FEASIBILITY REPORT

Palmer Lake Regional Wastewater Collection and Treatment

Town of Kent, New York

June 29, 2018

OBG

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EXECUTIVE SUMMARY

This Feasibility Report identifies and evaluates alternatives for meeting the Total Maximum Daily Load (TMDL) phosphorus allocation established for Palmer Lake by the NYSDEC in 2015, when it was officially designated as an impaired waterbody. The objective of this report is to provide solutions for wastewater collection and treatment that are economically and technically feasible, safe, robust, energy efficient, resilient, low maintenance, and politically acceptable. The report seeks to:

- Evaluate the most cost-effective methods to reduce phosphorus loading and protect the groundwater from wastewater impacts;
- Develop a feasibility study/conceptual wastewater management plan, which examines the feasibility of providing public sewers; and
- Using a long-term plan, solicit political and financial support for upgrading and expanding sewage treatment around Palmer Lake.

Palmer Lake is a 14-acre man-made lake located in the Towns of Carmel and Kent in Putnam County, approximately 50 miles north of New York City, and approximately seven miles west of the New York/ Connecticut state line. Palmer Lake was created as an impoundment to Michaels Brook for the recreational benefit of community homeowners. The watershed has a direct drainage of 460 acres, excluding its surface area and is oriented northwest to southwest, with a shoreline perimeter of approximately 8,465 feet.

Cyanobacteria blooms (blue-green algal blooms) are characteristic of lakes with elevated phosphorus concentrations and warm waters, and have become common summertime occurrences that threaten the viability of Palmer Lake.

The 2015 TMDL identified several sources that contribute to the lake's excessive phosphorus levels. The TMDL states "septic systems are the primary source of loading in the Palmer Lake watershed...Restoration of Palmer Lake is largely dependent on eliminating phosphorus loading from septic systems." All residences surrounding the lake are served by wells and sewage treated through residential on-site septic systems.

OBG was retained to examine the feasibility of extending public sewers to all properties within the Palmer Lake watershed and providing wastewater treatment. Potential alternatives for sewering include:

- Residential on-site septic systems
- Advanced treatment units
- Gravity collection system
- Grinder pump/ pressure sewer collection system
- Vacuum sewer collection system
- Effluent sewer collection system
  - Septic tank effluent pump (STEP) system
  - Septic tank effluent gravity (STEG) system
- Cluster collection/treatment system

The evaluation focused on providing initial service to residences within a 250-foot offset from the lake shore as this boundary has been determined by the NYSDEC and NYSDOH as the primary zone of nutrient influence on a waterbody due to failing or inadequate septic systems. For the purpose of this evaluation, detailed cost estimates were completed for the zone immediately surrounding the lake (Service Area 1) and estimates for serving the entire watershed (Service Area 2) under a long-term plan were developed.

It was determined through analysis and discussions with the NYSDEC and Town of Kent representatives that a cluster collection and localized subsurface treatment system is the preferred alternative for Palmer Lake, with a focus of addressing removal of septic systems within a 250-foot offset from the lakeshore and adjacent properties within a reasonable limit (Service Area 1). Implementation of this sewage collection and treatment program for the area surrounding Palmer Lake is recommended as a strategy to address the requirements of the TMDL and provide for less nutrient flow into Palmer Lake, thus reducing the potential for nuisance algal blooms. Preliminary cost estimates for the construction a cluster system to serve the customer base in Area 1 (92 customers) is approximately $5,300,000. To make this project economically feasible for the rate payers, substantial subsides in the form of grants will be required. It is further recommended to:

- Complete a preliminary design to further the process of defining the scope of the project. The preliminary design should include field and desktop investigations necessary to gain a better understanding of the project scope.
- Begin planning process for development of a sewer district to manage and fund the sewage facilities.
- Complete a siting evaluation to determine optimum location for cluster treatment system.
- Implement stormwater improvements along lake shoreline concurrently with collection sewer system.
- Evaluate potential of a regional WWTP to serve Lake Carmel and Palmer Lake areas.

1. BACKGROUND

1.1 INTRODUCTION

Palmer Lake (the Lake) is a 14-acre man-made lake located in the Towns of Carmel and Kent in Putnam County, approximately 50 miles north of New York City, and approximately seven miles west of the New York/ Connecticut state line. Palmer Lake was created as an impoundment to Michaels Brook for the recreational benefit to community homeowners. The community was originally comprised of summer retreat homes built in the late 1920s. Eventually, the summer cottages were converted to year-round residences or demolished and replaced by larger homes. Palmer Lake is a Class B waterbody under the New York Codes, Rules, and Regulations (6 NYCRR Part 864.6), meaning it is best intended for contact recreation (i.e., swimming and bathing), non-contact recreation (i.e., boating and fishing), aesthetics, and aquatic life. The primary uses at the Lake include swimming, boating, fishing, and aesthetics.

Palmer Lake watershed has a direct drainage of 460 acres, excluding its surface area. The Lake is oriented northwest to southwest, with a shoreline perimeter of approximately 8,465 feet. The location of the Lake may be seen in Figure 1.

In 2015, Palmer Lake was officially designated as an impaired water body by NYSDEC per Section 303(d) of the federal Clean Water Act. A Total Maximum Daily Load (TMDL) phosphorus allocation for the Lake was completed in 2015. Cyanobacteria blooms (blue-green algal blooms) have become common summertime occurrences that threaten the viability of the Lake for its multiple uses; these blooms are characteristic of lakes with elevated phosphorus concentrations and warm waters.

The 2015 TMDL identified several sources that contribute to the Lake's excessive phosphorus levels. The nonpoint sources contribute most the phosphorus to the Lake, which include groundwater, septic systems, open land, forest, streambank, and natural background. The TMDL states "septic systems are the primary source of loading in the Palmer Lake watershed, due to proximity of the systems to the Lake, and in some instances, relatively shallow bedrock, high groundwater and poor soils. Restoration of Palmer Lake is largely dependent on eliminating phosphorus loading from septic systems".

The topography surrounding Palmer Lake drops steeply into the Lake creating and when combined with small lots, results in the potential for inadequately treated septage to migrate downslope to the Lake. All residences surrounding the Lake are served by wells and sewage treated through residential on-site systems (septic tanks). Recent studies by the NYSDEC and Putnam County identify Palmer Lake as a septic "hot spot".

Based on the findings of the 2015 TMDL, prior studies, and the current water quality conditions of Palmer Lake, O'Brien & Gere Engineers, Inc. (OBG) was retained to examine the feasibility of extending public sewers to all properties within the Palmer Lake watershed and providing wastewater treatment.

1.2 EXISTING FACILITIES

Approximately 320 residences are located within the Palmer Lake watershed with approximately 92 residences close to the Lake (i.e.…. within Area 1). There are no commercial establishments adjacent to the Lake and all residences obtain water from wells and utilize residential on-site sewage systems for treatment of wastewater. Given the smaller lot size, it is likely that there are instances where wells and leachate fields may be in close proximity, resulting in septic systems imparting an influence on drinking water wells.

Located approximately half a mile from Palmer Lake on Rt. 52 is a privately owned WWTP (Kent Manor WWTP) constructed to serve the adjacent Kent Manor facility and sized for future development planned for the area. The Town of Carmel SD#2 WWTP is located within two miles of Palmer Lake and appears to have excess capacity. Further discussion of these facilities is included in subsequent sections.

NYSOGS
PALMER LAKE
PUTNAM COUNTY

LOCATION MAP

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1.3 OBJECTIVE

The objective of this study is to identify technically feasible and cost-effective approaches to provide public sanitary sewers and treatment to reduce the amount of phosphorus associated with wastewater entering Palmer Lake and protect the quality of the groundwater resource close to the Lake. These approaches will also consider energy efficiency, environmental impact, and political acceptability.

The following elements are included:

- Evaluate the most cost-effective methods to reduce phosphorus loading and protect the groundwater from wastewater impacts
- Develop a feasibility study/conceptual wastewater management plan, which examines the feasibility of providing public sewers
- Using a long-term plan, solicit political and financial support for constructing sewage collection and treatment around Palmer Lake

2. METHODOLOGY

2.1 REGULATORY REQUIREMENTS AND STANDARDS

The NYSDEC developed a Total Maximum Daily Loading (TMDL) for Palmer Lake will help drive initiatives to remove biodegradable phosphorus attributed to poorly operating residential on-site treatment systems.

Regulatory standards and guidance documents reviewed and referenced include:

- Individual facility SPDES permits and General Permits GP 0-05-001.
- Recommended Standards for Wastewater Facilities (Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (GLUMRB), 2004) - referred to as Ten States Standards. This guidance document is applicable to all WWTPs and includes standards for: sewers, pumping stations and force mains, as well as wastewater treatment facilities.
- Technical Report-16 (New England Interstate Water Pollution Control Commission, 2011) –referred to as TR-16. This guidance document is applicable to all WWTPs and PCI wastewater treatment systems and includes standards for: sewers, pumping stations and force mains as well as wastewater treatment facilities.
- New York State Design Standards for Intermediate Sized Wastewater Treatment Systems (NYSDEC, 2014) – referred to as Intermediate Design Standards. This guidance document is applicable to all PCI wastewater treatment systems that discharge to surface water and to groundwater dischargers of more than 1,000 GPD and less than 10,000 GPD. Portions of Ten State Standards are incorporated by reference.
- New York City Department of Environmental Protection (NYCDEP), Rules and Regulations for the Protection from Contamination, Degradation, and Pollution of the New York City Water Supply and its Sources.
- Unofficial Compilation of Codes, Rules, and Regulations of the State of New York Title 10 Department of Health, Chapter 11, Part 75. Standards for Individual Water Supply and Individual Sewage Treatment Systems Appendix 75-A – referred to as Appendix 75-A. This guidance document is applicable to individual septic systems that discharge 1,000 GPD or less to groundwater.
- Residential On-site Wastewater Treatment Systems Design Handbook (NYSDOH, 2012).

2.2 BASIC ASSUMPTIONS

The following assumptions were used to develop and evaluate potential alternatives:

- The average individual septic system influent total phosphorus concentration is 8 mg/L. This value is within the 6 mg/L to 12 mg/L typical range specified for Intermediate Sized Facilities (NYSDEC, 2014).

- The average hydraulic load per individual septic system is approximately 260 GPD. This number appears reasonable using two calculation methods:
  - The per capita hydraulic load is 100 GPD, in accordance with Ten State Standards, and the average household size is 2.61 people per dwelling unit, in accordance with the TMDL. Therefore, the hydraulic load is 100 GPD per person times 2.61 people = 261 GPD per individual septic system.
  - In accordance with the NYSDOH hydraulic flow rates for new construction (post 1994) is 110 gallons day per bedroom (GPDPB). It is a reasonable assumption that most homes have approximately 2.4 bedrooms. Therefore, 110 GPDPB times 2.4 bedrooms is 264 GPD per individual septic system.
- The design peak hourly flow is four times average flow (Ten States Standards).

2.3 EVALUATION CRITERIA

Criteria used to evaluate alternatives include:

Methodology for Establishing Benefit to the Lake

The benefit to the Lake was measured by the pounds of phosphorus removed per year when compared to estimated Lake loadings (current load).

Methodology for Identifying Areas Required to be Sewered

Subsurface discharge of individual septic systems or Private, Commercial or Industrial (PCI) wastewater treatment system effluent is prohibited in some areas by regulations or where operation and maintenance (O&M) of absorption beds may be difficult due to geological features. For the initial identification of areas that must be sewered, the following criteria were used:

Initial Criteria for Areas Required to be Sewered

- <u>Areas where the ground elevation is less than 5 feet above high Lake water level:</u> This criterion identifies areas where groundwater depth is too shallow in comparison with regulatory requirements for the installation of conventional absorption beds or trenches. Although there are allowable mounding methods for achieving minimum vertical separation distances, these methods would require the homeowner or PCI wastewater treatment system operator to maintain the structural integrity of the mounds, as well as direct surface water drainage pathways away from the mound. Since this requires a long-term commitment from the homeowner or PCI wastewater treatment system operator and there is no regulatory driver (i.e. a permit), installation of shallow absorption beds or trenches as a method to control residential phosphorus discharges to the Lake appears unfeasible.
- <u>Areas within 100 feet of a surface water (lake, creek, etc.)</u>: per Intermediate Design Standards absorption fields, must have a 100 feet horizontal separation distance from surface waters.
- <u>Areas in the 10-year flood plain are to be avoided</u>: This criterion identifies areas where flooding may occur. In addition to not installing septic systems in the 10-year flood plain areas, it is not recommended to locate systems in the 100-yr flood plain if possible.

Ancillary Benefits

In this Plan, ancillary benefits such as improvements to public health, economic stability, and environmental quality are presented in qualitative, not quantitative, terms. Although a dollar value is not assigned to these benefits, they will be cited in the Plan.

Public health risks can arise from poorly functioning or non-maintained failing individual septic systems and PCI wastewater treatment systems. The risk of failing individual septic systems and surface breakouts of wastewater are higher during wet weather events which could cause flooding or standing water over the individual septic system.

Perhaps the greatest improvement in water quality could be realized by conveying all sewage that is currently treated by a septic system or PCI to a WWTP for treatment instead. Septic systems and PCIs are not designed to treat contaminants such as household cleaners, heavy metals or toxic pollutants which may be inadvertently disposed of through a sink or toilet. These contaminants, even when discharged in small quantities, over time can pose a serious health and environmental risk. WWTPs are, however, capable of removing these contaminants to some degree prior to discharge to the Lake. Further, WWTPs routinely monitor influent and effluent for these contaminants and if levels increase, can adjust operations to improve reductions.

3. DESCRIPTION OF EXISTING SERVICE AREAS AND PHOSPHORUS SOURCES

The current loading to the Lake from individual septic systems, are shown in Table 1.

Table 1: Summary of Phosphorus Loads for Individual Septic Systems and Design Flows for Area 1

Individual septic systems within Area 1	
Quantity of residences	85
Quantity of Commercial Establishments	7
Flow (GPD)	23,940
P Load (lbs./yr.)	151.9
Total Current Number of Individual Septic Systems	92
Total Average Flow (GPD)	23,940
Total Peak Hourly Flow (GPD)[1]	3,991
Total phosphorus load to the Lake	151.9 lbs./yr.

Notes:

1. Based on a peak hourly flow peaking factor of 4.
2. Conservative estimate based on individual septic system locations presented in this plan.

To determine the total number of homes to be included in this analysis, OBG utilized tax parcel data provided by Putnam County to locate the center of the tax parcel.

Loading is based on individual septic systems located within 50 feet of the Lake with an annual phosphorus load of 6.1 lbs./ yr. while septic systems located between 50 and 250 feet of the Lake were assigned an average combined phosphorus load of 1.5 lbs./yr. Following methodology developed by the NYSDEC for the TMDL, this calculation assumes that 60% of the individual septic systems are performing normal (0 lbs. P/yr./system), 25% of the individual septic systems are short-circuiting (3.1 lbs. P/yr./system) and 10% are ponding (3.1 lbs. P/yr./system).

Table 2: Summary of Phosphorus Loads for Individual Septic Systems and Design Flows for Area 2

Individual septic systems within Area 2	
Quantity of residences	235
Quantity of Commercial Establishments	0
Flow (GPD)	61,100
P Load (lbs./yr.)	0
Total Current Number of Individual Septic Systems	235
Total Average Flow (GPD)	61,100
Total Peak Hourly Flow (GPH)[1]	10,183
Total phosphorus load to the Lake	0

Notes:

1. As all residences within Area 2 are located more than 250 feet from the lakeshore there is no phosphorus contribution provided that the septic systems are constructed and operated correctly.

Additional information pertaining to the development of the phosphorus loadings and residence count are included in Appendix A.

4. DESCRIPTION OF COLLECTION SYSTEM TECHNOLOGIES

Implementation alternatives are described below and may include one or more of the systems combined. Information has been obtained from the United States Environmental Protection Agency and the Water Environmental Research Foundation. Factsheets with additional information are included in Appendix B.

4.1 C1 - RESIDENTIAL ON-SITE SEPTIC TANK SYSTEM

Residential on-site treatment systems (generally known as septic tanks) utilize an anaerobic process followed by adsorption to treat wastewater. Septic tanks are the most common residential on-site treatment system and commonly used in rural areas where centralized collection and treatment systems are not available.

The system consists of two components: an enclosed below grade tank and an adsorption field located at grade or, in some cases, elevated to provide adequate separation above groundwater and to provide for use of imported granular fill when native material is unsuitable. In most cases, wastewater flows by gravity from the residence to the septic tank and then through the leach field. If the system includes a raised leach field, a small dosing pump is required.

A majority of the treatment takes place in the septic tank where solids are trapped and bacteria is reduced through the anaerobic process. Liquid leaving the septic tank (effluent) flows through the leach field where the remaining contaminants are adsorbed into the soils. Septic systems provide adequate removal for most residential pollutants but do not remove of readily available phosphorus.

While the longevity of properly installed residential on-site systems varies, typical lifespan for a septic tank and/or leach field is, at minimum, 15-20 years.

Elements of a properly installed and functioning septic tank and absorption area include:

- Septic tanks should be of concrete or plastic construction and sized for a minimum detention time of 36 hours;
- Absorption areas should be located a minimum of 2 feet above the seasonal high groundwater level;
- Absorption areas should be a minimum of 100 feet from any water body and 100 feet from any drinking water well;
- Allowable percolation rate of soil at the site (varies per site);
- Septic tanks within the NYCDEP watershed must be pumped out and inspected every 3 years.

4.2 C1A – ENHANCED TREATMENT UNITS

Removal of readily available phosphorus in a residential on-site system can be enhanced through the addition of an aeration step after the anaerobic septic tank. Typical installations consist of a three-compartment tank (anaerobic, aerobic and final settling) and the center compartment is outfitted with a small air pump and diffuser assembly. The air requirement is low and can be provided by a 120v air pump that can easily be installed in a new or existing system. While adding a second tank adjacent to an existing septic tank is possible, installation of an entirely new watertight system provides the most benefit.

The estimated installed cost for the aeration system in an existing tank is approximately $2,000 for a residential system.

Proper operation of the advanced treatment unit is dependent on the homeowner maintaining the aeration system and pumping out the septic tank on a regular basis. When coupled with properly constructed leach fields for subsurface disposal of effluent this alternative may be a good strategy for treatment in areas not directly adjacent to a waterbody. Quantitative results will vary with soil type, loading and condition of existing system.

4.3 C2 – GRAVITY COLLECTION SYSTEM

A gravity sewer system is used to collect wastewater from multiple sources and convey it by gravity to a central location where it can be treated. Wastewater from each source is conveyed through a lateral sewer to a collection line. Collection (sewer) lines are typically eight-inch or larger diameter pipe. Pipe diameters increase with increasing volume of water being transported. Pipes of sufficient size and slope are installed to keep the suspended solids moving through the system and to maintain an adequate flow, so as not to surcharge the system. If gravity flow is not possible throughout the system, lift (pumping) stations are employed. Lift stations are installed at low points of the network to pump the sewage via a force main up to another gravity line, to convey wastewater over hills, and/or up to a treatment facility. Manholes are installed at regular intervals to provide maintenance access to collection lines.

