WESTFORD COMMUNITY WASTEWATER DISPOSAL SYSTEM PRELIMINARY ENGINEERING REPORT

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I. PROJECT PLANNING

I.a. Location

Westford is a rural residential community located between Essex and Fairfax in northwest Vermont. The project area for the Town's 2007-8 alternatives study[1] included parcels within the Town Center zoning district, located near the center of the Town of Westford. Appendix C, Figure 1 shows the Town and the original study area in their wider geographical context.

The Town Center area includes the post office, Town offices, library, the Old Brick Meeting House, the Westford Common Hall (formerly Westford United Church), and the elementary school. The area around the Town Common additionally hosts businesses including the Westford Country Store and Café and a store with an apartment (now closed), two small apartment buildings (10 apartment units total), and 17 single family residences.

In 2016, the Town's land use, development, and zoning regulations were completely re-written[2]. Appendix A, Figure 1 shows the overall context for this PER and project. Following the 2007-8 alternatives study, consideration of community wastewater system options was progressively narrowed to providing capacity for what is now known as the Common District:

> *The purpose of the Common District is to provide for a community center – a place of civic pride and a focal point for development in Westford. The Common District is intended to:*
>
> *(1)Promote a higher-density and more compact settlement pattern than other places in town.*
>
> *(2)Allow a compatible mix of appropriately-scaled residential and business uses in a pedestrian-friendly setting.*
>
> *(3)Ensure that new development is consistent with the historic character and pattern of development.*
>
> *(4)Provide for walkways, green space, and recreation opportunities that will enhance connectivity, public use, and enjoyment of the area.*

I.b. Environmental Resources Present

Most of the developed portion of the Common and Village districts lies in a north-south lying valley formed in part by the Browns River, which runs from south to north (Figure 1). Morgan Brook runs from northeast to southwest along the eastern boundary, then turns back to the north and empties into the Browns River near the Town Common. Several small, unnamed streams run primarily from south to north through the area, all of which discharge to the Browns River. Limited wetland areas are present near the project area, primarily in the Maple Shade Town Forest and

[1] https://westfordvt.us/wp-content/uploads/2014/09/WestfordAlternatives_Web_2008.03.21.pdf
[2] https://westfordvt.us/wp-content/uploads/2019/09/Westford-Land-Use-Development-Regulations-Adopted-May-10-2018.pdf

along watercourses. Additional information about environmental resources present is provided in this project's Environmental Information Document (EID).

I.c. Population Trends

The Town of Westford's population grew from 1,740 in 1990 to 2,086 in 2000 but declined slightly from 2,086 to 2,029 in 2000-2010 (US Census and 2021 Westford Town Plan). The American Community Survey estimated the population of Westford to be 2,019 in 2017. The 2021 Town Plan projects slow but steady future population growth with an approximate 10% increase in Westford's population to 2,361 residents by 2050). The 0 to 19 year old population decreased and the 50 year old and over population increased from 2000 to 2010, and the Town Plan indicates that the population of individuals 19 or younger will stabilize over the course of the next 15 years, while elder population will increase dramatically. The 2021 Town Plan notes that "[f]uture demographics will play an important role in determining which projects and services the Town plans for and implements".

Notwithstanding these population estimates, planning initiatives undertaken by the Town are intended to support population growth within the state-designated Village Center and the state-designated Neighborhood Development Area, large segments of which will be served by the proposed wastewater project. As noted in Section 9 of the 2021 Town Plan, providing wastewater service (as well as other transportation enhancements) supports implementation of the Westford Town Common Conceptual Master Plan[3]. Many of the Town's Residential Development Options and Incentives, detailed in Section 3.2.5 of the 2021 Town Plan, such as the affordable housing density bonus adopted into the Town's subdivision ordinance for the creation of affordable units, the recent Neighborhood Development Area designation, and the Town's provisions for mixed use retail and residential buildings in the Town Plan area, are incentives for creating more and more diverse housing units that could facilitate population growth in the Town Center. However, implementation of these initiatives relies entirely on the provision of adequate wastewater treatment capacity.

