supply well, so additional area was removed.

The favorable acreage of the candidate sites was calculated in ArcGIS Pro and converted to square feet. The anticipated usable area was then multiplied by the maximum long-term acceptance rate for treated wastewater of 1.2 gpd/sq ft, (per the 2006 CT DEEP *Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems)*, to get the maximum estimated groundwater discharge capacity of each site. This was then divided by the typically required DEEP safety factor of 1.5 to determine the allowable groundwater discharge capacity.

The results of the desktop capacity screening are summarized in **Table 6-3** below. Sites near to each other could be grouped together to maximize discharge capacity from a single treatment facility. **Figure 6-2** shows the most promising candidate sites, with the total estimated capacity of each cluster.

Table 6-3 Estimated Capacity of Potential Groundwater Discharge Sites

Option	Location / Group of Parcels	Approximate Usable Area (acres)	Estimated Groundwater Discharge Capacity (GPD)
A	1055 Federal Road, 1044 Federal Road, 6 Production Drive	11.7	410,000
B	98 Laurel Hill Road, 20 North Mountain Road (portion east of Route 7)	3.8	130,000
C	535 Candlewood Lake Road (Candlewood Lake Club)	2.5	90,000
D	19A, 20, 21 Elbow Hill Road	0.9	30,000
E	20 North Mountain Rd (portion west of Route 7)	0.6	20,000

The combination of three parcels in the Federal Road/Production Drive area (shown on Figure 6-2 as Option A) comes closest to the potential maximum need of 500,000 gpd, with an estimated capacity of 410,000 gpd, making it the most viable option. The remaining sites have much lower potential capacities.

It is noted that some of the parcels (Options A, B, and D) are also indicated to be in an "Aquifer Protection" area per the Brookfield GIS, but it is unclear exactly how that is defined in the Town's GIS system. The parcels are not in state-designated APAs or areas of contribution to public water supply wells according to the 2018 CT DEEP Water Quality Classifications Map. This issue would have to be investigated further if this project were to proceed.

If the Town opts to proceed with an in-town treatment facility with groundwater discharge, further investigations of each site will be necessary. This will help better determine their viability and if there are any additional constraints that need to be considered. Subsurface investigations would need to be conducted to obtain better data on subsurface materials, depth to bedrock, and depth to groundwater. In-situ hydraulic conductivity testing and hydraulic load testing would also need to be performed to validate the appropriate maximum design/discharge capacity.

6.3.2.2 Discharge to Surface Water

Given the challenges associated with finding a suitable parcel(s) for groundwater discharge, additional options for potential discharge to surface water, specifically the Still River, were also examined.

A discharge to the Still River would be consistent with DEEP's goals for water quality in the region and may be permissible by DEEP if other options were not viable. The river currently has a Surface Water "Class B" designation per CT DEEP. The designated uses for Class B waters are habitat for fish and other aquatic life and wildlife; recreation; navigation; and industrial and agricultural water supply. Discharges from municipal and industrial wastewater treatment systems are permitted in Class B waters, as long as best available treatment is provided. Surface water discharge has some advantages over a groundwater discharge, in that seasonal high-water tables and site-specific soil conditions would not impact the maximum discharge limit. It would also leave potential for future expansion and, once constructed, the discharge outfall would require very little maintenance.

6.3.2.2.1 Potential Site Options

Two potential parcels have been identified that would facilitate surface water discharge to the Still River: the municipal parcel near the Dean and Pocono Roads area, and one privately-owned parcel near the BWPCA's Caldor Pump Station.

The Town of Brookfield's Municipal Center is located at 100 Pocono Road. The Municipal Center parcel is approximately 45 acres of Town owned property that abuts the Still River on the northwestern edge of the parcel near the US Route 7 Bridge Crossing. The property includes several ballfields and recreational areas in the vicinity of the Still River but no major structures. Much of the parcel is above/outside of the floodplain and a portion near the River is vacant. It would be feasible to construct a small treatment facility in this location, though relocation of some of the recreational areas may be required. It is also noted that this location is in proximity to the Dean Pocono Roads study area; flow from that project could be conveyed to this location instead of the existing collection system. Other potential sewer project areas around the Candlewood Peninsula could also be pumped to this location if needed.