Sanitary sewers are sized based on design flows, with a minimum pipe diameter (typically 8-inches) to reduce the chance of clogging. They are also designed to maintain a minimum velocity under low flow conditions to ensure self-cleaning of the pipes, while staying below a maximum velocity to avoid damage to sewers and manholes. Slopes of gravity sewers are designed to ensure velocities remain within the allowable range. Pipe depth is another important design parameter; which depends on the lowest connection point, the depth of the water table, topography, and the frost line; that could greatly affect costs, depending on the amount of necessary excavation.

In its purest form (i.e., uniform slope from service connections to treatment components) gravity is an inexpensive means to convey water. However, the topography is rarely conducive to purely gravity flow, and lift stations must often be included. The cost of gravity sewers may be prohibitive unless there is sufficient population density to justify the installation.

There are several advantages of gravity collection systems, including:

- Being the most common and established types of sewer systems.

- Large enough pipes to handle grit and solids.
- Maintaining velocities, which reduces hydrogen sulfide production and odor problems.

There are also disadvantages of gravity systems, including:

- Allowable slopes for maintaining acceptable flow, which could require deep excavations in less than desirable terrain, increasing capital construction costs.
- Excavations are deeper and wider than for pressure sewers resulting in substantial additional costs in difficult or rocky soils or with high groundwater conditions.
- The need for lift stations to pump wastewater from low points ultimately to a treatment plant, increasing costs considerably.
- Inflow and infiltration, resulting from manholes and deteriorated piping, increasing the volume of sewage, resulting in larger pipes and lift stations, which will increase costs.

4.4 C3 – GRINDER PUMP / PRESSURE SEWER COLLECTION SYSTEM

Pressure sewers are a means of collecting wastewater from multiple sources and conveying it to a central location for treatment by using pressure instead of gravity. Pressurized sewers eliminate the slope requirements of gravity sewer systems and are instead able to follow the contour of the terrain and maintain a relatively constant depth below the soil surface. A typical arrangement is for each connection (or small cluster of connections) to flow to a centralized basin. When the basin fills to a set point, a grinder pump within the basin pumps the wastewater into the pressurized sewer. Grinder pumps utilize a unique rotating assembly that reduces the size of solids and stringy matter that could otherwise plug a pipe and allow for small diameter pipes to be used for conveyance. As various grinder pumps along the length of the sewer inject sewage into the line, the wastewater is progressively moved toward the treatment facility.

Pressurized sewer systems have higher energy demands than traditional gravity sewer systems, since each grinder pump must be connected to a power source. The pumps do not work when there are power outages and the size of the pump basin provides some detention time to allow for connection to a backup power system. One method for addressing backup power during a power outage is to install a common electric drop for a series of several grinder pumps. With this approach, a single portable generator can be employed to operate grinder pumps serving a group of homes. The generator(s) can be rotated between the groups of homes such that each group of pumps is operated every few hours to coincide with available detention time within the grinder pump basin.

As an alternate to this approach, grinder pumps could be powered from the residence and the homeowner responsible for temporary electric as needed.

Grinder pumps are somewhat maintenance free but require annual inspections. While pumps reportedly will last 8-10 years, replacement can be planned or take place when the equipment fails. Maintenance could be the responsibility of the residence or set up to be the responsibility of the sewer district. If the responsibility of the district, an agreement would have to be in place to allow the sewer district staff to enter private property for maintenance of the equipment.

There are several advantages of pressure sewers, including:

- The ability to sewer areas with undulating terrain, rocky soil conditions, and high bedrock or groundwater tables.
- Reduced material and installation costs, resulting from shallower placement, lack of manholes and lift stations, and longer sections of smaller diameter piping.
- The pump basin can be located such that the existing house lateral can remain in place and interior plumbing modifications won't be required.
- The ability to handle low flow situations.

Pressure sewer systems also have disadvantages, including:

- Require temporary power during power outages.
- Systems are often located on private property requiring access agreements for sewer district staff to maintain the systems as needed.
- The lifespan of a grinder pump system is typically 8-10 years requiring replacement when they fail.

4.5 C4 – VACUUM SEWER COLLECTION SYSTEM

A vacuum sewer system is used to collect wastewater from multiple sources and convey it to a central location for treatment. As the name suggests, a vacuum (negative pressure) is drawn on the collection system. When a service line is opened to atmospheric pressure, wastewater and air are pulled into the system. The wastewater that enters with the air forms a "plug" in the line, and air pressure pushes the wastes toward the vacuum station. This differential pressure comes from a central vacuum station. Vacuum sewers can take advantage of available slope in the terrain, but are most economical in flat terrain. Vacuum sewers have a limited capacity to pull water uphill with a maximum expected lift is between 30 and 40 feet. Vacuum sewers are designed to be watertight since any air leakage into the system reduces the available vacuum.

Vacuum sewers do not require a septic tank however, a valve pit with a pneumatic pressure valve is used to separate gravity flow from a residence or commercial establishment. Often, a common valve pit will serve multiple locations. Each valve pit is fitted with a pneumatic pressure-controlled vacuum valve which automatically opens after a predetermined volume of sewage has entered the sump. The difference in pressure between the valve pit (at atmospheric pressure) and the main vacuum line (under negative pressure) pulls wastewater and air through the service line. When the vacuum valves close, atmospheric pressure is restored inside the valve pit. The sewage travels in the vacuum main as far as its initial energy allows, eventually coming to rest. As other valve pits in the network open, more sewage and air enters the system. Each input of energy moves the sewage toward the central vacuum station. The violent action in the pipe tends to break up the larger suspended solids during transport.

Vacuum systems typically consist of one (or few) vacuum pumping stations resulting in a centralized location for the bulk of the maintenance activities. Many successful vacuum sewer systems are located in warmer areas with flat topography and less impact from freezing temperatures however, there are a few systems located in the northern part of the United States. Other than the vacuum pumps, the only other item that requires regular maintenance is the valve pit located at each residence or commercial establishment. Typically, the sewer district will have responsibility of all components in the system up to the customer connection to the valve pit. As the valve pits are often located on private property, agreements will need to be in place for the sewer district staff to access the valve pit.

Vacuum pump stations include two or more vacuum pumps and a large vacuum tank. The vacuum pumps run on short cycles that are sufficient for creating an adequate vacuum in the system. The large vacuum tank at the station maintains the vacuum on the collection system and keeps the vacuum pumps from having to operate at all times. There is a loss in negative pressure as the valve pits are actuated. The vacuum pumps turn back on when this negative pressure reaches a certain set point. Sewage flows into a collection tank when it gets to the vacuum station and traditional sewage pumps then convey the collected wastewater via a force main to the treatment facility.

Advantages of vacuum sewer systems include:

- Being conducive to flat and hilly terrain, rocky soils, dense communities in rural areas, and high groundwater tables and bedrock.
- Less disruptive installation, resulting from the small diameter pipes (typically 4-inches) and shallow excavations.
- The ability to locate vacuum sewer mains outside of and adjacent to the edge of pavement.

- Less disturbance than gravity sewers, including no need for manholes.
- Typically, the need for only one vacuum station, instead of multiple lift stations, reducing energy costs.
- Reduced odors and hydrogen sulfide production in the collection system because of a sealed system with short detention times.

Disadvantages of vacuum sewers include:

- The maximum expected capacity to draw wastewater uphill is between 30 and 40 feet.
- Low population densities with few connections result in poor performance because the movement of wastewater depends on the differential pressure created when valves open.
- Large and expensive vacuum stations.
- Noise and odor created by the vacuum station.
- The need to regularly inspect system components by staff or remote monitoring via telemetry.
- Regular maintenance, including changing oil and oil filters on vacuum pumps, removing and cleaning inlet filters on vacuum pumps, testing alarm systems, checking motor couplings, and checking operation of the vacuum station shutoff and isolation valves.
- Rebuilding controllers every 3 to 6 years and rebuilding valves every 8 to 12 years.
- Wastewater backup when valves fail to open.
- Several mechanical components in the system at risk for failure.

4.6 C5 – EFFLUENT SEWER COLLECTION

An effluent sewer is used to collect wastewater from multiple sources that has undergone liquid/solid separation or primary treatment and convey it to a central location for final treatment. Septic Tank Effluent Pump and Septic Tank Effluent Gravity sewers (commonly referred to as STEP or STEG) use on-lot septic tanks to provide liquid/solid separation. Clarified effluent then moves into the watertight collection system using either a pump (STEP) or gravity (STEG). STEP and STEG configurations can also be combined within a gravity or pressure collection system.

Septic Tank Effluent Pump (STEP)

In a STEP system each wastewater source or group of sources flows into a conventional, watertight septic tank to capture solids and provide primary treatment. However, in this case, an effluent pump (typically capable of pumping 3 or more gallons per minute) is installed either in the outlet end of the septic tank or in a separate holding tank or vault. The pump injects the clarified effluent into a pressure or gravity sewer system. As each STEP pump in the collection systems operates, effluent is progressively moved toward the wastewater treatment facility.

Retrofitting existing septic tanks can sometimes be a means of cost savings, however, if many must be replaced because of insufficient capacity, deterioration of concrete, or leaking, costs for a STEP system will increase significantly.

Advantages of STEP systems include:

- The ability to handle low flow conditions.
- Opportunities for cost savings by potentially reusing some existing septic tanks.
- The ability to sewer areas with undulating terrain, rocky soil conditions, and high bedrock or groundwater tables.
- Reduced material and installation costs, resulting from shallower placement, lack of manholes and lift stations, and longer sections of smaller diameter piping.

- Modifications to existing plumbing within homes and businesses are not necessary.

Disadvantages of STEP systems include:

- Not having a large excess capacity typical of conventional gravity systems.
- There are several mechanical components located within the service area.
- O&M costs are typically higher than they are for gravity systems, due to the number of pumps.

Power outages can result in overflows, but generators can prevent this.

Septic Tank Effluent Gravity (STEG)

In a STEG system, each source or group of sources has a watertight septic tank with an effluent screen and an access riser. Effluent flows out of the tank and into a collection sewer by gravity. The collection sewer is typically plastic pipe 4 to 8 inches in diameter. The piping from the tank to the collection line includes an accessible cleanout. STEG systems operate via gravity to a low point in the system where a lift station can be utilized to transfer the liquid downstream to a gravity or larger pumped system.

There are several advantages of STEG systems, including:

- The septic tank provides primary treatment of wastewater and captures debris, grease and grit that could impact downstream treatment processes.
- Septic tanks that are watertight and in good condition can remain in place and be converted to effluent transfer by pumping or gravity.
- Suitable for cluster systems.
- The ability to handle low flow conditions.
- Opportunities for cost savings by potentially reusing some existing septic tanks.
- Reduced material and installation costs, resulting from shallower placement, lack of manholes and lift stations, and longer sections of smaller diameter piping.
- Modifications to existing plumbing within homes and businesses are not necessary.

STEG systems also have disadvantages, including:

- STEP systems require temporary power during extended power outages (more than 1 day)
- Most existing septic tanks aren't considered watertight enough to work for a STEP/STEG system and will require replacement.
- Existing house laterals or septic tanks may not be optimally located to support a STEG system or easy access for sewer district employees.
- Requires that septic tanks be pumped out on a routine basis, usually every 3-5 years.
- Pumps and discharge piping are often located on private property requiring access agreements for sewer district staff to maintain the systems as needed.
- The lifespan of a pumps is 8-10 years requiring replacement when they fail.
- Allowable slopes for maintaining acceptable flow, which could require deep excavations in less than desirable terrain, increasing capital construction costs.
- The need for lift stations to pump wastewater from low points ultimately to a treatment plant, increasing costs considerably.
- Not having a large excess capacity typical of conventional gravity systems.

4.7 C6 – CLUSTER COLLECTION / TREATMENT SYSTEM

Cluster / Decentralized collection systems treat wastewater from several homes (aka. cluster) and are typically designed to treat 1,000 to as much as 20,000 gallons per day. Most systems consist of one or more larger septic tanks followed by an appropriately sized adsorption field.

Under this alternative, flow currently treated by individual septic systems would be diverted to a common septic system sized to treat the quantity of homes connected. Discharge from each new septic tank would be conveyed by gravity or pumped to a to a subsurface discharge point located at a distance of 250 feet or more from the Lake or other watercourse. It is assumed that the wastewater treatment system would be designed so that nutrient loading to the Lake from each system would be minimized due to the distance from the adsorption field to the Lake. Key features of this alternative include:

- Construction of gravity collection sewers to convey sewage to a common location for treatment;
- Installation of a residential sewer lateral from each residence to a collection sewer. Installation, as well as maintenance of the sewer lateral, would be the responsibility of the home owner;
- Installation of a wastewater treatment system to serve each cluster of homes. Operation and maintenance of the wastewater treatment system would be the responsibility of the group of homes that it serves. Identification of a responsible entity for O&M, as well as reporting to the NYSDEC would be necessary;
- It is expected that design flows for each wastewater treatment system is estimated to be between 1,000 GPD and 10,000 GPD, with subsurface discharge, therefore, the systems would be designed to comply with Intermediate Design Standards (NYSDEC, 2014). A General Permit GP 0-05-001 may be required. Projected phosphorus load from these systems to the Lake is estimated at essentially 0 lb./d; and
- Location of the absorption field would require at least two feet of appropriate soil type between the bottom of the absorption bed and the highest groundwater level, bedrock or permeable strata, as well as meeting minimum distances from water wells, in accordance with the Residential On-site Wastewater Treatment Systems Design Handbook.

5. DESCRIPTION OF ALTERNATIVES

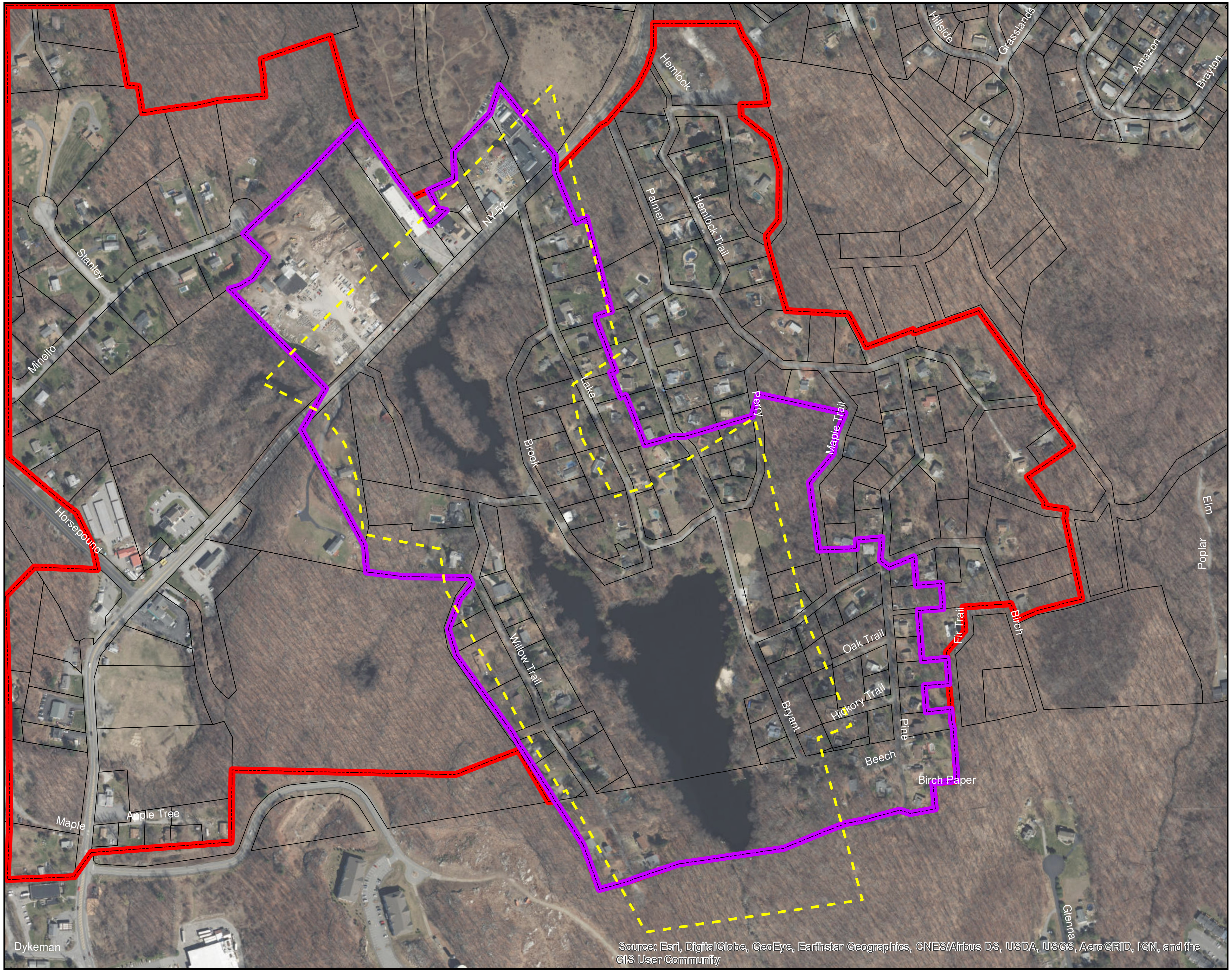
Potential alternatives are described below and may include one or more of the alternatives combined. To be considered a feasible alternative, the alternative must comply with regulations, reliably reduce phosphorus loads to the Lake, provide ancillary benefits, and be implementable. Evaluation of feasible alternatives to identify prime alternatives is contained in the next section – Evaluation of Alternatives.

The area surrounding the Lake is separated into project areas: Area 1 – within the proposed district boundary and Area 2 – remaining property within the lake watershed. The limits of Areas 1 and 2 are shown in Figure 2. As described under Basic Assumptions, residences located more than 250 feet from the Lake are assumed to discharge zero phosphorus load to the Lake; however, there is some evidence to suggest that this assumption is questionable as these discharges likely exert some phosphorus load particularly when there is a malfunction in the leach field. Inclusion of these areas in the long-term plan may have ancillary economic and health related benefits to the community. Alternatives considered for analysis are presented in Figures 3A, 3B, 3C and 3D.

5.1 BASELINE CONDITION

Baseline conditions represent conditions at the time the TMDL was developed. As the baseline condition, they serve as the basis of comparison for the evaluation of alternatives.

FIGURE 2



N

LEGEND

- Parcels
- Proposed Service Area 1
- Proposed Service Area 2
- 250-ft Offset

NEW YORK STATE OFFICE OF GENERAL SERVICES

PALMER LAKE PROPOSED DISTRICT EXTENSION

0 200 400 800
Feet

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MAY 2018

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5.2 ALTERNATIVE 1 – INSTALL NEW RESIDENTIAL ON-SITE SYSTEMS – FOR DISCHARGES WITHIN 250 FEET FROM THE LAKE

This alternative includes options for homeowners to reduce phosphorus loads to the Lake, without connecting to a collection system and diverting flow to an alternate location for treatment. Two options are considered:

- Install advanced treatment between the septic tank and the adsorption field. This approach includes upgrading the existing individual septic system, as well as installing an aeration step after the anaerobic septic tank. Aeration provides the biological mechanism to consume phosphorus and reduce levels prior to discharge from the system.
- Holding tank with subsequent removal and disposal of contents to a nearby WWTP.