I.d. Community Engagement

The alternatives and recommended project described in this PER reflect over a decade of community engagement in planning not only for wastewater service, but for the desired future land use and community character of the service area. The Town of Westford has established communication channels including a dedicated project website and FAQs to provide information and gather community input on the preferred alternative as engineering is advanced, and ultimately, for when a bond vote is scheduled. Upcoming community engagement will build on these channels and will be supplemented with direct communications as the project's details take shape (e.g., mail, Town Report information, Town Meeting presentations, Planning Commission and Select Board updates, and public hearings).

The Town of Westford began active community engagement in wastewater planning in 2007-2008[4] (Appendix C). After that initial phase, the Town spent several years updating the Town Plan and developing its Town Center initiatives. Options for advancing and implementing a community wastewater system were explored on a parallel track through a series of technical studies and

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[3] https://westfordvt.us/wp-content/uploads/2014/09/Final-ProductTownCommonConceptualPlan.pdf
[4] http://westfordvt.us/wp-content/uploads/2014/09/WestfordAlternatives_Web_2008.03.21.pdf

negotiations with individual landowners. In 2015, the same year a new Town Plan was adopted, the Town's voters approved funding to conduct further study of a previously-considered alternative, reflecting broad understanding among voters of the need to pursue Town Center wastewater solutions. In the fall of 2019, a Vermont Council on Rural Development Community Visit brought community members together to identify and prioritize goals, foster local leadership, connect to resources and develop and realize achievable action plans[5]. Through two public meetings, community members chose three community priorities for action, and signed up for task force groups to move them forward. "Boost[ing] local business and economic development…" was one of the top-three priorities, and participants acknowledged that wastewater capacity is critical to achieving the community's vision.

In 2019 and 2020, the outreach initiatives stemming from the original 2007-2008 work have been continually updated to ensure that citizens can directly link the Westford Community Wastewater Disposal System project to Westford's Town Center initiatives, and to the recent and prospective development in the Town Center (including prospective options for the Pigeon property at 1705 Vermont Rte. 128). This has been achieved principally through three actions:

1. Regular updates to the Select Board and Planning Commission
2. Posting of a regularly-updated "Frequently Asked Questions" document[6] to provide a comprehensive update on the status of the Wastewater Initiative. As of November 2020, this document includes:

   – Identification of the Maple Shade Town Forest (Brookfield Road) site as the preferred community wastewater dispersal field
   – The current status of planning and investigations for redevelopment of the Pigeon Property (1705 VT Route 128)
   – Identification of problems with the Town's existing structures
   – Discussion regarding the Maple Shade Town Forest site versus using the Common Hall site to accommodate wastewater flows from Town-owned and community buildings.
   – Preliminary information on mandatory vs. opt-in connections and construction phasing, as well as O&M costs and responsibility for maintenance
   – Identification of next steps, opportunities to vote, and where to find more information: PER preparation and review, where to seek information, and the fact that a vote will be required are discussed.

3. Maintenance of a dedicated Town Center Wastewater Initiative project website[7].This website provides bridge information between the 2007-2008 alternatives study and the identification of the Maple Shade Town Forest site (previously known as the Jackson Farm site) as the preferred community wastewater disposal field site.

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[5] https://www.vtrural.org/programs/community-visits/report/westford
[6] https://westfordvt.us/wp-content/uploads/2020/09/Town-Center-development-Questions-Answers-Revised-9.15.20.pdf
[7] https://westfordvt.us/westford-town-center-community-wastewater-project/

II. EXISTING FACILITIES

II.a. Location Map

A map of existing developed properties with wastewater treatment systems, as surveyed during the 2007-8 alternatives study, is provided in Appendix C, Figure 3. The analysis and recommendations shown on this figure are described below. No facilities have been abandoned, and photographs of existing facilities are not available as no site inspections were completed during the 2007-8 alternatives study.

II.b. History

Westford's Town Center is served by individual onsite sewage disposal systems. There are no wastewater treatment plants or sewers in the study area.

II.c. Condition of Existing Facilities

II.c.i. Wastewater Treatment Systems

Properties in the Project Area served by individual onsite sewage disposal systems. There are no wastewater treatment plants or sewers in the study area. Information on the existing sewage disposal systems was gathered from state permit files, property owner survey questionnaires, interviews, and area site visits.