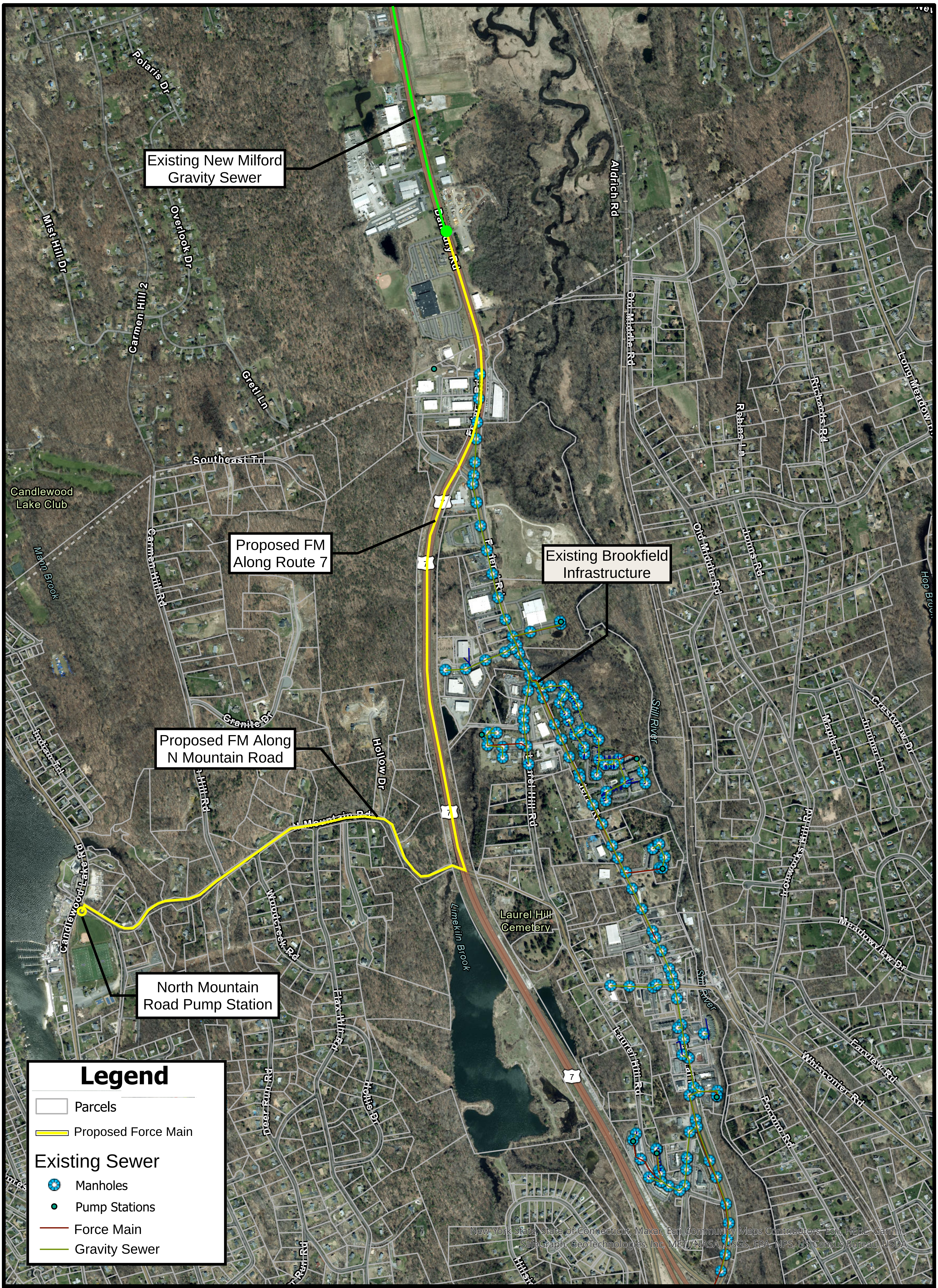
A second potential site was identified near the Caldor Pump Station at the southernmost end of the existing wastewater collection system at 23 Grays Bridge Road. The 5-acre parcel adjacent to the Still River is currently industrially zoned. It is vacant at the time of this report and given that the current collection system flows to the Caldor Pump Station, it would be a convenient location for a treatment facility. However, there is currently a development proposed for the parcel. If the development plans do move forward, this parcel should be eliminated from further consideration. However, if the development plans for this parcel do not move forward it could remain a possibility.