This approach relies on the homeowner to install and maintain these systems to reduce the phosphorus load to the Lake. These systems would be installed under regulatory oversight but operation in a manner which reduces phosphorus load could not be guaranteed. If the advanced treatment system fails or the holding tank overflows, phosphorus would be discharged to the Lake at current levels and therefore, the estimated, conservative phosphorus reduction to the Lake would be 0 lbs. P/yr. This alternative may be considered not feasible as a reliable phosphorus removal system; however, it may be appropriate under some site-specific circumstances. For the purpose of this evaluation, Alternative 1 will not be considered further.

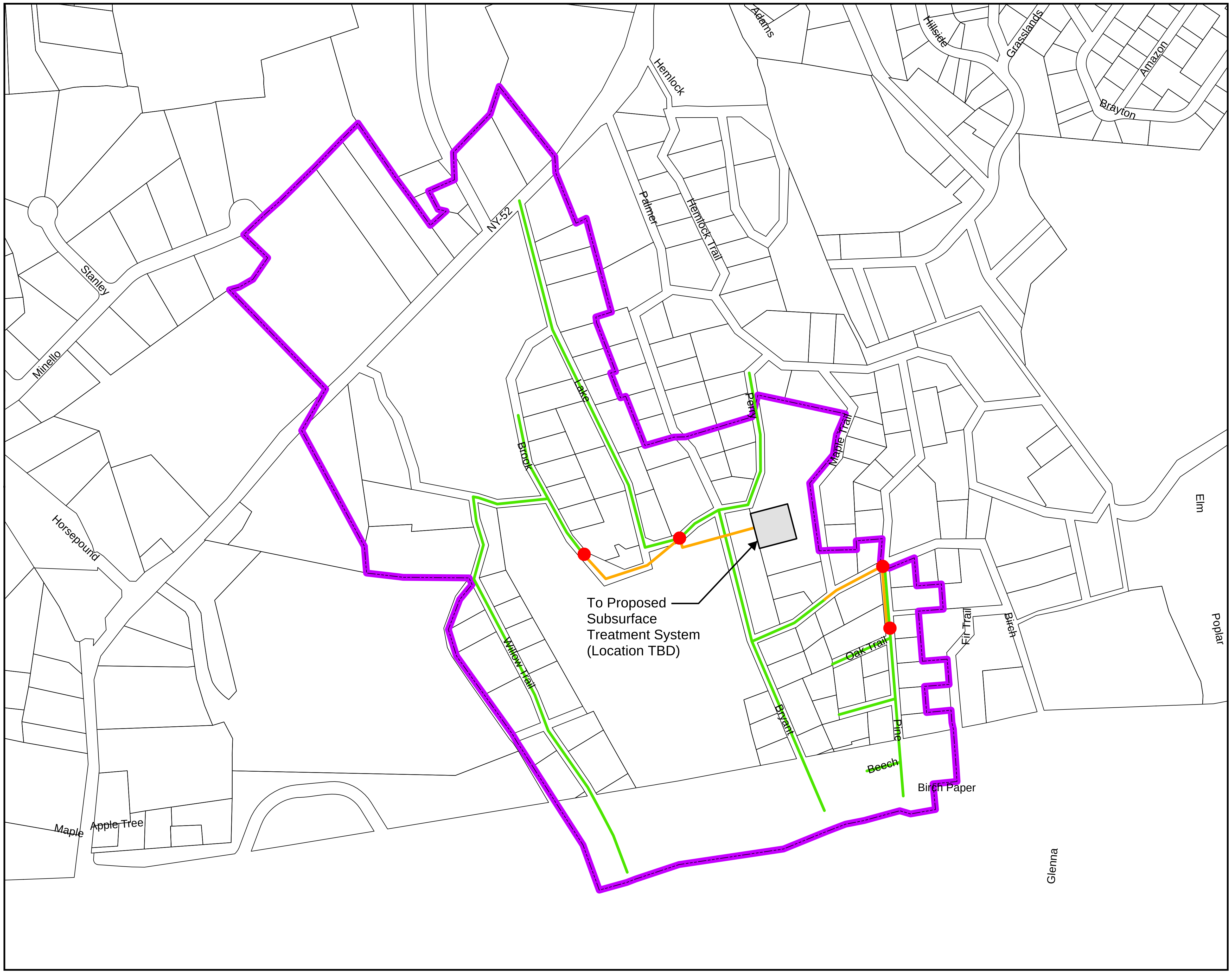
It should be further noted that New York State Public Health Code and environmental regulations have established minimum separation distances for individual septic system components. Septic tanks and absorption fields must be located 50 feet and 100 feet, respectively, from watercourses to protect against microbial contamination. Setbacks needed to reduce phosphorus loads could be significantly greater.

5.3 ALTERNATIVE 2 – INSTALL DECENTRALIZED CLUSTER SYSTEMS TO SERVE AREAS CURRENTLY TREATED BY INDIVIDUAL SEPTIC SYSTEMS – FOR DISCHARGES WITHIN 250 FEET FROM THE LAKE

Under this alternative, flow currently treated by individual septic systems within 250 feet of the Lake would be diverted to one or more strategically located cluster systems sized to support several residences. Discharge from each new decentralized system would be conveyed to a subsurface discharge point located a minimum distance of 250 feet from the Lake. It is assumed that the cluster wastewater treatment system would be designed so that phosphorus loading to the Lake from each system is estimated to be 0 lbs./yr. Palmer Lake is a candidate for installation of cluster systems to serve multiple homes due to the proximity of residences and open spaces adjacent to pods of homes. Based on a review of the area, it is feasible that homes could be clustered as follows and shown on Figure 3A:

- Form a sewer district for funding and maintenance of the collection system;
- Installation of residential sewer connections from each residence to a gravity collection system. Installation, as well as maintenance of the sewer connection, would be the responsibility of the home owner and estimated at $2,500;
- Installation of gravity sewers to connect homes with the cluster area to a common onsite PCI system;
- Installation of a PCI wastewater treatment system to serve clusters of homes (up to twenty homes per system) and consist of a septic tank, aeration step and leach field. Operation and maintenance of the PCI wastewater treatment system would be the responsibility of the residences served. Identification of a responsible entity for O&M, as well as reporting to the NYSDEC would be necessary;
- It is expected that design flows for each PCI wastewater treatment system is estimated to be between 1,000 GPD and 20,000 GPD, with subsurface discharge, therefore, the systems would be designed to comply with Intermediate Design Standards (NYSDEC, 2014). A General Permit GP 0-05-001 may be required. Projected phosphorus load from these systems to the Lake is estimated at 0 lbs./d; and
- Location of the absorption field would require at least two feet of appropriate soil type between the bottom of the absorption bed and the highest groundwater level, bedrock or permeable strata, as well as meeting

FIGURE 3A



N

LEGEND

- Parcels
- Proposed District Extension
- Gravity Sewer
- Force Main
- Pump Station

NEW YORK STATE
OFFICE OF GENERAL
SERVICES

PALMER LAKE
CLUSTER SYSTEMS

0 200 400 800
Feet

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MAY 2018

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I:\Nys-Ogs.2069\69637.C11-Engineering\Docs\DWG\MXD\Service Map - 3APalmer.mxd minimum distances from water wells, in accordance with the Residential On-site Wastewater Treatment Systems Design Handbook. Raised bed systems with lift stations may be required.

In some instances where individual septic systems are combined; operation of the systems by a Responsible Management Entity (RME) is an appropriate approach. RME is defined as a legal entity responsible for providing management services to ensure that decentralized onsite or clustered wastewater treatment facilities meet established criteria. An RME can be established to ensure long-term management of residential wastewater treatment systems. RME's may include: sewer districts, Counties, Towns, Villages, Hamlets, utilities, municipal authorities or other entities with the authority to enforce and the capacity to finance the long-term operation and maintenance requirements necessary to ensure residential wastewater treatment systems are functioning properly. Several RMEs have already been established within New York State to serve as a model for Palmer Lake.

Under this model as described in the Water Environment Research Foundation guidelines, the operating permit is issued to an RME instead of the property owner to provide the needed assurance that the appropriate maintenance is performed. The RME program includes:

- Establishment of system performance and monitoring requirements;
- Professional O&M services through RME (either public or private);
- Provides regulatory oversight by issuing operating or NPDES permits directly to the RME. (System ownership remains with the property owner.);
- Inventory of all systems; and
- Tracking system for operating permit and compliance monitoring.

The RME program limitations include the following:

- Enabling legislation may be necessary to allow RME to hold operating permit for an individual system owner;
- RME must have owner approval for repairs; may be conflict if performance problems are identified and not corrected;
- Need for easement/right of entry; and
- Need for oversight of RME by regulatory authority.

It is likely that both the regulatory authority and the property owner will face increased costs in improving management practices and programs. The cost impacts may increase as the level of management increases; however, trade-offs exist. Costs incurred by the regulatory authority and/or management entity may be offset by increased permit fees and more efficient data management tools, while the costs to the property owner may be offset by reduced repair and replacement costs, avoidance of environmental restoration costs, and increased property values and quality of life.

For a service fee, an RME takes responsibility for the operation and maintenance. This approach can reduce the number of permits and the administration functions performed by the regulatory authority. System failures are also reduced as a result of routine and preventive maintenance. The operating permit system is identical to that of the Operating Permit Model except that the permittee is a public or private RME. States have a regulatory structure to oversee the rate structures that RMEs establish and any other measures that a public services commission would normally undertake to manage private entities in noncompetitive situations.

Establishment of a RME for the interim period before a public sewer system is constructed and placed into service appears to be a viable option to avoid water quality impacts of failing or poorly operating PCI wastewater treatment systems and individual septic systems.

5.4 ALTERNATIVE 3 – CONNECT UNSEWERED AREAS TO EXISTING OR NEW WASTEWATER TREATMENT PLANT

This alternative includes decommissioning/abandoning existing individual septic systems in unsewered areas and diverting flows to a collection system. Each homeowner would be responsible for installation, operation and maintenance of the residential sewer connection from the residence to the collection system (gravity sewer, grinder station, forcemain, etc.). For planning purposes, connection costs are estimated at $2,500. A new sewer district will be formed to support the installation, upgrade, operation and maintenance of the collection system.

While decommissioning individual septic systems within 250 feet of the Lake will address phosphorus loadings, it is recommended that all homes as well as PCI wastewater treatment systems within the potential service area be included in a collection system project to maximize the benefit to the community.

The following paragraphs describe each alternative considered for evaluation. Potential facilities for each alternative are estimated for Areas 1 and 2. However, Figures of proposed infrastructure were developed for Area 1 improvements only as these will provide the most benefit to the Lake relative to removal of readily available phosphorus.

The following collection system alternatives were short listed and evaluated and are based on discharge to a WWTP within one mile of Palmer Lake:

Alternative 3A: Gravity Collection

Alternative 3A generally consists of installing gravity sewers within existing streets and directing flows to low points to small pump stations. These pump stations would transfer flow to a larger pump station for discharge to a regional WWTP. To install new house laterals, each property owner would abandon their existing septic system and install a new gravity 4-inch diameter lateral from their residence to the right of way at the street. This may require some internal plumbing modifications, depending on the locations of the existing septic tank and new gravity sewer. Additionally, the property owner could expect to perform infrequent maintenance consisting of sewer cleaning, tree root removal and repairing damaged lines. The proposed facilities are shown on Figure 3B and further described below:

Area 1:

- Approximately 9,000 LF of 8-inch diameter gravity sewer (5 to 8 ft. deep)
- Approximately 36 manholes
- Four (4) lift stations
- Approximately 5,000 LF of 4-inch diameter force main
- Laterals to each residence
- Disconnect and decommission each residential on-site treatment system

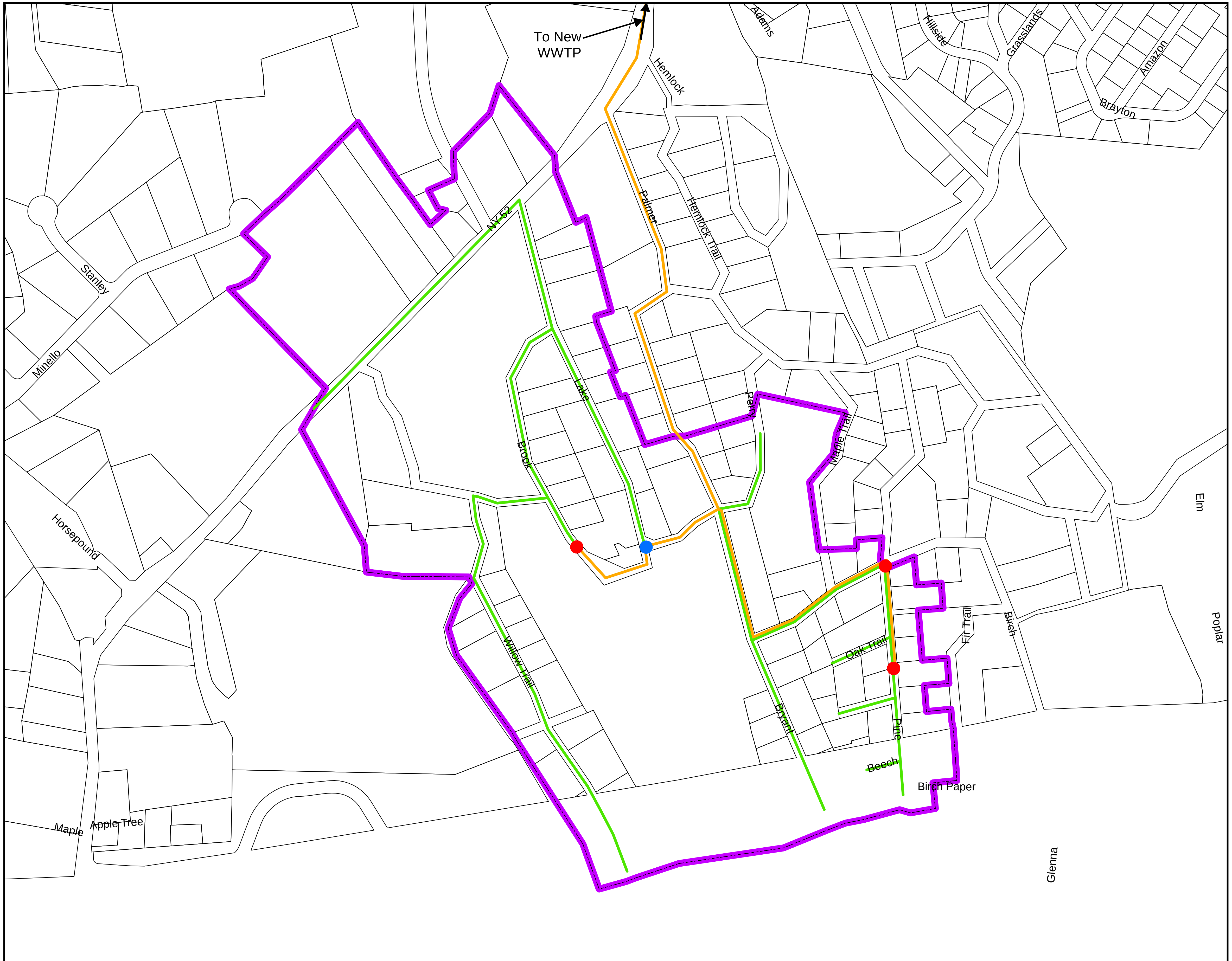
Area 2:

- Approximately 12,000 LF of 8-inch diameter gravity sewer (5 to 8 ft. deep)
- Approximately 48 manholes
- Four (4) lift stations
- Approximately 8,000 LF of 4-inch diameter force main
- Laterals to each residence
- Disconnect and decommission each residential on-site treatment system

Alternative 3B: Pressure Sewers

Alternative 3B generally consists of installing grinder pumps and pressure sewers throughout the service area. The pressure sewers would transfer flow to a WWTP within one mile the Lake. The property owner would be responsible for the installation of the sewer lateral from the house to the grinder pump station as well as decommissioning the existing septic tank. The estimated cost for installation of the sewer lateral is $1,500. Routine maintenance would likely consist of replacing the grinder pump approximately every 5 to 10 years. The proposed facilities are shown on Figure 3C and further described below:

FIGURE 3B



N

LEGEND

- Parcels
- 8" - 10" Gravity Sewer
- 4" Force Main
- Proposed District Extension
- Pumping Station (50-100 gpm)
- Pumping Station (100-200 gpm)

NEW YORK STATE OFFICE OF GENERAL SERVICES

PALMER LAKE GRAVITY COLLECTION SYSTEM

0 200 400 800
Feet

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MAY 2018

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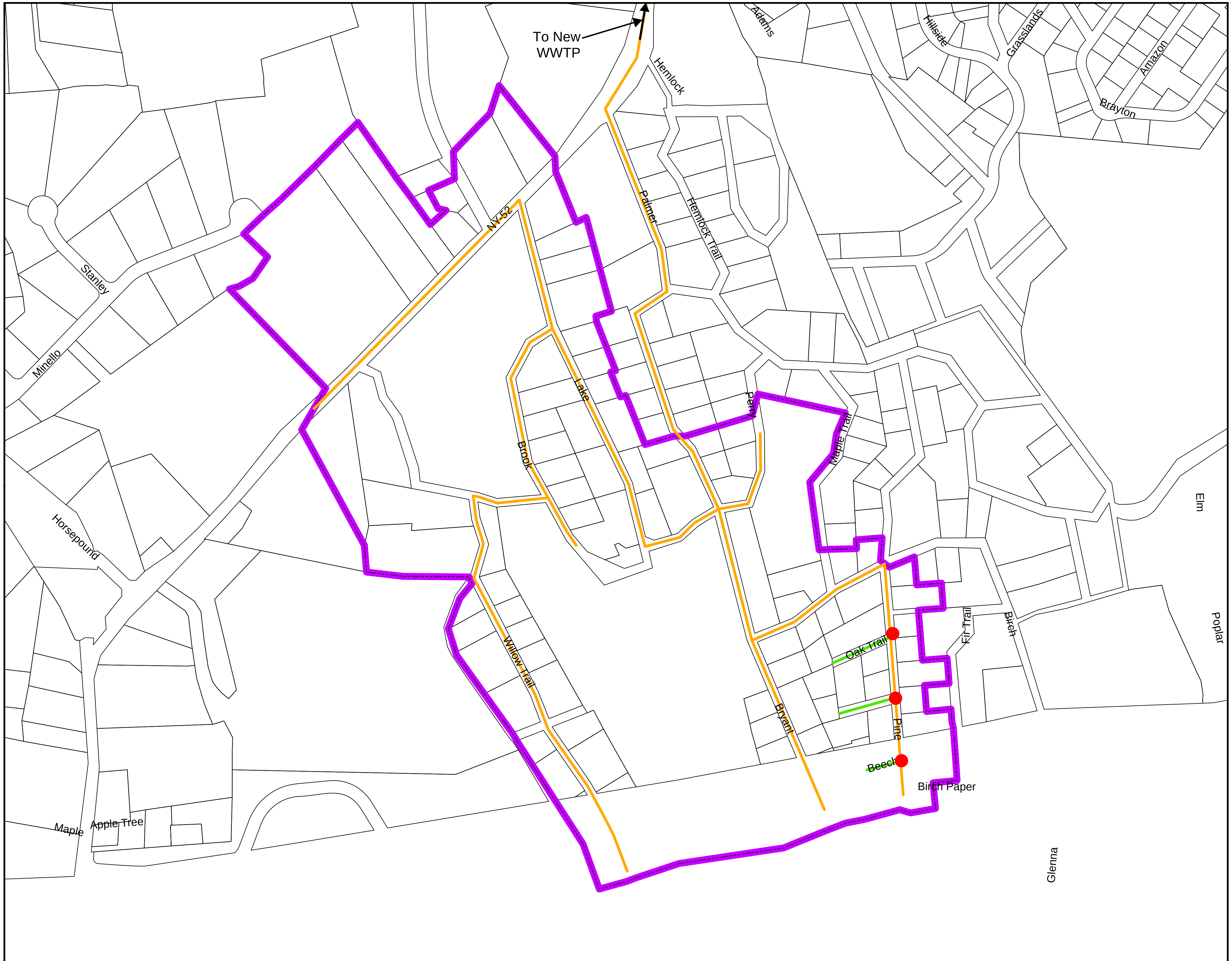