Permits were found for all public buildings in the study area, except for the Common Hall and the general store (Appendix C, C-2. Table of Wastewater Permits in Project Area, October 2020). A total of 36 permits were found for 25 parcels in the study area. Most of these permits, particularly for those issued before 2007, were for subdivisions or new construction. Several properties received permits for subdivision, for renovations that included changes to the septic systems, or for repairs to existing systems, at least one of which appeared to represent a "best fix" situation. Permits issued since 2007 were for replacements of failed systems (four, two of which were "best-fix" solutions), subdivisions or new construction (six, at least one of which included a performance-based design), and one permit was issued for redevelopment of an existing residential property into a convenience store with deli using existing water supply and wastewater treatment systems (the new Westford General Store).

During the 2007-8 alternatives study, the property owner survey collected information regarding existing water supplies and septic systems. Of the 63 surveys sent, responses were received from 32 owners (52%). Appendix C contains a summary of the responses. The data collected provided information about ages and types of septic systems, when septic tanks were last pumped, and repairs or plans on file. Information about types and locations of water supplies and indications of water quality were also collected.

Approximately 13% of the respondents' onsite systems were constructed prior to 1982, when the first major technical design standards for Vermont were published. Sixty-eight percent of the properties contained leach fields, and one respondent (3%) had a drywell. Five mound systems and two advanced treatment units were identified in the study area. About half of the septic tanks were two or more feet below grade, which means they are difficult to access unless they have access risers on the tanks, and it means that the leach fields may be deeper in order for gravity flow to reach the field. More than half of the responding property owners (58%) said they have a copy of the sketches, plans, or permits for their system.

Three questions were directed towards maintenance of septic tanks and system repairs. Approximately half (48%) of the respondents indicated they pumped their tanks every 1 to 5 years. Eighty-six percent indicated they had pumped their tank since 1995, with 73% pumping since 2000. Twenty percent of the respondents indicated upgrades or repairs to their systems had been made within the last ten years.

II.c.ii. Water Supplies

Most properties in the study areas are served by individual onsite water supplies. The locations of water supplies in the study area were gathered from property owner surveys, from state permits, and from a walking tour of the study area. These individual water supplies with their 100 foot or 150-foot protective buffers are shown on Appendix C, Figure 2. In the Project Area of concern for this PER, five properties are served by shallow water supplies; the majority of the remaining developed properties are served by individual drilled wells. A shared drilled well serves the library and Town offices. Two public drilled wells serve the elementary school (System ID VT0006745), and the Westford Country Store and Café is in the process of applying for and receiving a public water supply permit for its drilled well.

II.c.iii. Wastewater Needs Assessment Results

In 2007-8, a data-driven Geographic Information System (GIS) analysis was completed that combined spatial information, such as USGS topography and NRCS soils information, with local information such as parcel boundaries, building footprint areas, and building uses, to determine what, if any, constraints a property may contain for onsite wastewater treatment and disposal. The results of the GIS analysis are indicated on Appendix C, Figure 3 by colors summarizing the key constraint(s), if any, for each property. Details of the analysis methods may be reviewed in Appendix C.

The results of that analysis were confirmed by including all other sources of information collected and described above. This review resulted in an overall recommendation for each property of either maintaining and upgrading a system onsite, or potentially connecting to an offsite solution. A recommendation of "connecting to an offsite solution" meant that, if an individual system were to fail, it may be difficult to site a replacement system on the property that meets all of the setbacks and separation distances required by zoning ordinances and State wastewater rules. The results of this assessment are summarized in Appendix C, Section 4.3, Table 5 and Figure 3.

The GIS analysis estimated that 36 parcels could not support an onsite wastewater disposal system, primarily clustered around the Town Common in the heart of the historic village area. Of these parcels, five were constrained only by environmental setbacks, 19 parcels were constrained only by shallow groundwater, and none were constrained only by shallow bedrock. The remaining 11 parcels had a combination of setback and groundwater constraints.