6.4 Estimated Project Costs

As noted above, there are numerous challenges associated with siting a new treatment facility and more detailed investigations would be required if Brookfield ultimately would like to pursue this option. For preliminary planning purposes for the range of potential treatment facilities, a range of costs were estimated. Manufacturer package costs were obtained and additional components and equipment that are not part of a manufacturer's package were estimated for the project. These additional items include pumping and equalization facilities, flow channels and provisions for isolation of multiple process trains, administrative/monitoring facilities, site work, electrical work, and other general construction conditions and ancillary items.

It is estimated that a new 400,000 to 500,000 gpd treatment facility may cost upwards of $30 million to $40 million, with a groundwater discharge being on the higher end of that range due to the need to construct a subsurface leaching field. It is also possible that costs could be higher depending on stringency of discharge limits and site complications. The proximity of any treatment or discharge sites to the sewer service area and any required upgrades within the existing system would also impact the project costs.

At this point, negotiations with Danbury to maximize available capacity at the Danbury WPCF are ongoing. Assuming capacity can be obtained for the projects that the BWPCA actually intends to implement, continuing to convey the required flow to Danbury is likely to be more cost-effective than the other options presented herein.



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CDM Smith

Figure 6-1

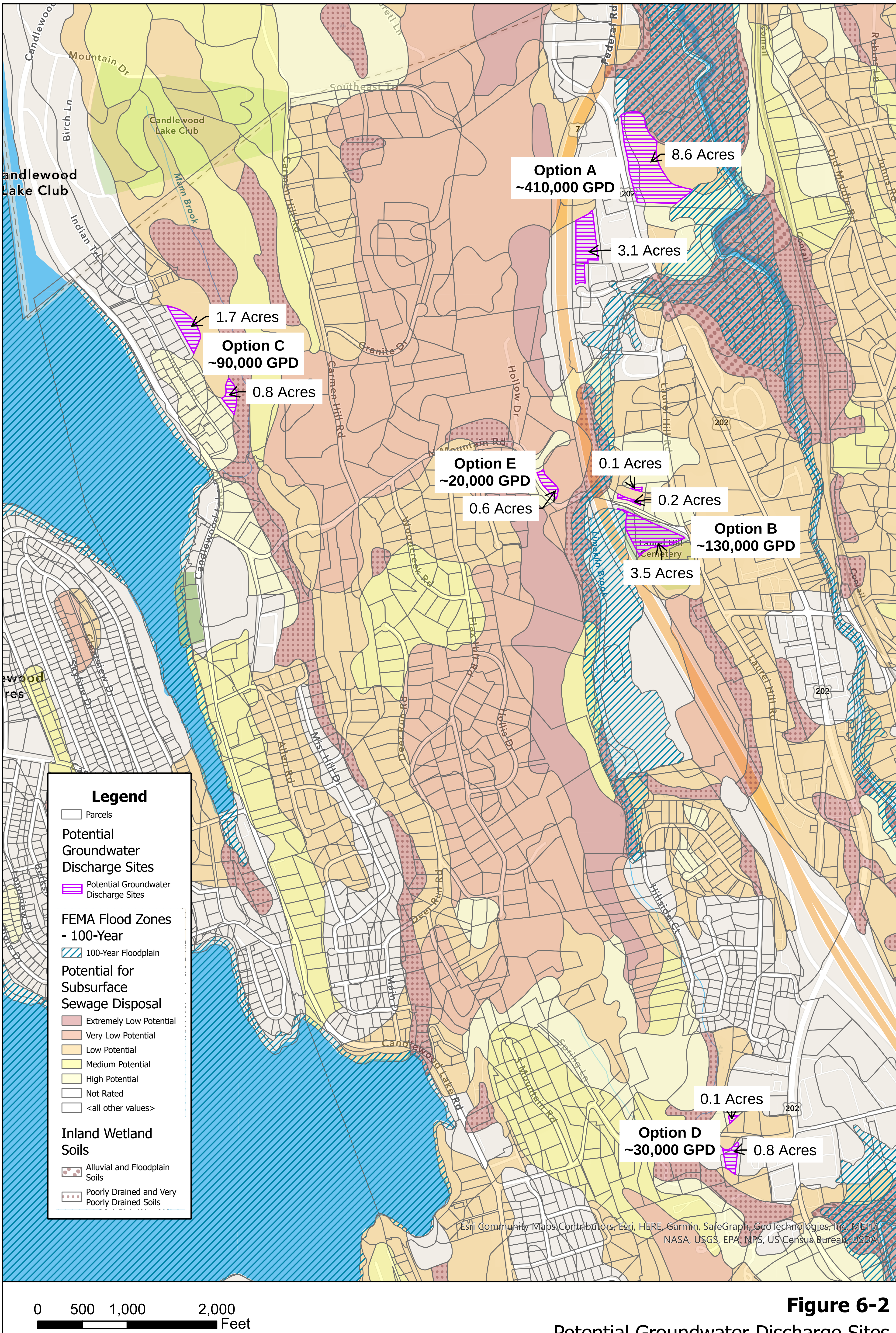
Candlewood Peninsula Study Area; New Milford Connection Alternative