N

LEGEND

- Parcels
- 8" Gravity Sewer
- 4" Force Main
- Proposed District Extension
- Duplex Grinder Pump

NEW YORK STATE
OFFICE OF GENERAL
SERVICES

PALMER LAKE
GRINDER PUMP / PRESSURE
SEWER COLLECTION SYSTEM

0 200 400 800
Feet

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MAY 2018

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Area 1:

- Approximately 14,000 LF of 2-inch diameter low pressure sewer
- Approximately 80 grinder pumping stations
- Disconnect and decommission each residential on-site treatment system

Area 2:

- Approximately 24,000 LF of 2-inch diameter low pressure sewer
- Approximately 235 grinder pumping stations
- Disconnect and decommission each residential on-site treatment system

5.4 ALTERNATIVE 4 – SEPTIC TANK EFFLUENT COLLECTION AND TREATMENT

This alternative includes utilizing residential on-site treatment and collection of effluent for treatment offsite at a POTW. For this alternative to be most effective, all existing septic tanks will be replaced with new equipment properly designed to support effluent collection and transfer. In this case, responsibility of the interior plumbing and lateral to the new septic tank would be the responsibility of the homeowner and septic tank, effluent collection and district-wide collection and transfer systems would be the responsibility of the district

Alternative 4A: STEG – Septic Tank Effluent Gravity Collection

Based on the presumed location of septic tanks behind most homes and the additional work required to route gravity piping around the residence to the appropriate location for connection this alternative as deemed not feasible.

Alternative 4B: Septic Tank Effluent Pumped Collection

Alternative 4B generally consists of replacing existing septic tanks and installing new tanks with effluent pumps to convey flow to a common lift station. This lift station would then transfer flow to an existing gravity collector sewer nearby (assumed to be located on RT 52). The proposed facilities are shown on Figure 3D and further described below:

Area 1:

- Approximately 92 new septic tanks with effluent pumping system
- Approximately 13,500 LF of 2-inch diameter low pressure sewer
- One (1) lift station
- Approximately 2,000 LF of 2-inch diameter force main

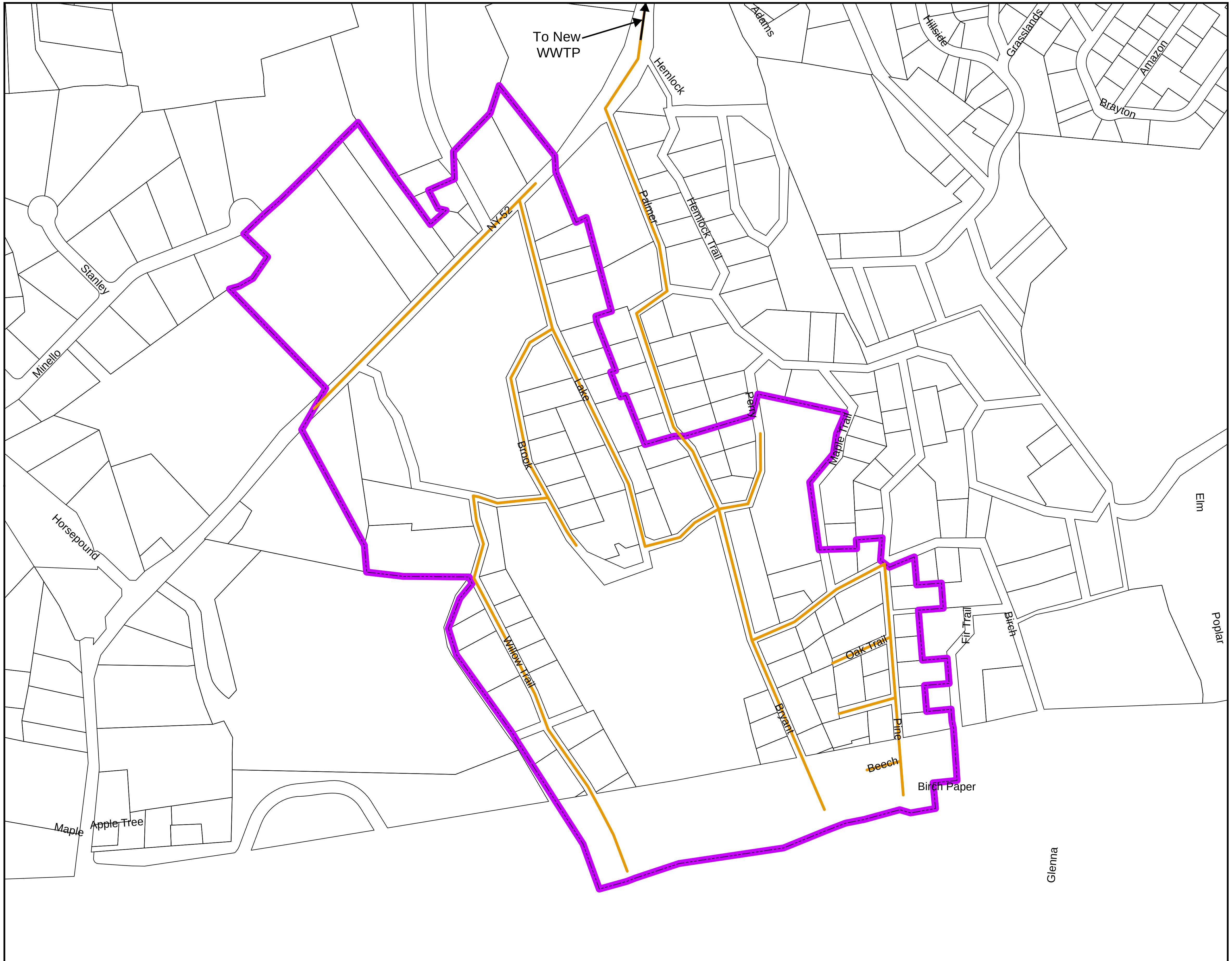
Area 2:

- Approximately 235 new septic tanks with effluent pumping system
- Approximately 24,000 LF of 2-inch diameter low pressure sewer

5.5 ALTERNATIVE 5 – PUBLIC OUTREACH

Public outreach is included as an alternative due to the fact that many individual septic systems are installed and then forgotten about, unless problems arise. Due to this fact, people are unaware that their system may not be performing as designed and could be negatively impacting Palmer Lake. Since the homeowners are responsible for maintaining the individual septic system, it is important to teach the public about the proper way to maintain their individual septic systems.

The United States Environmental Protection Agency (EPA) has started a SepticSmart initiative (http://water.epa.gov/infrastructure/septic/septicsmart.cfm), a nation-wide public education effort which



N

LEGEND

- Parcels
- Proposed District Extension
- 1.5" Force Main

NEW YORK STATE
OFFICE OF GENERAL
SERVICES

PALMER LAKE
PROPOSED SEPTIC TANK
EFFLUENT PUMP SYSTEM

0 200 400 800
Feet

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I:\Nys-Ogs.2069\69637.C11-Engineering\Docs\DWG\MXD\Service Map - 3DPalmer.mxd works to inform owners of individual septic systems about the importance of proper maintenance. The EPA provides many resources, brochures and fact sheets for outreach organizations and government leaders to assist in educating the public.

Septic system maintenance and proper care includes:

- Inspections should be completed at least every three years by a septic service professional
- Septic tanks should be pumped out every three to five years
- Using less water with water-efficient products reduces the risk of septic system failure as well as saving money, water and energy
- Individual septic systems should not be used as a trash can, anything that goes down the toilet, sink, shower or bath ends up in the individual septic system. Avoid sending anything besides human waste and toilet paper to the individual septic system.
- Maintenance of drain fields includes no parking or driving on these systems, no planting trees where roots could grow into the septic system and keep rain water systems separate.

Public outreach is the easiest and cheapest way to reduce the amount of phosphorus entering Palmer Lake through individual septic systems. By educating the public of proper maintenance, there is hope that more people will provide proper maintenance to their systems and will help clean the Lake. While an exact amount of phosphorus reduction cannot be assigned to this alternative, it is possible a great benefit could come from this effort. Public outreach may have the fastest positive impact on the Lake while the implementation of a permanent sewage management system is being implemented, which may take many years.

6. WASTEWATER TREATMENT ALTERNATIVES

NYCDEP regulations generally prohibit the construction of new surface discharge facilities unless a septic emergency is determined and require substantial permitting and studies to advance the project. Construction of subsurface discharge facilities are more feasible and the permitting process can be more straightforward.

Given the difficulty in development of a new surface discharge WWTP in the NYCDEP watershed directing flows to an existing facility is most favorable.

6.1 EXISTING PUBLICLY OWNED TREATMENT WORKS

The Kent Manor WWTP (SPDES NY0207322) is located on Nichols St, approximately 0.5 miles from the northern side of Palmer Lake.

The facility was constructed to serve the Kent Manor housing complex and future development along Route 52. Currently, the facility processes a maximum flow of 14,000 GPD and is permitted for up to 103,200 GPD resulting in available capacity of approximately 89,000 GPD which exceeds the treatment needs for Palmer Lake Area 1, currently estimated as 23,940 GPD.

As the facility is privately owned, the sewer district would need to develop a service agreement to process flows from the Palmer Lake watershed.

The Town of Carmel SD#2 WWTP (SPDES NY0031356) is located within two miles of Palmer Lake and is permitted for a flow of 1.1 MGD and currently is processing approximately 0.9 MGD. Based on this brief analysis it appears that the facility has potential excess capacity to treat flows from the Palmer Lake service area.

Table 3 – Palmer Lake Wastewater Treatment Alternatives

	Kent Manor (SPDES NY0207322)	Town of Carmel SD#2 (SPDES NY0031356)
Permitted Capacity (GPD)	103,200	1,100,000
Historical Flow (GPD)	14,000	900,000
Available Capacity (GPD)[1]	89,200	200,000
Projected Area 1 Flows (GPD)[2]	23,940	23,940
Projected Area 2 Flows (GPD)[3]	61,100	61,100
Available Capacity for Palmer Lake Flows	Area 1 – ✓ Area 2 – NO	Area 1 – ✓ Area 2 – ✓
Distance from Palmer Lakes	1 mile	2 miles

Notes:

1. Unconfirmed with POTW. Data is based on the NYSDEC database
2. Estimated flows generated within 250 feet of the lakeshore
3. Estimated flows generated within service area minus Area 1

6.2 POTENTIAL ADDITIONAL TREATMENT REQUIREMENTS

Provided that a suitable arrangement can be developed with the Kent Manor WWTP and/or Town of Carmel SD No. 2 WWTP for treatment of wastewater from the Palmer Lake service area, there will be no need for additional treatment facilities to treat flows from this service area.

However, in the event that an arrangement cannot be made, a new wastewater treatment system will be required to process the flows from this area. If cluster treatment is not implemented.

7. ALTERNATIVES COST EVALUATION

The basis of cost estimates is a combination of costs presented in previous consultants' reports and updated based on current bid tabs and standards. They have been utilized to develop conceptual screening level costs for various infrastructure improvements. A summary of unit prices is included as Appendix C and a breakdown of the overall costs in Appendix D.

As implementation of cluster systems with subsurface discharge is a preferred alternative, discharge to a WWTP will not be required. However, if other alternatives are selected, treatment at a WWTP will be required. The costs for expanding an existing or proposed WWTP to serve Palmer Lake are included in the following sections.

An opinion of probable costs, potential O&M costs and potential user costs, was developed for each alternative and is presented below:

Table 4: Probable Project Cost for Palmer Lake Collection Sewers

	Area 1	Area 2	Treatment[2]	Total
Alternative 2 - Cluster Collection[1]				
Area 1	$5,300,250	---	---	$5,300,250
Area 2	---	$10,044,375	---	---
Alternative 3A -Gravity Collection				
Area 1	$6,151,050	---	$3,000,000	$9,151,050
Area 1 & 2	$6,151,050	$9,723,375	$3,000,000	$18,874,425
Alternative 3B - Grinder/Pressure Collection				
Area 1	$3,306,225	---	$3,000,000	$6,306,225
Area 1 & 2	$3,306,225	$8,033,175	$3,000,000	$14,339,400
Alternative 4B - Effluent Collection				
Area 1	$4,570,350	---	$3,000,000	$7,570,350
Area 1 & 2	$4,570,350	$8,745,675	$3,000,000	$16,316,025

Notes:

1. The capital cost for Alternative 2 includes collection and subsurface treatment.
2. Cost for WWTP facilities based on additional capacity required in a regional Carmel/Palmer facility.

Table 5 summarizes collection and treatment operation and maintenance (O&M) costs.

Table 5: Estimated Annual O&M Costs

Alternatives	Staffing	Electrical	Collection System Miscellaneous	Sub Total	Wastewater Treatment Primary Treatment O&M	MBR O&M	Total
3A - Gravity Sewers - Area 1	$22,250.00	$2,500.00	$7,500.00	$32,250.00	$15,728.58	$15,466.44	$63,445.02
3A - Gravity Sewers - Area 2	---	$1,200.00	$7,500.00	$8,700.00	$40,142.70	$39,473.66	$88,316.36
3A - Gravity Sewers - Total	$22,250.00	$3,700.00	$15,000.00	$40,950.00	$55,871.28	$54,940.09	$151,761.37
3B - Pressure Sewers - Area 1	$22,250.00	$6,624.00	$7,500.00	$36,374.00	$15,728.58	$15,466.44	$67,569.02
3B - Pressure Sewers - Area 2	---	$16,920.00	$7,500.00	$24,420.00	$40,142.70	$39,473.66	$104,036.36
3B - Pressure Sewers - Total	$22,250.00	$23,544.00	$15,000.00	$60,794.00	$55,871.28	$54,940.09	$171,605.37
4B - STEP - Area 1	$22,250.00	---	$7,500.00	$29,750.00	$10,922.63	$15,466.44	$56,139.06
4B - STEP - Area 2	---	---	$7,500.00	$7,500.00	$27,876.88	$39,473.66	$74,850.53
4B - STEP - Total	$22,250.00	---	$15,000.00	$37,250.00	$38,799.50	$54,940.09	$130,989.59
2 - Cluster - Area 1	$22,250.00	---	$7,500.00	$29,750.00	---	---	$29,750.00
2 - Cluster - Area 2	---	---	$7,500.00	$7,500.00	---	---	$7,500.00
2 - Cluster - Total	$22,250.00	---	$15,000.00	$37,250.00	---	---	$37,250.00

Notes:

1. Electrical cost for pumps under Alternate 2B will be borne by homeowner.
2. Collection system staffing estimated at 0.5 FT employee employed by District.
3. Primary wastewater treatment O&M based on $1.80/1,000 gallons treated for raw wastewater and $1.25/1,000 gallons treated for STEP.
4. MBR O&M based on $1.77/1,000 gallons treated.
5. Grinder pump electrical costs estimated at $6/month and will be borne by District.

Tables 6 through 13 present potential user cost scenarios for Area 1 alternatives 2, 3A, 3B, and 4B. As noted in previous sections, detailed O&M and user costs scenarios were not developed for Area 2 dues to the high cost of the proposed improvements and limited benefit to lake water quality.

Table 6: Alternative 2 Funding Analysis

	Area 1
Capital Cost Sewer	$5,300,250.00
Capital Cost Treatment	---
NYCDEP Capital Cost Subsidy[1]	---
Total Local Capital Cost	$5,300,250.00
NYSEFC Financing[2] (Annual)	$232,015.44
O&M (Annual)	$29,750.00
NYCDEP O&M Subsidy[3]	---
Annual Cost Subtotal	$261,765.44
No. of Users	92
Annual Cost/ User w/o Grants	$2,845.28
Annual O&M Per User[4]	$323.37
Capital Cost Repayment	$2,521.91

Notes:

1. NYCDEP subsidy for tertiary treatment capital cost.
2. Based on 30-year loan at 2% annual interest.
3. NYCDEP subsidy for tertiary treatment O&M.
4. O&M Costs for primary and secondary treatment are not grant eligible.

Table 7: Alternative 2 Estimated Grant Requirements

Annual User Fee	Required Grant Funding
$400.00	$6,748,963
$500.00	$6,472,963
$600.00	$6,196,963
$700.00	$5,920,963
$800.00	$5,644,963
$900.00	$5,368,963
$1,000.00	$5,092,963

Table 8: Alternative 3A Funding Analysis

	Area 1
Capital Cost Sewer	$6,151,050.00
Capital Cost Treatment	$3,000,000.00
NYCDEP Capital Cost Subsidy[1]	$2,500,000.00
Total Local Capital Cost	$6,651,050.00
NYSEFC Financing[2] (Annual)	$291,145.95
O&M (Annual)	$63,445.02
NYCDEP O&M Subsidy[3]	$15,466.44
Annual Cost Subtotal	$47,978.58
No. of Users	$339,124.53
Annual Cost/ User w/o Grants	92
Annual O&M Per User[4]	$3,686.14
Capital Cost Repayment	$521.51

Notes:

1. NYCDEP subsidy for tertiary treatment capital cost.
2. Based on 30-year loan at 2% annual interest.
3. NYCDEP subsidy for tertiary treatment O&M.
4. O&M Costs for primary and secondary treatment are not grant eligible.

Table 9: Alternative 3A Estimated Grant Requirements

Annual User Fee	Required Grant Funding
$600.00	$8,517,736
$700.00	$8,241,736
$800.00	$7,965,736
$900.00	$7,689,736
$1,000.00	$7,413,736

Table 10: Alternative 3B Funding Analysis

	Area 1
Capital Cost Sewer	$3,306,225.00
Capital Cost Treatment	$3,000,000.00
NYCDEP Capital Cost Subsidy[1]	$2,500,000.00
Total Local Capital Cost	$3,806,225.00
NYSEFC Financing[2] (Annual)	$166,615.34
O&M (Annual)	$67,569.02
NYCDEP O&M Subsidy[3]	$15,466.44
Annual Cost Subtotal	$52,102.58
No. of Users	$218,717.92
Annual Cost/ User w/o Grants	92
Annual O&M Per User[4]	$2,377.37
Capital Cost Repayment	$566.33

Notes:
1. NYCDEP subsidy for tertiary treatment capital cost.
2. Based on 30-year loan at 2% annual interest.
3. NYCDEP subsidy for tertiary treatment O&M.
4. O&M Costs for primary and secondary treatment are not grant eligible.

Table 11: Alternative 3B Estimated Grant Requirements

Annual User Fee	Required Grant Funding
$600.00	$4,905,538
$700.00	$4,629,538
$800.00	$4,353,538
$900.00	$4,077,538
$1,000.00	$3,801,538

Table 12: Alternative 4B Funding Analysis

	Area 1
Capital Cost Sewer	$4,570,350.00
Capital Cost Treatment	$3,000,000.00
NYCDEP Capital Cost Subsidy[1]	$2,500,000.00
Total Local Capital Cost	$5,070,350.00
NYSEFC Financing[2] (Annual)	$221,951.70
O&M (Annual)	$56,139.06
NYCDEP O&M Subsidy[3]	$15,466.44
Annual Cost Subtotal	$40,672.63
No. of Users	$262,624.32
Annual Cost/ User w/o Grants	92
Annual O&M Per User[4]	$2,854.61
Capital Cost Repayment	$442.09

Notes:

1. NYCDEP subsidy for tertiary treatment capital cost.
2. Based on 30-year loan at 2% annual interest.
3. NYCDEP subsidy for tertiary treatment O&M.
4. O&M Costs for primary and secondary treatment are not grant eligible.

Table 13: Alternative 4B Estimated Grant Requirements

Annual User Fee	Required Grant Funding
$500.00	$6,498,730
$600.00	$6,222,730
$700.00	$5,946,730
$800.00	$5,670,730
$900.00	$5,394,730
$1,000.00	$5,118,730

8. PERMITTING

Table 14 identifies potential permits and approvals which may be necessary to construct the proposed improvements. The applicability of these programs will be reviewed and confirmed as the design progresses.

Table 14: Potential Required Permits and Approvals

	Permit	Activity	Agency
	Federal		
1	Section 404 of the Clean Water Act	Discharge of dredged or fill material into waters of the United States (including non-isolated wetlands; delineation required for application). Nationwide Permits vs. Project-Specific Permit.	United States Army Corps of Engineers (USACE)
2	ESA (Section 7 of ESA)	Consultation process to identify Federally- or State-listed, proposed or candidate species and/or critical habitats that occur within the proposed project area. The presence of certain bat species requires time of year restrictions on tree-cutting.	United States Fish & Wildlife Services (USFWS), New York State Department of Environmental Conservation (NYSDEC)
	State		
3	Section 401 of the Clean Water Act (401 Water Quality Certification)	Certification is used to ensure that federal agencies issuing permits or carrying out direct actions, which may result in a discharge to waters of the United States do not violate New York State's water quality standards or impair designated uses.	NYSDEC
4	Protection of Waters (6 New York Codes, Rules and Regulations (NYCRR) Part 608; Article 15 of the Environmental Conservation Law (ECL))	Work within protected water bodies (bed and banks)	NYSDEC
5	Freshwater Wetlands (6 NYCRR Parts 663 – 664; Article 24 of the ECL)	Activities within State-regulated wetlands and buffer areas (mapped by NYSDEC).	NYSDEC
6	State Pollutant Discharge Elimination System (SPDES) General Permit for Storm Water Discharges from Construction Activity (GP-0-15-002)	Storm water discharges from construction phase activities disturbing one-acre or greater. Includes preparation and implementation of SWPPP and review of Stormwater Pollution Prevention Plan (SWPPP) by Municipal Separate Storm Sewer Systems (MS4s) local jurisdictional authorities.	NYSDEC MS4s
7	SPDES Permit for the Discharge of Wastewater (and Stormwater) (6 NYCRR Part 750)	Combined SPDES Permit (wastewater from treatment facility and site storm water discharges). See No. 32 below if wastewater from pre-treatment facility is discharged to local POTW.	NYSDEC
8	Wastewater Disposal System (Approval of Plans & Specifications)	Approval of wastewater facility designs.	NYSDEC (tie-in to public sewer may also require local approval)
9	Highway Work Permit	Work within highway rights-of-way (highway and utility improvements).	New York State Department of Transportation (NYSDOT) and/or local DOT
10	State Environmental Quality Review Act (Article 8 of the ECL; 6 NYCRR Part 617)	Environmental impact assessment. Preparation of Full Environmental Assessment Form (EAF). May also involve "Environmental Justice"-related public participation activities. Federal funding/permits may require National Environmental Policy Act (NEPA) review.	Lead & Involved Agencies

	Permit	Activity	Agency
11	Federal & State Preservation Laws (36 Code of Federal Regulations (CFR) 800; 9 NYCRR Part 428; Sections 3.09 and 14.09 of the NYS Parks, Recreation and Historic Preservation Law)	Activities affecting historic, architectural, archaeological and cultural resources. Involved State agency determines need for consultation with SHPO. Consultation via SHPO's Cultural Resource Information System (CRIS). Initial consultation includes submission of project description and location, photographs, and documentation of prior disturbance and/or cultural resource investigation. Goal is to obtain "No Effect" letter from SHPO.	NYS Parks, Recreation and Historic Preservation (NYSOPRHP) – Field Services Bureau (State Historic Preservation Office (SHPO))
12	Floodplain Development Permit	Work within 100-year floodplain. Approval process is typically delegated to local floodplain administrator.	Municipality (typical)
	Regional		
13	New York City (NYC) Watershed Rules & Regulations	Consultation with NYCDEP regarding potential impacts on NYC watershed (NYC's water supply source); typically coordinated with SPDES storm water permitting processes.	New York City Department of Environmental Protection (NYCDEP)
	Local (Municipal)		
14	Water and Wastewater System Improvements Approval of Plans	Approval of water and wastewater infrastructure improvements and connections.	New York State Department of Health (NYSDOH), NYSDEC, Putnam County Health Department
15	Industrial Wastewater Discharge Permit (Local Sewer Use Ordinance & Federal Pretreatment Regulations)	Approval of additional sanitary and process waste discharges to POTW. Modification of existing permit. Also includes approval of pre-treatment program.	Municipality (only required for certain commercial businesses)
16	Building Permits	Building code compliance. It is assumed that the municipality will self-permit proposed public facilities (*i.e.,* code review and issuance of building permits).	Local Code Enforcement Office
17	Certificate of Occupancy	Approval to occupy building.	Local Code Enforcement Office

9. ENVIRONMENTAL REVIEW (SEQRA)

New York's State Environmental Quality Review Act (SEQRA) requires state and local government agencies to consider environmental impacts equally with social and economic factors during discretionary decision-making. This means these agencies must assess the environmental significance of all actions they have discretion to approve, fund or directly undertake. SEQRA requires the agencies to balance the environmental impacts with social and economic factors when deciding to approve or undertake an "Action".

As a first step in the environmental review process, the agency must classify the action as a Type I, Type II (Exempt) or Unlisted Action. The project exceeds regulatory thresholds, which would require the action to be classified as a Type I Action requiring a coordinated review with other local and State involved Agencies. Upon the completion of a 30-day (maximum) Lead Agency coordination process, a single entity will be designated as the SEQRA Lead Agency, which will be responsible for coordinating the SEQRA compliance for the project. The lead agency and the project sponsor should be identified early in the project.

Any action classified as Type I requires the project sponsor to complete Part 1 (Project & Setting) of a Full Environmental Assessment Form (EAF) (also known as the Long Form). The Lead Agency will subsequently complete Parts 2 (Identification of Potential Project Impacts) and 3 (Evaluation of the Magnitude & Importance of Project Impacts) of the EAF. The Lead Agency shall then decide on the significance of the impact on the environment, as a result of the project, based on the information provided in the EAF as well as input from the Involved Agencies. The Lead Agency's issuance of a "Negative Declaration" indicates that the project will not result in a significant adverse impact on the environment; issuance of a "Positive Declaration" indicates that the project may result in one or more significant adverse impacts, which need to be evaluated in an Environmental

Impact Statement (EIS). The SEQRA process must be completed prior to local and state agency discretionary decision-making.

Included in the SEQRA process is determination of potential archeologically sensitive areas within the project boundary. State agencies making discretionary decisions must document compliance with the State Historic Preservation Act prior to making those decisions. Generally speaking, it is desirable to avoid any areas of archeological sensitivity as completing field surveys to confirm presence of archeological features and addressing the same can be costly and result in substantial project delays. It is recommended that these areas be avoided to the extent practicable and that the proposed infrastructure be located in previously disturbed areas.

10. FUNDING STRATEGIES

A review of the prime alternatives presented in previous sections include the following types of projects:

- Construction of new cluster system facilities;
- Construction of new collection and pumping facilities;
- Consolidation and management of individual septic systems and PCI wastewater treatment systems.

There are several funding sources/programs available for supporting the above listed wastewater improvement projects including:

- New York State Clean Water State Revolving Fund (CWSRF) administered by New York State Environmental Facilities Corporation (NYSEFC). Based on review of recent census data, this project does not appear to be eligible for hardship financing and would be eligible for low interest loans;
- NYS Department of Environmental Conservation (NYSDEC) /NYSEFC Wastewater Infrastructure Engineering Planning Grant Program (EPG);
- New York State Community Renewal Community Development Block Grant Program (CDBG);
- Local Government Efficiency (LGE);
- New York City Department of Environmental Protection (NYCDEP) Filtration Avoidance Program funding for tertiary treatment;
- New York State Water Infrastructure Improvement Act (WIIA) grant program administered by New York State Environmental Facilities Corporation (NYSEFC);
- New York State Water Quality Improvement Program (WQIP) grant opportunities administered by New York State Environmental Facilities Corporation (NYSEFC) and New York State Department of Environmental Conservation (NYSDEC); and
- New York State Energy Research and Development Authority (NYSERDA).

In addition, periodically federal dollars are made available for specific projects that have a significant impact on water quality. The above funds can be combined with local municipal dollars.

The Intended Use Plan (IUP) of the CWSRF includes scoring criteria that reflect a primary emphasis on water quality improvement and secondary emphasis on water quality protection. Projects addressing water quality problems in a NYSDEC approved watershed management plan receive additional points in the scoring system. The scoring system is based on:

- The existing conditions that cause or caused the problem;
- The value of the resource that will be improved or protected based on the classification of the receiving water;
- The severity of impairment to the desired usage of the affected water;
- The degree of improvement to the desired usage likely to result;

- Consistency with an approved management plan;
- An obligation or mandate for the project; and
- The financial impact on the applicant municipality.

Review of the above criteria indicates that the Palmer Lake related water quality improvement projects may score well.

11. FINDINGS & RECOMMENDATIONS

Implementation of a sewage collection and treatment program for the area surrounding Palmer Lake is recommended as a strategy to address the requirements of the TMDL and provide for less nutrient flow into Palmer Lake this reducing the potential for nuisance algal blooms. Additional benefits to providing public sewers to the area are less tangible and typically result in higher property values.

- Begin planning process for development of a sewer district to manage and fund the sewage facilities.
- Identify potential sites for cluster system septic tank(s) and leach field(s) to serve Palmer Lake.
- Expand public education programs on proper maintenance of septic systems.
- Confirm with the operators of the Kent Manor WWTP and T/Carmel SD #2 WWTP potential for excess capacity.
- While implementation of sewage collection and treatment for Area 2 may not provide substantial benefits and be economically feasible, consideration should be given to protecting individual water wells and evaluating the potential of a regional drinking water system serving the Palmer Lake area.
- Begin dialogue with the NYCDEP regarding requirements for construction of cluster systems in the vicinity of Palmer Lake.
- Implementation of the recommended alternative (Cluster System) is estimated to cost $5,300,250 and substantial grant funding will be required to bring the annual user fee down to a level that is considered acceptable to the public. Based on the evaluation presented herein, required grants of $5,644,965 are required to result in a user fee of $800/yr, considered by many communities as a reasonable cost for service. For comparison, approximately $6,472,960 in grants would be required to bring the annual cost down to $500 annually.
- Based on the selected collection system approach, complete a preliminary design to further the process of defining the scope of the project. The preliminary design should include field and desktop investigations necessary to gain a better understanding of the project scope.
- Implement stormwater improvements along lake shoreline concurrently with collection sewer system.

Appendix A – Flow and Loading Calculations

Palmer Lake Service Area Flow Estimate

AREA 1

Within 50 feet of the lake

Property Code	Quantity	Flow Rate (GPD)	Total Flow (GPD)	Description
210	16	260	4160	One-family year round residence
311	3	0	0	Vacant
			4,160	***Gallons per Day***

Outside 50 feet and within 250 feet of the lake

Property Code	Quantity	Flow Rate (GPD)	Total Flow (GPD)	Description
210	41	260	10660	One-family year round residence
215	2	520	1040	One-family year round residence with accessory apartment
311	9	0	0	Vacant
330	1	0	0	Commercial Vacant
433	1	100	100	Auto Body, Tire Shops, Other Related Auto Sales
441	2	100	200	Fuel Storage and Distribution Facilities
444	1	100	100	Lumber Yards, Sawmills
481	1	100	100	Downtown Row Type
484	1	100	100	One Story Small Structure
485	1	200	200	One Story Small Structure - Multi occupant
592	2	0	0	Athletic Fields
			12,500	***Gallons per Day***

Outside 250 feet and within the service area

Property Code	Quantity	Flow Rate (GPD)	Total Flow (GPD)	Description
210	24	260	6240	One-family year round residence
215	2	520	1040	One-family year round residence with accessory apartment
311	4	0	0	Vacant
			7,280	***Gallons per Day***

TOTAL FLOW	**23,940**	***Gallons per Day***

AREA 2

Outide Area 1 limits and within Area 2 limits

Property Code	Quantity	Flow Rate (GPD)	Total Flow (GPD)	Description
210	320	260	83200	One-family year round residence
215		520	0	One-family year round residence with accessory apartment
220		520	0	Two-family year round residence
260		260	0	Season Residences
281		520	0	Multiple Residences
311		0	0	Vacant
330		0	0	Vacant Land Located in Commercial Areas
432		2000	0	Service and Gas Stations
652		100	0	Office Building (Gov't)
			83,200	***Gallons per Day***

TOTAL AREA 2 FLOW	**83,200**	***Gallons per Day***

Appendix B – Collection System Technology Fact Sheets

Fact Sheet C1

Performance & Cost of
Decentralized Unit Processes

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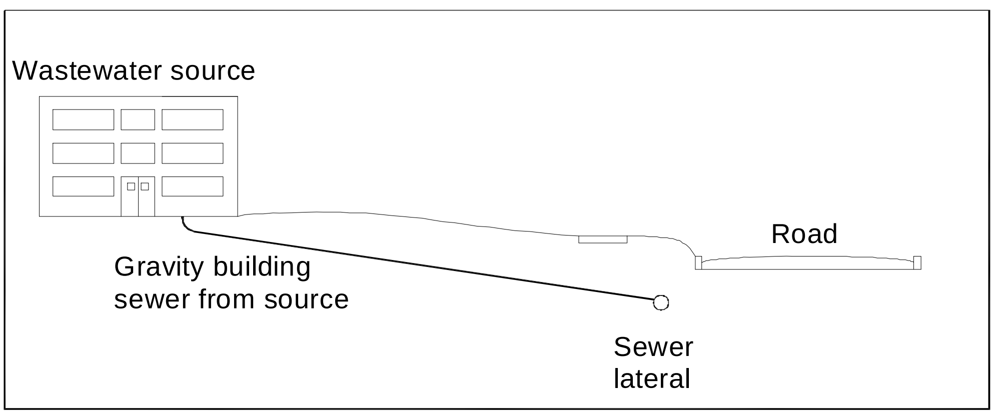
DECENTRALIZED WASTEWATER SYSTEMS

COLLECTION SERIES

GRAVITY SEWER SYSTEMS

What is a Gravity Sewer System?

A gravity sewer system is used to collect wastewater from multiple sources and convey the wastewater by gravity to a central location. Wastewater from each source is conveyed through a building sewer to a collection line. Collection (sewer) lines are typically eight-inch or larger diameter pipe. Pipe diameters increase with increasing volume of water being transported. Pipes are installed with sufficient slope to keep the suspended solids moving through the system. If gravity flow is not possible throughout the system, lift stations (pumps) are employed. Lift stations are installed at lower elevations of the network in order to pump the sewage up to another gravity line, to convey wastewater over hills, and/or up to a treatment facility. Manholes are installed at regular intervals to provide maintenance access to collection lines.



Properly designed and constructed gravity sewers are a viable collection option for urban areas, but can be expensive for small communities. In its purest form (i.e., uniform slope from service connections to treatment components) gravity is an inexpensive means to convey water. However, the topography is rarely conducive to purely gravity flow, and lift stations must often be included. The cost of gravity sewers may be prohibitive unless there is sufficient population density to justify the installation.

Selecting any wastewater collection option must be considered within the context of a community's broad, long-range plans for land use. Changes in development patterns, population density, livability, and delivery of services will occur as a result of the choices made and these must all be taken into account.

Compatibility with the Community Vision

Installation costs for gravity sewers are significant. The community must have a good vision of its future to ensure that the sewer is properly sized. If the capacity for long-term use is built into the design, the system can accommodate the anticipated growth for the next 50 or more years. Realistically, over-building the sewer means that the current users will bear the cost of that future use.

Once installed, the components of a gravity sewer are minimally visible. Manhole lids and lift stations will be evident at the surface but are not obtrusive. Odors may be associated with access points and odor control may be necessary. The potential loss of trees or other local charm during installation must be considered because of the need for broad and deep cuts during excavation. For this reason, it is a common practice to install sewers under paved roads resulting in severe and lengthy community disruption.

When considering options for a Management Program, the community must decide whether on-lot costs for installation, maintenance and repair will be borne directly by the landowner or spread across the community.

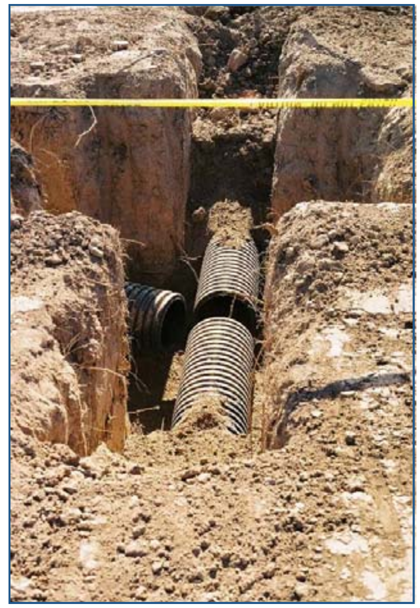
Land Area Requirements

The land area required for a gravity sewer system is a function of the area required for installation of piping. Horizontal Directional Drilling (HDD) boring can minimize the need for large, deep trenches that disrupt existing utilities, landscaping, roads and driveways. Additional land will be required for each lift station. Lift stations can be fairly compact, but sufficient space is needed to install a wet-well, pumps and controls, and the electric service. Manholes do not require additional land, but they must be accessible.