Sanitary Sewer Extension Study

Dean and Pocono Roads and Candlewood Lake Area

Brookfield, Connecticut

DRAFT October 2023



CDM Smith

Figure 6-2

Potential Groundwater Discharge Sites

Sanitary Sewer Extension Study
Dean and Pocono Roads and Candlewood Lake Area
Brookfield, Connecticut

DRAFT October 2023

Section 7

Cost Summary and Implementation Considerations

CDM Smith

Section 7

Cost Summary and Implementation Considerations

The construction of either the Dean and Pocono Roads Area sewer extension or the Candlewood Peninsula and Candlewood Lake Roads Area sewer extension would require a significant commitment of financial resources by the BWPCA, as well as support from the public and Town leaders. This section summarizes the potential capital and life cycle costs for either project and discusses permitting, funding options, feasibility and implementation considerations.

7.1 Summary of Potential Sewer Extension Costs

Total project capital and life cycle costs were estimated for each of the alternatives outlined in this Report. These costs are described in more detail in Sections 4 and 5.

A summary of potential project costs for the Dean and Pocono Roads Area are summarized in **Table 7-1** below.

Table 7-1 Cost Summary of Alternatives for Dean and Pocono Roads Area Sewer Extension

Alternative	Initial Project Capital Cost ($)	Initial Project Capital Cost ($) (after 20% CWF Grant)	50 Year Estimated Life Cycle Cost	Approximate Annual Cost, $/year per property
Dean and Pocono Alternative 1 Gravity Sewer with One BWPCA Pump station	$6,700,000	$ 5,400,000	$ 9,700,000	$ 2,100
Dean and Pocono Alternative 2 Low-Pressure Sewer System	$3,400,000	$ 2,700,000	$ 9,200,000	$ 2,000
Dean and Pocono Alternative 3 Septic System Maintenance/ Upgrades/ Replacement	n/a	n/a	$ 9,300,000	$ 2,000

The capital costs presented for the Dean and Pocono Roads projects assume a midpoint of construction in 2025. If the project is implemented beyond that time frame, cost allocations should be re-evaluated and escalated further. Other detailed cost factors and assumptions are noted in Section 4.