Note that additional land area will be required for the treatment and dispersal components selected by the community.

Construction and Installation of Gravity Sewer Systems

Gravity sewers must be installed so that the pipeline has a sufficient slope to prevent suspended solids from settling. If the community has relatively flat topography, the sewers will get progressively deeper (and more expensive) along their length. In rolling terrain, the sewer lines are installed to move wastewater from the



top of hills to the valley bottom. If the slope is sufficient to transport sewage, then the pipeline need not get deeper with length.

Installation of pipe, manholes, lift stations, building connections, junction chambers or boxes and terminal cleanouts requires large amounts of excavation. This results in disruption of utilities, temporary road closures and detours. Overall, there is a significant amount of disturbance over a long duration associated with the installation of traditional gravity sewer. However, once installed, most gravity components are either below ground or flush with finish grade.

Most jurisdictions set the minimum sewer pipe diameter at eight inches. As more wastewater is collected and carried by a given pipeline, the pipe diameter must increase. Although larger pipes require wider excavations, pipe depth is the primary driver for excavation costs. The pipes are sized to carry the peak flow rate that would be expected from a given service area. The peak flow rate is often calculated as four times the daily flow rate plus an estimation of the amount of groundwater infiltration that will occur.

Licensing requirements for personnel who install gravity sewer systems varies with jurisdictions, but typically they must be licensed as a public utility contractor by the state or region in which they work.

Operation and Maintenance

Effective operation of a conventional gravity sewer begins with proper design and construction. Regular inspection of system components is critical. Leaky pipe connections are a potential source of groundwater and stormwater infiltration. This extra water must be treated. Infiltration must be controlled, or the capacity of the treatment system will be exceeded during wet weather conditions. Modern construction materials have reduced the infiltration issue. However, tree roots, shifting soils, and poor pipe connections (especially to manholes) are still major problems and gravity sewers commonly are designed to carry up to 40% clear water.

Regular service is important for all systems to ensure best long term performance to protect public health and the environment. This also protects the investment. Frequency of operation and maintenance is dependent upon wastewater volume, relative risk to public health and the environment as well as the complexity of any pretreatment components used prior to dispersal.

Proper maintenance includes periodic line repairs and inspection, cleaning out blockages, and repairing areas where significant infiltration is occurring. On an approximate 10-year rotation, each sewer line should be inspected via a down-the-hole closed-circuit camera so that areas needing repair can be identified. Service providers must have the knowledge and skills related to sewer cleaning technologies and the associated safety precautions. Operators must have proper training and may be subject to certification requirements depending upon jurisdiction.

Costs for Gravity Sewer Systems

Installation costs include five major factors: Pipe diameter, excavation depth, total length, restoration, and labor. Larger flows require larger diameter pipe which is more expensive. Deeper, excavation may be required to provide sufficient slope or overcome soil and site issues. The extent of site disturbance and nature of the restoration required affect costs. Roads, sidewalks, and yards will be highly disturbed during installation. Existing utilities may have to be moved or worked around. Horizontal Directional Drilling (HDD) can be used in some cases to minimize time and money during actual installation because utility replacement, road closings, detours and expensive dewatering and restoration costs associated with trenching are substantially reduced. While each of these factors is system-specific, the purchase and installation of gravity sewer components could easily range from $100 to $200 and more per foot of main line service.

Larger flows require larger diameter pipe for gravity sewer systems. Deeper (and more expensive) excavation is also needed but the cost may be offset by the fact that pumps and lift stations are only required in areas with inadequate slope for gravity flow.

Gravity sewers in cluster or small community systems do not include septic tanks for primary treatment on each lot. Thus, the central treatment facility must provide primary treatment (liquid-solid separation).

If gravity flow can be maintained throughout the system, there is no electrical requirement. If lift stations are needed, energy costs vary according to the number, specifications and size of the pumps used. The required number of lift stations is dependent on the topography of the community. Engineers will evaluate the location and strive to use gravity flow to collect wastewater and direct it to points of lower elevation. At these low points in the system, lift

For other Collection system options, see:

Factsheet C2: Pressure sewers

Factsheet C3: Effluent sewers

Factsheet C4: Vacuum sewers

stations followed by short pressure mains can be installed to move the wastewater back to a higher elevation. The energy cost will depend on the daily wastewater volume and the distance (both horizontally and vertically) that wastewater has to be transferred.

Tables 1-3 are cost estimations for the materials, installation, and maintenance of conventional gravity sewer. These costs assume an estimated average distance between wastewater sources of 200 feet, relatively flat topography, 20% overhead and profit to the contractor, and no sales tax on materials. Engineering fees and other professional services are not included in the costs. Communities may choose to have lot owners pay for materials and installation of on-lot components. Tables 1 and 2 assume that the lot-owner will build and maintain the system components that are installed on-lot and that the utility will build and maintain the collection network. Table 3 assumes that a utility will build the collection network and the on-lot components; however, the lot-owner would still be responsible for the building sewer maintenance. For the purpose of estimating costs, Tables 2 and 3 provide three example gravity sewer systems developed and priced for flows ranging from 5,000 to 50,000 gpd. The costs given in this document are for comparison purposes only. The actual cost for a system will vary tremendously depending on site conditions and local economics. The costs for the systems below include piping, manholes, installation, and maintenance. These examples do not include a lift station.

Table 1. Estimated cost to the lot owner if utility does not cover the materials and installation of on-lot components.

On-Lot Cost	Cost Issues	Costs
Materials and Installation	Install building sewer and connect to sewer main	$1,800 - $2,700
Annual electricity	No energy unless source needs lift pump to sewer main	-0-
Annual O&M	Annualized cost to clean building sewer	$16 - $24 per yr

The costs provided in this document are for comparison purposes only. The actual costs will vary significantly depending on site conditions and local economics. For localized cost investigations, consult the Cost Estimation Tool associated with these materials.

Table 2. Estimated cost of materials and installation to build the collection network not including the on-lot components.

Network Cost	Wastewater Volume (gpd)		
	5,000 gpd or 20 homes	10,000 gpd or 40 homes	50,000 gpd or 200 homes
Materials and Installation	$210,000 - $315,000	$419,000 - $629,000	$2,182,000 - $3,273,000
Annual O&M	$6,400 - $9,600	$12,800 - $19,200	$65,000 - $97,000
Annual electricity	Lift stations are the primary energy demand for gravity collection systems		

Table 3. Estimated cost of materials and installation for utility to install both the collection network and on-lot components

	Wastewater Volume (gpd)		
Network and On-Lot Cost	5,000 gpd or 20 homes	10,000 gpd or 40 homes	50,000 gpd or 200 homes
Materials and Installation	$234,000 - $352,000	$469,000 - $703,000	$2,429,000 - $3,644,000
Annual O&M	$6,400 - $9,600	$12,800 - $19,200	$65,000 - $97,000
Total Cost per lot	$11,700 - $17,600	$11,700 - $17,600	$12,000 - $18,000
60 year life cycle cost – present value (2009 dollars)	$435,000 - $653,000	$871,000 - $1,306,000	$4,472,000 - $6,708,000

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Performance & Cost of
Decentralized Unit Processes

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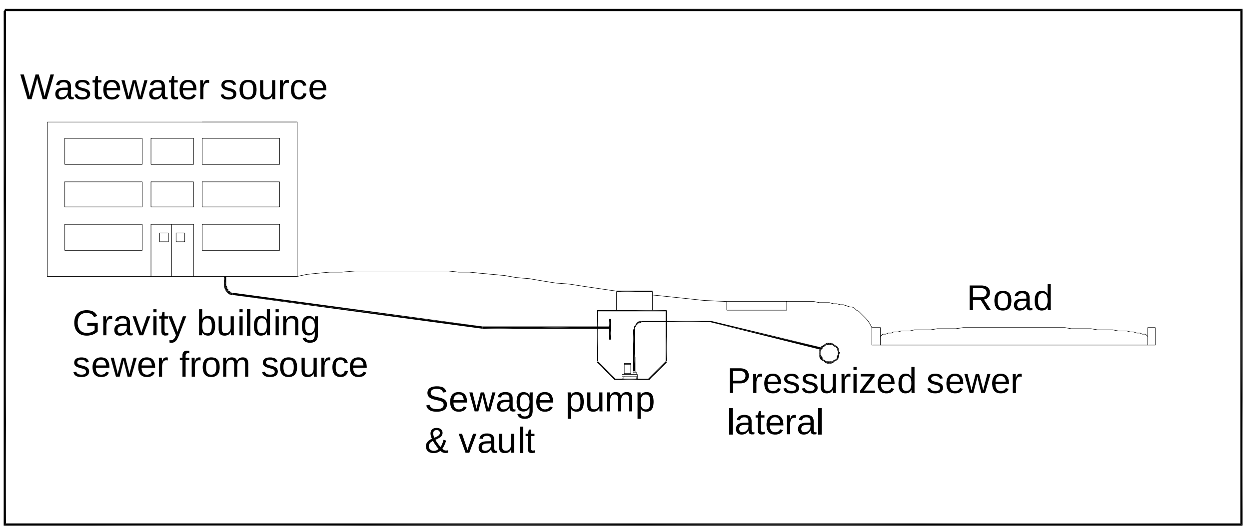
DECENTRALIZED WASTEWATER SYSTEMS

COLLECTION SERIES

PRESSURE SEWER SYSTEMS

Pressure Sewers and Their Use

Pressure sewers are a means of collecting wastewater from multiple sources and delivering the wastewater to an existing collection sewer, and/or to a local or regional treatment facility. Pressurized sewers are not dependent on gravity to move wastewater; and thus there is less concern about the local topography. A typical arrangement is for each connection (or small cluster of connections) to have a basin that receives wastewater. When the basin fills to a set point, a pump within the basin injects wastewater into the sewer. This transfer of wastewater pressurizes the sewer. As various pumps along the length of the sewer inject sewage into the line, the wastewater is progressively moved to the treatment facility.



The principle advantage of pressure sewers is the ability to sewer areas with undulating terrain, rocky soil conditions and high groundwater tables. Because lines are pressurized, sewer pipe installation can follow the surface topography and remain at a relatively constant depth below the soil surface. As compared to gravity sewers, pressure sewers have smaller diameter pipes. Shallower placement, lack of manholes or lift stations and longer sections of smaller diameter piping equates to a less expensive and less obtrusive installation. This is especially true for road crossings. Horizontal directional drilling (HDD) allows small diameter systems to be installed without disrupting traffic, opening trenches across paved roadways, or moving existing utilities. The piping can also be located along the shoulder instead of the middle of the paved surface.

A community has four basic options when choosing a means of collecting wastewater. This factsheet will focus on solids-handling pumps as a means of taking all the wastewater from a source. The other options are gravity, effluent and vacuum sewers. These three options are discussed in other Fact Sheets in this series. Often, collection technologies can be combined within the same network to provide the best solution for a small community. The most common hybrid includes solids -handling pumps in combination with gravity sewers.

For more information, see:

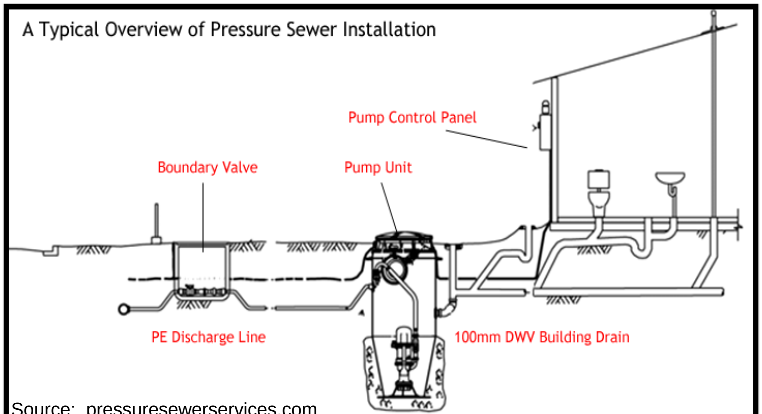
Factsheet C1: Gravity sewers

Factsheet C3: Effluent sewers

Factsheet C4: Vacuum sewers

The typical installation includes a pump basin at each home or business. This basin provides some wastewater storage. When a designated volume of wastewater has been produced, the pump engages and transfers the sewage into the sewer line. A pump basin for an individual residence typically has a capacity to store about 30 to 70 gallons between pumping events. Each pump basin contains floats or pressure sensors that detect the water depth in the basin. When the predetermined depth is achieved, the pump activates and continues to remove wastewater until a low-water level is reached. Backflow into the pump basin is prevented by a check valve that is integral to the pump. Most pumps operate on 240VAC, which is easily available from the home or business that is being serviced by the pressure sewer system

A Typical Overview of Pressure Sewer Installation



Source: pressuresewerservices.com

As a comparison, conventional gravity sewers use a few (but large) lift stations to offset excessive excavations that are often required to achieve minimum slope or to move sewage over hills. Pressure sewers have small pump stations at each connection. There are advantages and disadvantages to each method. For a small community, the primary advantage of pressure sewers is the reduced cost of sewer pipe installation. Small communities have smaller population densities; and therefore, there are fewer people per square mile of service to bear the cost of the system.

Compatibility with Community Vision

Pressure sewer systems are expandable. A community may desire to only provide sewer to the existing population. As new neighborhoods are established, it might be reasonable to connect them to the collection system on an as-needed basis if there is sufficient available capacity. A better solution might be to create a new cluster or neighborhood system to service them. In contrast, conventional gravity sewage collection systems are generally built to accommodate maximum growth that may or may not occur and are difficult to finance through the current users.

Selecting any wastewater collection option must be considered within the context of a community's broad, long-range plans for land use. Changes in development patterns, population density, livability, and delivery of services will occur as a result of the choices made and these must all be taken into account.

A management issue that was addressed early in the history of pressure sewers was that of pump ownership. Some communities chose to put the burden of ownership on the property owners and homeowner associations with disastrous results. Today, pressure sewer systems are wholly maintained by a local utility (either private or public). In most cases, the connection fee includes the cost (including installation) of all the on-lot components. The operation and maintenance costs are amortized into the monthly sewer bill. This level of utility ownership helps to ensure consistent and sustainable performance.

Land Area Requirements for Pressure Sewers

The on-lot land area required for a pressure sewer system is a function of the area required for installation of the pump basin and the piping that connects it to the sewer main. A single-family home will typically have a basin with 30 to 70 gallon capacity installed below ground with a tank lid 18 to 30 inches in diameter that allows access to the pump and controls. Institutional, commercial or industrial facilities (schools, restaurants, supermarkets, apartment complexes factories, etc.) will have larger basins and may require multiple pumps.

Note that additional land area will be required for the treatment and dispersal components selected by the community.

Construction and Installation of Pressure Sewers

Pressure sewer systems can typically be installed with trenchers and small excavators. Trenches for small diameter pipes can often be dug and restored in the same day. The collection network is comprised of mostly two-inch to six-inch diameter plastic pipe. Occasional clean-outs, air release valves at high points, isolation valves, and other components must also be installed within the network. Large, deep trenches are rarely needed with pressure sewers. The shallower trench width and depth results in minimum surface disturbance, and quicker restoration. Directional boring can reduce highway closures and other urban disruptions and save both time and money. The small diameter piping is flexible and can be routed around obstacles. Pressure sewer mains can often be located on the shoulder of the road.

A licensed electrician must run a circuit from the owner's electrical breaker box out to a sub-breaker box on the exterior of the house or business located near the pump. Once the pump basin has been set, the electrician connects the pump and controls to the owner's electric service.

Licensing requirements for personnel who install pressure sewer systems vary, but they must typically be licensed as a public utility contractor by the state or region in which they work.

Operation and Maintenance for Pressure Sewers

Solids-handling pumps are used under harsh conditions. Corrosive gases and moisture in pump basins will eventually penetrate seals and bushings, resulting in pump failure. These small pumps are designed to be rebuilt, which is more economical than replacing the pump. They are rugged devices, but they are only intended to move the food wastes, fecal solids and the associated paper products, not plastic or metallic objects. When considering the nature of their management program, the community must decide who is financially responsible for pump repair and replacement costs.

Regular service is important for all system components to ensure best long term performance to protect public health and the environment. This also protects the investment. Frequency of operation and maintenance is dependent upon wastewater volume, relative risk to public health and the environment as well as the complexity of components used.

Pressurized sewer systems transmit the entire wastewater flow, thus providing the possibility of oils and fats congealing in the pipe network. System cleaning is not normally required for properly designed systems, but if cleanouts are installed in the network, cleaning procedures are facilitated. It is rare that mainline clearing is required. On-lot service line cleaning can be minimized by requiring all commercial food preparation businesses to install grease interceptors before the grinder pump to remove excessive fats, oils and grease (FOGs).

Because the system is pressurized, it is inherently watertight and groundwater infiltration should not be a problem. However, the pump basins must be periodically inspected to ensure that surface water and groundwater are not entering the system through the building sewer. Illegal connections from downspouts, foundation drains and similar sources must be identified and excluded. Avoiding excessive water inflow prevents overloading the pump and wastewater treatment facility.

Costs for Pressure Sewers

The cost of a pressure sewer system can be divided into two major components: The on-lot cost and the collection network cost. On-lot costs include the pump, basin, controls, building sewer, lateral piping, electrical service, and installation. The collection network includes all the piping in the utility easements that directs the sewage to the treatment facility. A small community may consider several means of funding a pressure sewer system. One means is to secure sufficient funding to install the collection network and install the on-lot components. Federal funding and low interest loans are sometimes available to fund these projects. A second means is for the utility to build the collection network and charge each connection for the on-lot cost. Depending on the style of pump and basin selected by the managing utility, on-lot costs are estimated to be $4,800 to $7,200 for an existing single-family home. Typical solids-handling pumps will use less than 1kW-hr of power per day and the electrical cost would be about 50 dollars per year depending upon local electrical rates.

Using many low power-consuming pumps reduces installation cost as compared to a conventional gravity system that may require one or more large-capacity lift stations. Further, it allows more flexibility in choosing locations for and routes to treatment facilities. Larger capacity pumps require three-phase electricity, and this may not be available in remote areas within small communities.

Tables 1-3 are cost estimations for the materials, installation, and maintenance of pressure sewers. These costs assume an estimated average distance between wastewater sources of 200 feet, relatively flat topography, 20% overhead and profit to the contractor, and no sales tax on materials. Engineering fees and other professional services are not included in the costs. Communities may choose to have the lot owners pay for the materials and installation of the on-lot components. Tables 1 and 2 assume that the lot-owner will pay for the system components that are installed on-lot and that the utility will build and maintain the collection network. Table 3 assumes that a utility will build and maintain the collection network and the on-lot components. Tables 2-3 also provide cost estimates for the collection network for three different sizes of communities.

Table 1. Estimated cost to the lot owner if utility does not cover the materials and installation of on-lot components.

On-Lot Cost	Cost Issues	Costs
Materials and Installation	Pump, pump basin, pump controls, excavation, and connection to network	$4,800 - $7,200
Annual electrical	Estimated at 1 kW-hr per day (paid by the lot owner)	$44 - $66 per yr
Annual O&M	Annualized major pump overhaul every 10 years	$120 - $240 per yr

Table 2. Estimated cost of materials and installation to build the collection network not including the on-lot components.

Network Cost	Wastewater Volume (gpd)		
	5,000 gpd or 20 homes	10,000 gpd or 40 homes	50,000 gpd or 200 homes
Materials and Installation	$33,000 – $49,000	$65,000 - $98,000	$344,000 - $516,000
Annual O&M	$6,400 - $9,600	$13,000 - $19,000	$56,000 - $84,000
Annual electricity	No network energy cost unless lift stations are needed		

Table 3. Estimated cost of materials and installation for utility to install both the collection network and on-lot components

Network and On-Lot Cost	Wastewater Volume (gpd)		
	5,000 gpd or 20 homes	10,000 gpd or 40 homes	50,000 gpd or 200 homes
Materials and Installation	$132,000 - $199,000	$265,000 – $397,000	$1,341,000 - $2,012,000
Annual O&M	$11,000 - $16,000	$21,000 - $32,000	$106,000 - $159,000
60 year life cycle cost present value (2009 dollars)	$243,000 - $365,000	$811,000 - $1,216,000	$4,707,000 - $6,106,000

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4. Water Environment Federation. 2008. Alternative Sewer Systems, Manual of Practice FD-12, Second Edition. WEFPress, Alexandria, Virginia.

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Fact Sheet C4

Performance & Cost of
Decentralized Unit Processes

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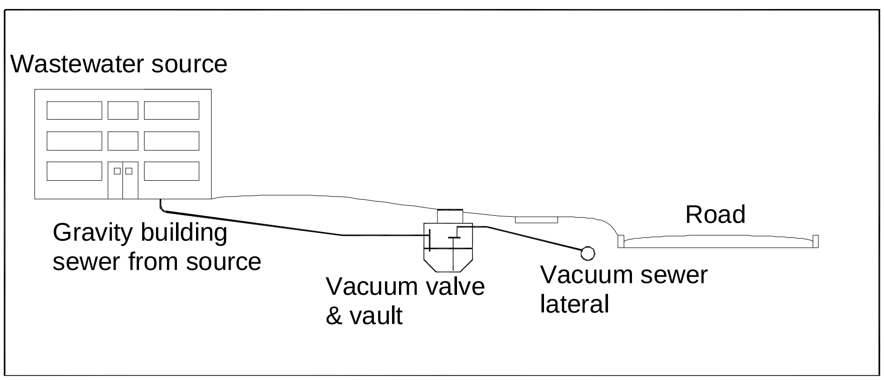
DECENTRALIZED WASTEWATER SYSTEMS

COLLECTION SERIES

VACUUM SEWER SYSTEMS

What is a Vacuum Sewer System?

A vacuum sewer system is used to collect wastewater from multiple sources and convey it to a central location where it can be treated. As the name suggests, a vacuum (negative pressure) is drawn on the collection system. When a service line is opened to atmospheric pressure, wastewater and air are pulled into the system. The wastewater that enters with the air forms a "plug" in the line, and air pressure pushes the wastes toward the vacuum station. This differential pressure comes from a central vacuum station. Vacuum sewers can take advantage of available slope in the terrain, but are most economical in flat terrain. Vacuum sewers have a limited capacity to pull water uphill. The maximum expected lift is between 30 and 40 feet. Vacuum sewers are designed to be watertight since any air leakage into the system reduces the available vacuum.



Vacuum sewers do not require a septic tank at each wastewater source. All of the domestic wastewater and waste constituents are collected and transported by this collection method. Sewage from one or more homes or businesses flows by gravity into a small valve pit. A service line connects the valve pit to the main vacuum line. Each valve pit is fitted with a pneumatic pressure-controlled vacuum valve. This valve automatically opens after a predetermined volume of sewage has entered the sump. The difference in pressure between the valve pit (at atmospheric pressure) and the main vacuum line (under negative pressure) pulls wastewater and air through the service line. The amount of air that enters with the sewage is controlled by the length of time that the valve remains open. When the vacuum valves closes, atmospheric pressure is restored inside the valve pit. The sewage travels in the vacuum main as far as its initial energy allows, eventually coming to rest. As other valve pits in the network open, more sewage and air enters the system. Each input of energy moves the sewage toward the central vacuum station. The violent action in the pipe tends to break up the larger suspended solids during transport.

Like gravity sewers, vacuum sewers are installed on a slope toward the vacuum station. Periodic upturns or 'lifts' are installed in the vacuum line to return it to a shallower elevation. Overall, the lines are installed in a saw-tooth or vertical zigzag configuration so that the vacuum created at the central station is maintained throughout the network.

Pipes for vacuum sewers are installed in a saw-tooth or zigzag configuration to maintain a vacuum throughout the system.

Vacuum stations may include two or more vacuum pumps and a large vacuum tank. The pumps run on 3 to 5 minute cycles or long enough to create adequate vacuum in the system. The tank at the vacuum station holds the vacuum on the collection network and prevents the vacuum pumps from having to operate continuously. As valve pits are activated, there is a loss in the vacuum (negative pressure) in the system. When the negative pressure reaches a threshold level, the vacuum pumps re-engage to pull more vacuum. When sewage reaches the vacuum station, it flows into a collection tank. Sewage pumps are then used to convey the collected sewage through a force main to the treatment component. As with vacuum pumps, multiple sewage pumps are used to provide a backup in case of pump failure.

How is a vacuum sewer system used?

Because of the cost of a vacuum station, vacuum sewers are most appropriate for communities with 200 or more connections. However, in some circumstances, as few as 75 to 100 connections can be feasible. A typical vacuum station can pull from a 15,000-foot radius and serve about 1,200 connections. The general conditions conducive to the use of vacuum sewers include: unstable soil; flat terrain; rolling land with many small elevation changes; high water table; rocky conditions; new and denser urban development in rural areas; and sensitive ecosystems. Established communities that have historical neighborhoods with narrow streets and limited access can also effectively utilize vacuum sewers because the small diameter pipe and shallow excavation takes less area to install.

It is generally not advisable to use this technology in areas with low population and low population densities. Because the movement of wastewater depends upon the differential pressure created when valves open, long pipe runs with few connections can result in poor performance. The same problem is seen when connections are installed but are not yet in use. As a solution for this, temporary valve pits installed at strategic locations can be fitted with timer-controlled valves that allow air to enter even though wastewater is not being generated by the source.

Compatibility with Community Vision

Vacuum sewers are scalable. The system can be zoned (divided into sections) to accommodate the rate of build-out as well as to facilitate maintenance. Access locations to valve boxes and cleanouts (if required) will be evident at the soil surface but are not obtrusive. Higher population densities are well-accommodated with this option. If maintaining local charm while improving infrastructure is a priority, communities can preserve assets such as historical areas or heritage trees.

Vacuum stations are centrally located within their service area. Usually only a single vacuum pump station is required rather than multiple lift stations found in conventional gravity and pressure networks. This frees up land, reduces energy costs and reduces some operational costs. No manholes are necessary and odors and risks associated with hydrogen sulfide gas are significantly reduced because the system is sealed and detention times are short. Vacuum stations are quite large and expensive compared to effluent or pressure sewer system components, but can be designed to blend into the landscape.

Selecting any wastewater collection system option must be considered within the context of a community's broad, long-range plans for land use. Changes in development patterns, population density, livability, and delivery of services will occur as a result of the choices made and these must all be taken into account.

A particular problem with vacuum sewers is the noise and odor created by the central vacuum station. As air is drawn through the system, sewer gases are extracted. A good solution to this problem is to pass the exhaust air through a bio-filter, which can absorb much of the gas and reduce odors.

Land Area Requirements for Vacuum Sewers

The land area required for a vacuum sewer system is a function of the area required for installation of the valve pit, the vacuum network and the central vacuum station. Valve pits for single-family residences typically have a 10-gallon capacity and occupy a relatively small area. Tanks for multiple connections or commercial facilities may require larger area (depending upon daily wastewater volume) and thus occupy more space. The area disturbed during excavation of the valve pit will be larger than the dimensions of the valve pit and piping. Horizontal directional drilling (HDD) helps to eliminate the need for large, deep trenches that disrupt existing utilities, landscaping, roads and driveways with installation of conventional sewers. Vacuum collector system pipes are typically only four inches in diameter and thus a trencher or small excavator is often used for excavation.

Note that additional land area will be required for the treatment and dispersal components selected by the community.

Construction and Installation

A valve pit is located at each wastewater source or cluster of sources. Valve pits are typically prefabricated and ready to install. They must be properly oriented and set at the correct elevation to allow for gravity flow from the source. Anti-flotation measures are required in areas with high water tables. An air intake must be installed on the building sewer downstream of the plumbing house trap to ensure adequate venting for the valves. On-lot excavation is typically accomplished using a backhoe. The service line from the valve pit to the vacuum main can also be installed with a backhoe, but this often results in over-excavation. Using a chain trencher instead will result in less property disruption and require less site restoration. Proper bedding and backfilling techniques must be used to avoid settling over time. Service lines that connect valve pits to vacuum mains must be separated from potable water lines to avoid cross-contamination. Vacuum mains must also be separated from other utilities.

A valve pit is installed at each wastewater source.

Piping for most vacuum sewer mains is O-ring gasketed PVC pipe, so solvent welding is not required. It is normally buried about 36 inches deep, but depths of 4 to 5 feet are not uncommon in colder climates. The small diameter piping used for vacuum sewers is flexible and can be routed horizontally around obstacles. Vacuum sewer mains can often be located outside of and adjacent to the edge of pavement. Division valves must be installed at branch/main intersections, both sides of a bridge and road crossings, both sides of areas of unstable soils, and at periodic intervals on long routs. Some local codes still require cleanouts at specified intervals.

Vacuum testing of both valve pits and mains is performed over the course of the installation and upon completion of the entire system. Overall, there is a significant amount of disturbance associated with the installation, but not nearly as much as with deeper conventional gravity sewers. Once installed, most components are either below ground or flush with finish grade. Licensing requirements for personnel who install vacuum sewer systems vary, but they must typically be licensed as a public utility contractor by the state or region in which they work.

Maintenance Requirements

__Regular service is important for all systems to ensure best long term performance to protect public health and the environment. This also protects the investment. Frequency of operation and maintenance is dependent upon wastewater volume, relative risk to public health and the environment as well as the complexity of any pretreatment components used prior to dispersal.__

Effective operation of a vacuum sewer system begins with proper design and construction, but regular inspection of system components by staff or remote monitoring is critical. Vacuum stations can be remotely monitored via telemetry or visited daily to record pump running hours and lubricant levels. A variety of tasks must be performed on a regular weekly, monthly or semi-annual basis. These tasks include changing oil and oil filters on vacuum pumps; removing and cleaning inlet filters on vacuum pumps; testing all alarm systems; checking/adjusting motor couplings, and; checking operation of vacuum station shut-off and isolation valves. The operator must conduct external leak tests on all vacuum valves and check/adjust valve timing. Preventive maintenance includes annual visual inspections of valve pits and valves, as well as rebuilding controllers every 3 to 6 years and rebuilding valves every 8 to 12 years.

As with all mechanical devices, vacuum valves will fail with some frequency. When a valve sticks open the whole system has reduced vacuum. Locating the stuck valve may be time consuming and require two persons. When a valve fails to open, wastewater will backup in the valve pit (and potentially into the source). These failures are easier to locate but can result in an on-lot backup or the discharge of sewage.

Good recordkeeping of system performance and costs is critical. The advent of web-based telemetry has greatly improved the operator’s ability to monitor system status. Vacuum sewer system operators must be capable, dependable and knowledgeable. About 2.5 to 3 hours per year per service connection is a good estimate for time commitment. Training and certification is advisable and will typically be required by the local jurisdiction.

Costs for Vacuum Sewers

Long term costs include vacuum station utilities, clerical costs, transportation, supplies/spare parts as well as miscellaneous expenses such as insurance and accounting. Additional costs will be incurred for equipment reconditioning and replacement by trained service providers. Vacuum station equipment has a life expectancy between 15 and 25 years, but there are annual costs associated with reconditioning that offset replacement. Vacuum valves must typically be rebuilt every 8 to 12 years and their controllers require rebuilding every 4 to 6 years.

The vacuum pumps and sewage pumps are the only elements of the vacuum sewer system that require electricity. It is reported that monthly power costs range from $1.66 to $3.34 per month per connection. Larger stations typically have lower power consumption per connection. Each vacuum station must have a standby electric generator to keep the system operating during electric power failures. Part of the energy cost must include the fuel needed to operate this backup power source.

Because 150 to 200 connections are needed before the cost of the vacuum station can be justified, this fact sheet will only investigate the cost of a 200-home community. The vacuum station given in this example is capable of handling more connections and so costs would come down if the full capacity of the station is used. Thus, at full capacity, the cost per connection would decrease. The costs given in this document are for comparison purposes only. The actual cost for a system will vary significantly depending on site conditions and local economics. The costs for the systems below include valve pits and controller valves at all connections, system piping, vacuum pumps, sewage pumps and all additional appurtenances. The extent of site disturbance and nature of the restoration required will also affect costs.

To justify the cost of a vacuum system, 150 to 200 connections are needed.

Table 1 provides cost estimation for the materials, installation, and maintenance of a vacuum sewer system. These costs assume that the wastewater sources average about 200 feet apart, the topography is relatively flat, the contractor would charge 20% for overhead and profit, and there are no sales tax on materials. Engineering fees and other professional services are not included in the costs. With a vacuum sewer system, it is assumed that one vacuum pit will serve at least two sources. Thus, for a 200-connection community, there are only 100 vacuum pits. This example assumes that the utility will install and maintain the vacuum pits. Each lot owner must still to pay for installation of a building sewer to the nearest vacuum pit.

The costs provided in this document are for comparison purposes only. The actual costs will vary significantly depending on site conditions and local economics. For localized cost investigations, consult the Cost Estimation Tool associated with these materials.

Table 1. Estimated cost of materials and installation to build the vacuum collection network, including the on-lot components.

Cost Factor	Building Sewer to Vacuum Pit	Collection Network Cost including 100 Vacuum Pits
Materials and Installation	$1,800 - $2,700	$1,869,000 - $2,804,000
Annual electricity	-0-	$9,500 - $14,000
Annual O&M	$16 - $24 per yr	$82,000 - $123,000
60 year life cycle cost – present value (2009 dollars)		$4,775,000 - $7,162,000

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Fact Sheet C3

Performance & Cost of
Decentralized Unit Processes

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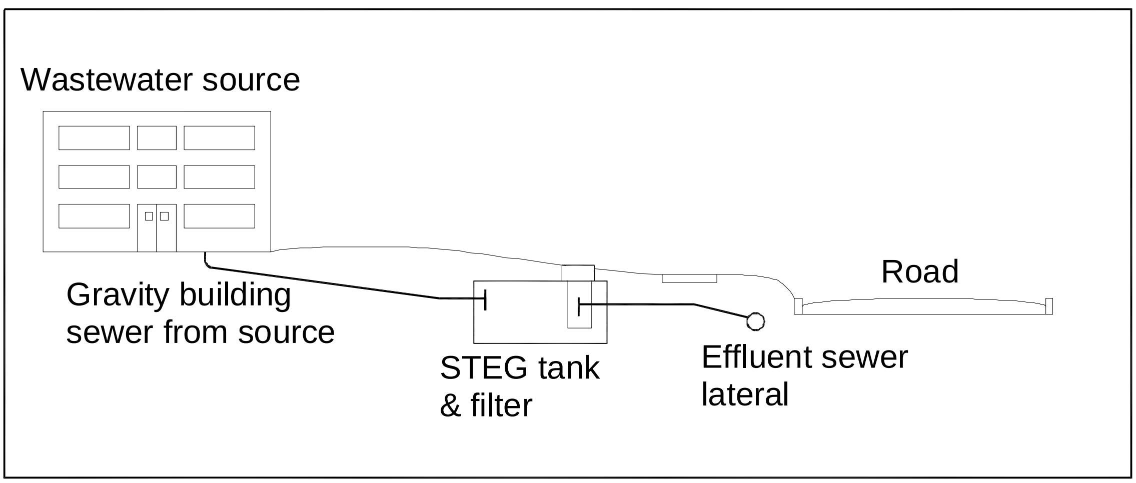
DECENTRALIZED WASTEWATER SYSTEMS

COLLECTION SERIES

EFFLUENT SEWER SYSTEMS

Effluent Sewer Systems and Their Use

The term effluent is commonly is defined as *liquid flowing out of a component or device after undergoing treatment.* An effluent sewer carries wastewater that has undergone liquid/solid separation or primary treatment. Septic Tank Effluent Pump and Septic Tank Effluent Gravity sewers (commonly referred to as STEP or STEG) use on-lot septic tanks to provide liquid/solid separation. Raw sewage flows from the house or business to a watertight underground tank (septic tank). The clarified effluent then moves into the collection system using either a pump (STEP) or gravity (STEG). As a collection system, effluent sewers are used to convey effluent from multiple sources to a central location where it can be treated. STEP and STEG configurations can be combined within a given system.



In a STEG system, each source or group of sources has a watertight septic tank with an effluent screen and an access riser. Effluent flows out of the tank and into a collection sewer by gravity. The collection sewer is typically plastic pipe about 4 to 8 inches in diameter. The piping from the tank to the collection line includes an accessible cleanout.

In a STEP system each wastewater source or group of sources is again fitted with a watertight septic tank. However, in this case, an effluent pump (typically capable of pumping 3 or more gallons per minute) is installed in the outlet end of the septic tank or in a separate pump tank or vault. The pump injects the clarified effluent into a pressure sewer system. As each STEP pump in the collection systems operates, effluent is progressively moved toward the wastewater treatment facility.

In a STEP system, an effluent pump is installed within a pump vault in the outlet end of a septic tank.

STEG systems operate totally via gravity owing to a higher elevation relative to the treatment facility. STEP systems operate via pressure owing to a lower elevation or complex topography relative to the treatment facility. Thus, a typical effluent sewer is a mixture of STEP and STEG depending upon the location of the service lines.

Properly designed and constructed STEP/STEG systems are a viable wastewater collection option for individual residences, cluster developments as well as small communities. All styles of collection systems require significant excavation since a pipe network must be installed to connect all the wastewater sources within the designated service area. With STEP/STEG systems, the width and depth of the required excavation for piping is greatly reduced relative to conventional gravity sewers. Because a STEP system is pressurized it does not depend on a slope to move effluent. If topography allows gravity flow, then pumps are not needed at each location. While STEG systems flow by gravity, because solids have been removed in the septic tank, the pipe slope requirements are reduced or eliminated. When compared to conventional gravity sewers, STEP/ STEG systems have lower installation expense and result in less community disruption.

Solids remain in the on-lot tank in STEP/STEG systems, resulting in the collection of a lower-strength effluent. Costs of downstream treatment components may thus be reduced. A STEP/STEG community must have a plan for the pumping and management of the residuals held in the tanks. See the Fact Sheet on Liquid-solid Separation for information on expected reduction of organic strength and solids that can be expected from septic tanks. Information on septage handling can be found in the Fact Sheet on Residuals Management.