A summary of potential project costs for the Candlewood Peninsula and Candlewood Lake Roads Area are summarized in **Table 7-2** below.

Table 7-2 Cost Summary of Alternatives for Candlewood Areas Sewer Extension

Alternative	Initial Project Capital Cost ($)	Initial Project Capital Cost ($) (after 20% CWF Grant)	50 Year Estimated Life Cycle Cost	Approximate Annual Cost, $/year per property
Candlewood Alternative A Gravity Sewer System with Seven BWPCA Pump Stations	$90 - $95+ million	$75 million	$130 million	$2,400
Candlewood Alternative B Shallower Gravity Sewer System with Seven BWPCA Pump Stations	$85 - $90 million	$69 million	$130 million	$2,400
Candlewood Alternative C Hybrid Sewer System with Five BWPCA Pump Stations	$65 - $70 million	$55 million	$120 million	$2,200
Candlewood Alternative D Hybrid Sewer System with Three BWPCA Pump Stations	$60 - $65 million	$49 million	$120 million	$2,200
Candlewood Alternative E Low-Pressure Sewer System	$55 - $60 million	$45 million	$130 million	$2,400
Candlewood Alternative F Septic System Maintenance/ Upgrades/ Replacement	n/a	n/a	$110 million	$2,000

The capital costs presented for the Candlewood Peninsula and Candlewood Lake Road Area projects assume a midpoint of construction in 2026. If the project is implemented beyond that time frame, cost allocations should be re-evaluated and escalated further. Other detailed cost factors and assumptions are noted in Section 5.

Additionally, as outlined in Section 6, it is recommended that the Town continue negotiations with Danbury to maximize Brookfield's available flow allotment at the Danbury WPCF. Conveyance to and treatment at the Danbury WPCF is likely to be more cost-effective than construction of a new Brookfield treatment facility or re-routing flows to a different town.

7.2 Permitting and Approvals

Several permits and approvals at the local and state levels would be required if a sewer extension project is implemented in the Dean and Pocono Roads Area or the Candlewood Peninsula and Candlewood Lake Roads Area. Most relevant permits and approvals would be secured during the design phase.

Portions of the project areas are located within wetlands, a Natural Diversity Data Base (NDDB) shaded area, and within proximity of a potable water supply well. The Dean and Pocono Roads area is also located near the Still River and partially in the floodplain. Permitting is required for construction near these sensitive/regulated areas. A brief overview of identified permitting requirements follows:

- Per the Brookfield Inland-Wetlands Commission requirements, wetlands approval is required if any work (such as disturbing the ground by removing or depositing material for any construction and installing structures) is planned within 75 feet of wetlands soils, 100 feet of a watercourse and/or within 200 feet of the mean waterline of Candlewood Lake, Lake Lillinonah, and the Still River. It is likely that the construction of any pumping stations would require local wetlands approval based on the potential sites identified.
- Any pumping stations required would also require zoning and building department approval.
- Depending on any selected pumping station locations, CT DEEP Flood Management Certification may be required. Flood Management Certification is required, or an exemption must be obtained, if a state agency proposes (or funds) an activity within or affecting a floodplain. Furthermore, infrastructure within the floodplain would require protection from flooding per TR-16 and CT DEEP requirements including elevation of critical components at least 3 feet above the 100-year base flood elevation.
- Portions of the study areas, specifically the Dean and Pocono Roads area and the southern end of the Candlewood Lake Road area, are mapped within a CT DEEP NDDB area. As such, an NDDB Request submittal would be required to determine if the proposed activity is located within an area identified as a habitat for endangered, threatened or special concern species or is located less than half of a mile upstream or downstream of such an area.
- In order to maintain eligibility for funding under the CT DEEP CWF, CWF regulations must be followed. CT DEEP approval would be sought to move forward with design of any sewer extension project.
- Since a sewer extension project will expand the existing sewer service area in Brookfield, CT DEEP may conduct a public scoping process to determine whether an Environmental Impact Evaluation (EIE) under the Connecticut Environmental Policy Act (CEPA) would be required. The decision whether or not an EIE is required for a specific project will be made by CT DEEP. If so, the EIE process will be facilitated by CT DEEP and will require information and cooperation from the BWPCA, including preparation of an EIE report by an independent consultant.