For more information, see:

Factsheet T1: Liquid-Solid Separation

Factsheet T8: Residuals Management

Compatibility with the Community Vision

Selecting any wastewater collection option must be considered within the context of a community's broad, long-range plans for land use. Changes in development patterns, population density, livability, and delivery of services will occur as a result of the choices made and these must all be taken into account.

Once installed, the components of a STEP/STEG system are minimally visible. Cleanouts are installed within the collection network, but are not obtrusive. Odors may be associated with access points (primarily air-relief valves at high points in the system) and odor control may be necessary. Odor control is usually achieved by venting to soil beds which can be blended into local landscapes. The potential loss of trees or similar obstacles during installation is reduced because STEP/STEG systems can be built with flexible plastic pipe that can be routed around obstacles.

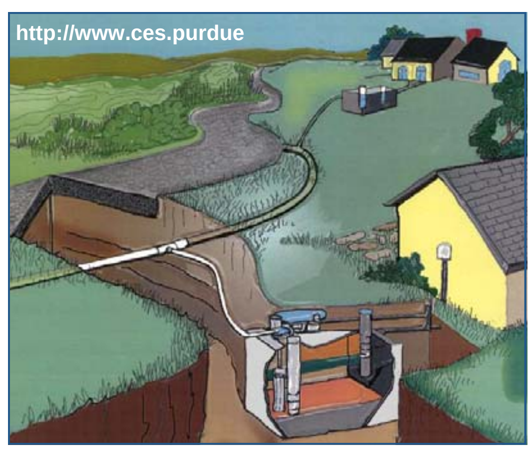
As with any collection system, the use of STEP/STEG can result in (or facilitate) increased population density, but these options have far less capacity to drive community growth than central sewers. Because effluent is collected and conveyed to a central location for treatment, the need for on-lot dispersal systems is eliminated. If a STEP/STEG system is being installed in community that already has septic tanks and drainfields, it is strongly recommended to abandon those components and install a new building sewer, a new tank and on-lot piping from the source to the collector in the street. STEP/STEG tanks and building sewers must be watertight so that stormwater and groundwater does not enter the system.

When considering options for a Management Program, the community must decide whether individual on-lot costs for installation, maintenance and repair will be borne directly by the landowner or amortized into the monthly sewer bill.

Land Area Requirements for STEP/STEG Systems

The land area required for a STEP/STEG system is a function of the area required for installation of the septic tank and piping. Tanks for single-family residences have a typical capacity of 1,000 to 1,500 gallons and occupy an area of about 4 feet by 8 feet. Tanks for multiple connections or commercial facilities may require larger capacity (depending upon daily wastewater volume) and thus occupy more space. The area disturbed during excavation will be larger than the dimensions of the tank.

Note that additional land area will be required for the treatment and dispersal components selected by the community.



Construction and Installation

STEP/STEG systems are built in two stages: (1) the collection network and (2) the on-lot components that provide the liquid/solid separation. The major on-lot component is the watertight tank. When possible, tanks are placed such that wastewater can flow from the source by gravity. Tanks are bedded with crushed gravel to provide level and stable support. For STEP tanks, an effluent pump is placed in a screened pump vault installed in the discharge end of the tank. A control panel is installed on the side of a building that is in close proximity to the tank. If included, cleanouts and air release devices (and associated access enclosures) are installed in the outlet piping. STEG tanks also have an effluent screen that prevents excess solids from leaving the tank. Both types of tanks must have access risers that come to the soil surface. The risers should have tamper-resistance fasteners to prevent unauthorized entry into the tanks.

Like all other alternative collection systems STEP collection network require minimum excavation. The required depth of the pipeline is minimal and can generally follow the terrain. The collection network is installed either through trenching or Horizontal Directional Drilling (HDD). HDD reduces or eliminates the need for large, deep trenches that disrupt existing utilities, landscaping, roads and driveways. STEG systems must maintain an overall slope toward a lift station or treatment facility. However, since there are no heavy sewage solids to be transported, slope can be significantly reduced or eliminated. In all cases, slope and sewage velocity requirements are less than a conventional gravity sewer. Many small communities have both STEP and STEG within the same cluster of sources.

Licensing requirements for personnel who install STEP/STEG systems varies, but they must typically be licensed by the state or region in which they work.

Maintenance Requirements

Effective operation of a STEP/STEG system begins with proper design and construction, but regular inspection of system components is critical. Leaky tanks or pipe connections are a potential source of groundwater infiltration that can overload the system's capacity. Tank residuals must be pumped out on a requisite basis (ideally, when solids are 25 to 33% of the liquid depth of the tank) and effluent screens (in STEG tanks) must be inspected annually and cleaned as needed. Service providers must be properly trained and have knowledge and skills related to effluent screens, electrical connections and controls and other sewer appurtenance technologies. They must know and observe the associated safety precautions. Operators must have proper training and may be subject to certification requirements depending upon jurisdiction.

Regular service is important for all systems to ensure best long term performance protect public health and the environment. This also protects the investment. Frequency of operation and maintenance is dependent upon wastewater volume, relative risk to public health and the environment as well as the complexity of any pretreatment components used prior to dispersal.

If pumps in STEP configurations are installed with quick-disconnect fittings, maintenance is facilitated and replacement costs are reduced. System components should be standardized as much as possible to facilitate easy maintenance. Some wastewater sources may need more powerful pumps if they are located at lower elevations or at distant sites. When these special pumps fail, they must be replaced with pumps of similar capacity.

Typically, preventive maintenance visits are required for the on-lot components as well as the communal collection components. Historically, STEP unit service callouts are overwhelmingly related to electrical/control issues. With STEG systems, effluent screens should be checked annually and cleaned as needed.

Costs for STEP/STEG Systems

The cost of a STEP/STEG system can be divided into two major components: The on-lot cost and the collection network cost. On-lot installation costs include the pump, tank, controls, building sewer, and electrical service. A STEG system would not have the pump, controls and electric service costs. The initial on-lot costs are usually paid by the lot owner. The installer must follow the guidelines established by the utility for the selection and placement of components. Depending on the style of pump and tank selected by the utility, and the STEP pressure requirements needed to inject sewage into the network, the on-lot costs are estimated to be $3,500 to $5,000 for a single-family home. The electrical cost would be about 30 dollars per year.

The cost of the collection network is variable and will be driven by the primary nature of the system. For a STEP system, it will likely consist of mostly two to four-inch diameter plastic pipe. If the system is primarily a STEG, the pipe sizes are more likely to be four to six-inch plastic pipe. Included within the network are occasional clean-outs, air release valves at high points, isolation valves that allow the operator to shut down sections of the system, and other components. Installation costs must account for rocky soils, wet soils, utility easements, site restoration, and labor.

Tables 1-3 are cost estimations for the materials, installation, and maintenance of STEP/STEG effluent sewers. These costs assume an estimated average distance between wastewater sources of 200 feet, relatively flat topography, 20% overhead and profit to the contractor, and no sales tax on materials. Engineering fees and other professional services are not included in the costs. Communities may choose to have the lot owners pay for the materials and installation of the on-lot components. Tables 1 and 2 assume that the lot-owner will pay for the system components that are installed on-lot and that the utility will build and maintain the collection network. For this example, Table 1 assumes that all connections are STEP. A STEG would not include the cost of the pump. Table 3 assumes that a utility will build and maintain the collection network and the on-lot components.

The costs provided in this document are for comparison purposes only. The actual costs will vary significantly depending on site conditions and local economics. For localized cost investigations, consult the Cost Estimation Tool associated with these materials.

Table 1. Estimated cost to the lot owner for if utility does not cover the materials and installation of on-lot STEP components.

On-Lot Cost	Cost Issues	Costs
Materials and Installation	Pump, septic tank, controls, excavation, and connection to network	$3,000 - $5,000
Energy	Estimated at one-half kW-hr per day	$24 - $36 per yr
O&M	Annualized pump replacement and septage removal every 10 years	$56 - $84 per yr

Table 2. Estimated cost of materials and installation to build the STEP collection network, not including the on-lot components.

Network Cost	Wastewater Volume (gpd)		
	5,000 gpd or 20 homes	10,000 gpd or 40 homes	50,000 gpd or 200 homes
Materials and Installation	$32,000 - $48,000	$65,000 - $97,000	$340,000 - $510,000
O&M	$6,000 - $9,000	$12,000 - $18,000	$61,000 - $91,000
Energy	No network electric cost unless lift stations are needed		

Table 3. Estimated cost of materials and installation for utility to install both the STEP collection network and on-lot components

Network and On-Lot Cost	Wastewater Volume (gpd)		
	5,000 gpd or 20 homes	10,000 gpd or 40 homes	50,000 gpd or 200 homes
Materials and Installation	$88,000 - $133,000	$177,000 - $265,000	$901,000 - $1,352,000
O&M	$6,000 - $9,000	$12,000 - $18,000	$60,000 - $90,000
60 year life cycle cost – present value (2009 dollars)	$243,000 - $365,000	$487,000 - $730,000	$2,452,000 - $3,678,000

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Appendix C – Cost Estimating Unit Prices

Work Item Description	Unit Price
1. 8” & 10” Sanitary Sewer (green space)	$150 LF
2. 8” & 10” Sanitary Sewer (pavement)	$175 LF
3. Pumping Stations (50-100 GPM wastewater)	$195,000 EA
4. Pumping Stations (100-200 GPM wastewater)	$225,000 EA
5. Pumping Station (50–100 GPM effluent)	$100,000 EA
6. Grinder Station (simplex)	$12,000 EA
7. Grinder Station (duplex)	$15,000 EA
8. 4” Force Main (green space)	$75 LF
9. 4” Force Main (pavement)	$100 LF
10. 4” Gravity Lateral	$75 LF
11. Connect 4” Gravity Lateral to Main	$600 EA
12. 4” Lateral to Grinder Station	$115 LF
13. 1.5” Force Main Lateral (assume 100 LF)	$3,500 EA
14. 2” Grinder Pump Force Main	$40 LF
15. Air Release Valves	$6,000 EA
16. Flushing Connections (1,000 LF intervals)	$2,600 EA
17. Grinder Station Electrical Service	$3,000 EA
18. Septic Tank Replacement (single)	$15,000 EA
19. STEP System (residential)	$20,000 EA
20. Septic Tank (5000 G – cluster)	$20,000 EA
21. Leachfield (cluster)	$15,000 EA
22. Leachfield (residential)	$12,000 EA
23. Abandon and Decommission Septic Tank	$3,000 EA

Appendix D – Cost Estimates

Alternative 2 - Cluster / Decentralized Collection System

AREA 1

Item	Quantity	Unit	Unit Price	Total
8" & 10" Sanitary Sewer (Green Space)	0	LF	$150	$0
8" & 10" Sanitary Sewer (Pavement)	8,400	LF	$175	$1,470,000
Manholes	35	EA	$4,500	$157,500
Pumping Station (50-100gpm)	5	EA	$100,000	$500,000
Centralized Septic Tank (10,000 gal)	1	EA	$20,000	$20,000
4" Gravity lateral	4,600	LF	$75	$345,000
Electrical Service	5	EA	$3,000	$15,000
Leachfield (Cluster)	1	EA	$250,000	$250,000
Abandon and decommission septic tank	92	EA	$3,000	$276,000
Rock Removal Contingency	1	LS	$500,000	$500,000
			Subtotal	$3,533,500
			20% Contingency	$706,700
			Total Construction	**$4,240,200**
			25% Engineering, Legal & Misc.	$1,060,050
			ESTIMATED AREA 1 PROJECT COST (2018)	**$5,300,250**

AREA 2

Item	Quantity	Unit	Unit Price	Total
8" & 10" Sanitary Sewer (Green Space)	0	LF	$150	$0
8" & 10" Sanitary Sewer (Pavement)	12,000	LF	$175	$2,100,000
Manholes	48	EA	$4,500	$216,000
Pumping Station (50-100gpm)	13	EA	$100,000	$1,300,000
Multiple Residence Septic Tank (5000 gal)	13	EA	$20,000	$260,000
4" Gravity lateral	11,750	LF	$75	$881,250
Electrical Service	13	EA	$3,000	$39,000
Leachfield (Cluster)	13	EA	$15,000	$195,000
Abandon and decommission septic tank	235	EA	$3,000	$705,000
Rock Removal Contingency	1	LS	$1,000,000	$1,000,000
			Subtotal	$6,696,250
			20% Contingency	$1,339,250
			Total Construction	**$8,035,500**
			25% Engineering, Legal & Misc.	$2,008,875
			ESTIMATED AREA 2 PROJECT COST (2018)	**$10,044,375**
			ESTIMATED TOTAL PROJECT COST (2018)	**$15,344,625**

Alternative 3A - Gravity Collection System

AREA 1

Item	Quantity	Unit	Unit Price	Total
8" & 10" Sanitary Sewer (Green Space)	0	LF	$150	$0
8" & 10" Sanitary Sewer (Pavement)	8,900	LF	$175	$1,557,500
Manholes	36	EA	$4,500	$160,200
Pumping Station (50-100gpm)	3	EA	$195,000	$585,000
Pumping Station (100-200gpm)	1	EA	$225,000	$225,000
4" Force Main (green space)	0	LF	$75	$0
4 " Force Main (Pavement)	4,400	LF	$100	$440,000
4" Gravity lateral	4,600	LF	$75	$345,000
Air Release Valves	2	EA	$6,000	$12,000
Abandon and decommission septic tank	92	EA	$3,000	$276,000
Rock Removal Contingency	1	LS	$500,000	$500,000
			Subtotal	$4,100,700
			20% Contingency	$820,140
			Total Construction	**$4,920,840**
			25% Engineering, Legal & Misc.	$1,230,210
			ESTIMATED AREA 1 PROJECT COST (2018)	**$6,151,050**

AREA 2

Item	Quantity	Unit	Unit Price	Total
8" & 10" Sanitary Sewer (Green Space)	0	LF	$150	$0
8" & 10" Sanitary Sewer (Pavement)	12,000	LF	$175	$2,100,000
Manholes	48	EA	$4,500	$216,000
Pumping Station (50-100gpm)	4	EA	$195,000	$780,000
Pumping Station (100-200gpm)	0	EA	$225,000	$0
4" Force Main (green space)	0	LF	$75	$0
4 " Force Main (Pavement)	8,000	LF	$100	$800,000
4" Gravity lateral	11,750	LF	$75	$881,250
Air Release Valves	0	EA	$6,000	$0
Abandon and decommission septic tank	235	EA	$3,000	$705,000
Rock Removal Contingency	1	LS	$1,000,000	$1,000,000
			Subtotal	$6,482,250
			20% Contingency	$1,296,450
			Total Construction	**$7,778,700**
			25% Engineering, Legal & Misc.	$1,944,675
			ESTIMATED AREA 2 PROJECT COST (2018)	**$9,723,375**
			ESTIMATED TOTAL PROJECT COST (2018)	**$15,874,425**

Alternative 3B - Grinder Pump/Pressure Sewer Collection System

Area 1- Within 250 feet of the lake

Item	Quantity	Unit	Unit Price	Total
Grinder Station (simplex)	77	EA	$12,000	$924,000
Grinder Station (duplex)	3	EA	$15,000	$45,000
4" Gravity lateral	600	LF	$75	$45,000
6" Lateral to Grinder Station	3	EA	$3,500	$10,500
1.5" Force main lateral (Assume 100LF)	14,150	LF	$35	$495,250
Air Release Valves	6	EA	$6,000	$36,000
Flushing Connections (1,000 LF Intervals)	9	EA	$2,600	$23,400
Electrical Service	30	EA	$4,500	$135,000
Abandon and decommission septic tank	80	EA	$3,000	$240,000
Rock Removal Contingency	1	LS	$250,000	$250,000
			Subtotal	$2,204,150
			20% Contingency	$440,830
			Total Construction	**$2,644,980**
			25% Engineering, Legal & Misc.	$661,245
			ESTIMATED AREA 1 PROJECT COST (2018)	**$3,306,225**

Area 2 - Outside 250 feet and within the service area

Item	Quantity	Unit	Unit Price	Total
Grinder Station (simplex)	235	EA	$12,000	$2,820,000
Grinder Station (duplex)	0	EA	$15,000	$0
4" Gravity lateral	0	LF	$75	$0
6" Lateral to Grinder Station	0	EA	$3,500	$0
1.5" Force main lateral (Assume 100LF)	23,750	LF	$35	$831,250
Air Release Valves	3	EA	$6,000	$18,000
Flushing Connections (1,000 LF Intervals)	12	EA	$2,600	$31,200
Electrical Service	100	EA	$4,500	$450,000
Abandon and decommission septic tank	235	EA	$3,000	$705,000
Rock Removal Contingency	1	LS	$500,000	$500,000
			Subtotal	$5,355,450
			20% Contingency	$1,071,090
			Total Construction	**$6,426,540**
			25% Engineering, Legal & Misc.	$1,606,635
			ESTIMATED AREA 2 PROJECT COST (2018)	**$8,033,175**
			ESTIMATED TOTAL PROJECT COST (2018)	**$11,339,400**

Alternative 4B - Effluent Sewer Collection System

Area 1- Within 250 feet of the lake

Item	Quantity	Unit	Unit Price	Total
Pumping Station (100-200gpm)	1	EA	$225,000	$225,000
4" Force Main (green space)	0	LF	$75	$0
4 " Force Main (Pavement)	2,000	LF	$100	$200,000
1.5" Force main lateral (Assume 100LF)	13,500	LF	$35	$472,500
Air Release Valves	6	EA	$6,000	$36,000
Flushing Connections (1,000 LF Intervals)	9	EA	$2,600	$23,400
STEP System (residential)	92	EA	$20,000	$1,840,000
Rock Removal Contingency	1	LS	$250,000	$250,000
			Subtotal	$3,046,900
			20% Contingency	$609,380
			Total Construction	**$3,656,280**
			25% Engineering, Legal & Misc.	$914,070
			ESTIMATED TOTAL PROJECT COST (2018)	**$4,570,350**

Area 2 - Outside 250 feet and within the service area

Item	Quantity	Unit	Unit Price	Total
Pumping Station (100-200gpm)	0	EA	$225,000	$0
4" Force Main (green space)	0	LF	$75	$0
4 " Force Main (Pavement)	0	LF	$100	$0
1.5" Force main lateral (Assume 100LF)	23,750	LF	$35	$831,250
Air Release Valves	3	EA	$6,000	$18,000
Flushing Connections (1,000 LF Intervals)	12	EA	$2,600	$31,200
STEP System (residential)	235	EA	$20,000	$4,700,000
Rock Removal Contingency	1	LS	$250,000	$250,000
			Subtotal	$5,830,450
			20% Contingency	$1,166,090
			Total Construction	**$6,996,540**
			25% Engineering, Legal & Misc.	$1,749,135
			ESTIMATED TOTAL PROJECT COST (2018)	**$8,745,675**
			ESTIMATED TOTAL PROJECT COST (2018)	**$13,316,025**

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THERE'S A WAY