- If sewer extension projects do not move forward and the BWPCA elects to implement a systematic septic system inspection and upgrade program, collaboration with the Town Board of Health would be required.

7.3 Cost Feasibility and Funding Options

Historically, the BWPCA has funded infrastructure improvement projects through the contributions of the residents it affects as Benefit Assessments. Previously, residents have been charged up to 10 percent of their property values. To estimate the maximum budget of the sewer extension in the project area, the most recent (October 2021) grand list values of properties affected by the projects were gathered and 10 percent of each of these property values were determined for reference.

7.3.1 Dean and Pocono Roads Area

In the Dean and Pocono Roads project area, based on information provided by the BWPCA, the total grand list value of the 91 residential parcels is approximately $20 million. 10 percent of this is $2 million, therefore the total project cost after confirmed grants and/or other funding sources, such as the Town of Brookfield, would have to be less than $2 million for the homeowners in this area to be able to bear the cost at less 10 percent Benefit Assessment. The assessed values of the developed properties range from approximately $160,000 to $340,000. As a result, if Benefit Assessments are established as 10 percent of grand list value for each developed property, they would range from $16,000 to $34,000.

The Town's municipal complex is located south of Silvermine Road at 100 Pocono Road. It includes the Town Hall, Senior Center, Police Station, and a former residential property at 43 Silvermine Road. These buildings on the 45-acre complex are currently not connected to the Brookfield sanitary sewer system and have a septic system with a leaching field behind the police station. The proposed gravity sewer along Silvermine Road is at a depth that appears to allow the Town Hall complex to connect to the system by gravity, by intercepting the piping to the leaching field and connecting to the gravity sewer to the west of the police station on Silvermine Road.

- The assessed value of the Town Hall complex is $10.1 million. If the Town contributes 10 percent of this value as a Benefit Assessment, it will account for approximately a $1 million reduction in the project costs that would have to be borne by the residential property owners. If only some of the municipal buildings were to connect, the Town would have to determine the appropriate assessment and contribution to the project.

7.3.2 Candlewood Peninsula and Candlewood Lake Roads Area

In the Candlewood Peninsula and Candlewood Lake Roads project area, based on information provided by the BWPCA, the total grand list value of the approximately 1,100 parcels are approximately $420 million; this includes some Town-owned properties and some large commercial properties. 10 percent of this total is $42 million, therefore the total project cost after confirmed grants and/or other funding sources, such as the Town of Brookfield, would have to be less than $42 million for the property owners in this area to be able to bear the cost at less 10 percent Benefit Assessment. The assessed values of the developed properties range from approximately $100,000 to over $3,000,000; the highest value properties are commercial. As a result, if Benefit Assessments are established as 10 percent of grand list value for each developed property, they would range from approximately $10,000 to $300,000.

7.3.3 Potential Project Affordability

Benefit assessments at the higher end of that range noted above, up to $300,000, are not likely palatable or appropriate per Clean Water Fund regulations, which cap betterments at the estimated value by which the property increases with the addition of sewer service. Other methods for funding the project could include using a different benefit assessment formula, such as considering the frontage or number of bedrooms. The project could also be entirely or partially funded through contributions by the town tax base to offset the burden placed directly on the new users.

The cost analyses presented herein assume a 20 percent CWF grant on the initial project construction costs. Any additional grants, such as a higher CWF grant percentage or other funding sources further discussed below, would lower capital costs and life cycle costs of any sewering options.

As shown in summary tables, the lowest cost sewering alternatives have similar life cycle costs to a program of septic maintenance, inspections, and improvements. However, as discussed in Sections 1, 4, and 5, there are limitations to the functionality of septic systems associated with shallow groundwater, shallow rock, small lot sizes, and density of development in portions of the study areas.

The current study phase of this project is being funded by a 55 percent grant from the Connecticut Department of Energy and Environmental Protection (CT DEEP) Clean Water Fund (CWF). If the project moves forward into the design and construction phases, it will be eligible for continued funding from the CWF likely in the form of a 20 percent grant and with low-interest loan for the balance, as long as CWF requirements continue to be followed and funding is available.

In addition to the 20 percent CWF grant discussed above (which could be increased to 25 percent if CT DEEP can consider these project areas to be a "small community"), there are additional grant opportunities that may be applicable to this project. Some of those opportunities are listed below; applicability and available funding in all would need to be investigated further as the project moves forward:

- State of Connecticut Small Town Economic Assistance Program (STEAP): Grant funding may be available for the project from the Office of Policy and Management (OPM) STEAP grant, which provides funding for capital projects that fund economic development, community conservation, and quality of life projects. This includes environmental protection. Each individual municipality can receive up to $500,000 in a fiscal year, which can be used to offset construction costs. Brookfield is an eligible town and has received STEAP grants for other projects in the past.
- Environmental Protection Agency (EPA) State and Tribal Assistance Grants (STAG): STAG Grants are administered through the CWF, and projects eligible for CWF funding are also eligible to apply for STAG grants. STAG grants offer additional grant funding on the total

capital cost of the project. Selection of STAG grant recipients is competitive and criteria are not specifically enumerated, but local governmental leaders can advocate for the project to receive funding based on magnitude of impact to the region. STAG grants have ranged up to $3 million.

- National Fish and Wildlife Foundation (NFWF); Long Island Sound Futures Fund (LISFF): The NFWF's LISFF provides grants to projects that support the health of the Long Island Sound. Brookfield's Still River, which runs along Dean and Pocono Roads, discharges into the Housatonic River, which then releases into the Long Island Sound. Replacing Dean and Pocono's septic systems with a sanitary sewer system could help prevent excess nutrients and pollution from reaching the Long Island Sound. The LISFF grants ranged from approximately $50,000 to over $800,000 in Connecticut in 2022.

- United States Department of Agriculture (USDA), Rural Development (RD) Water & Waste Disposal Loan & Grant Program: This RD program provides funding for various projects including sanitary sewer projects. Eligible applicants include most local government entities with rural areas with populations of 10,000 or less. Brookfield's total population is approximately 17,000, but the town was divided into multiple tracts in the 2020 census. RD can sometimes consider the population of a single tract when determining funding eligibility. The details of eligibility must be explored further; this program can include grants as well as long-term loans with up to 40-year repayment.

- The DEEP Clean Water Act Section 319 Nonpoint Source Grant provides funding for projects that promote watershed protection by reducing pollutant loads or restoring impaired waters. Section 319 grants have a 40 percent non-federal match requirement for each awarded grant. This project may be eligible as it would help reduce the impact of Brookfield's impaired septic systems on the watershed of the impaired Still River.

- Bipartisan Infrastructure Law (BIL) which is providing additional funding to infrastructure projects in Connecticut through 2026 through multiple mechanisms.

- Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) - The United States Environmental Protection Agency (EPA) administers a financing program known as the Water Infrastructure Finance and Innovation Act of 2014 (WIFIA), for eligible water and wastewater infrastructure projects. WIFIA is not a grant program but is a mechanism to extend debt service over a longer period than the CWF. This project may be eligible for a loan under the WIFIA program, as it includes large wastewater conveyance and treatment projects (greater than $5 million for small communities with population less than 25,000 people) that also meet the requirements of a state revolving fund (SRF). The WIFIA program may cover up to 49 percent of the total project costs, including land acquisition, with a debt service payment schedule of up to 35 years.

7.4 Summary and Next Steps

At this point, CDM Smith recommends that the BWPCA hold public information sessions and solicits additional input from the public, possibly via a formal mailed questionnaire, for both the Dean and Pocono Roads Area and the Candlewood Peninsula and Candlewood Lake Road Area. Public support for any project of the magnitude discussed herein will be critical and this input is important before the BWPCA determines which Alternatives to proceed with for each study area.

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