Once the results of the GIS analyses were produced, a lot-by-lot review was conducted. This review included using all of the additional information known about the properties, confirming the results of the GIS analyses, and developing recommended solutions for each parcel. Onsite solutions were recommended for most properties that did not have any constraints identified in the GIS analyses. Slightly less than half (46%) of the properties were identified as likely benefiting from an offsite wastewater treatment solution. Parcels with both groundwater and available area limitations are clustered primarily in the immediate vicinity of the Town Common, indicating that a small community system may be needed to meet the needs of these properties.

II.d. Financial Status of any Existing Facilities

All properties in the Town Center project area are served by onsite wastewater treatment systems. No rate schedules, annual O&M cost information or current energy cost breakout, or tabulation of users by monthly usage categories for a recent typical fiscal year are available.

Per the 2019 Town Report[8], Westford's General Fund expense budget (general administration and highway) was $2,009,198 for Fiscal Year 2020, and $2,021,365 for Fiscal Year 2021. The Town maintains a Capital Budget and Program. Its outstanding debt for the FY 2019 was $558,463, a reduction of $294,092 from the prior fiscal year's balance. The Town maintains eight reserve accounts with a cumulative balance of $495,056.61 at the conclusion of FY 2019. A wastewater reserve account would be established for implementation of the Westford Community Wastewater Disposal System.

II.e. Water/Energy/Waste Audits

Not needed or applicable (per review by Lynnette Claudon dated June 20, 2019).

[8] https://westfordvt.us/wp-content/uploads/2020/02/2019-Annual-Town-Report.pdf

III. NEED FOR PROJECT

The Westford Town Center area, not unlike other areas in Town, has clay soils, significant ledge, and a high water table, making the soils generally unsuitable for wastewater disposal systems. As documented in Section II, the area around the Town Common, and the Village District generally, is the heart of the Town's civic infrastructure. Without community wastewater capacity, small lot sizes and challenging soil and groundwater conditions severely limit the Village District (this PER's Project Area) in terms of supporting both present and desired future uses.

Since the alternatives study, this area's needs related to **health**, **sanitation**, and **aging infrastructure** have become clearer and more urgent. The septic system serving the Town office and library is about 50 years old[9]. The library's septic tank was replaced in 2016, after it collapsed; leakage from the tank had contaminated the water supply shared by the Town Office and library. The shared leach field sits under the parking lot for the Town office and is at the end of its useful life. If this system fails, there is no option or location for an alternate system. It was recently discovered that the septic tank for the 1705 VT Route 128 property, located east of the Town office, also uses the same leach field as the Town office and library. The septic system for the Brick Meeting House is also compromised and nearing the end of its useful life. The White Church has only a holding tank, no leach field or disposal area. The tank needs to be pumped regularly. The White Church recently spent several thousand dollars repairing the line that runs from the church to the holding tank.

At the very least, the Town must find solutions for its public buildings and civic meeting spaces. The lack of wastewater capacity is limiting commercial development in the village. If the Town concentrates only on finding solutions to the wastewater challenges facing the Town's public structures, a dearth of capacity will still exist for other properties in and around the village. This will prevent significant redevelopment of the village, including the development of any small-scale business or affordable housing. If the Town can develop a community wastewater system, it will eliminate the biggest barrier to the future revitalization and redevelopment of the Town Center.

While working to find solutions for the wastewater challenges facing the Town Common area, the Town has taken several strategic actions to both foster and accommodate **reasonable growth**, including:

- Applying for and receiving Village Center designation for the area surrounding the Town Common in 2010.
- Adopting a form-based zoning code for the Town Center area in 2016[10], which includes detailed design standards to help ensure that any new development honors the character of the Town Common.
- Continuing to investigate possible community wastewater disposal sites identified in the alternatives study, ultimately securing capacity at the Area 1 site as part of the Jackson Farm and Forest Project (now known as the Maple Shade Town Forest[11]); and

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[9] https://westfordvt.us/Fwp-content/uploads/2020/F08/Town-Center-development-Questions-Answers.pdf

[10] https://westfordvt.us/wp-content/uploads/2019/09/Westford-Land-Use-Development-Regulations-Adopted-May-10-2018.pdf

[11] https://westfordvt.us/wp-content/uploads/2019/10/WTL-Long-Term-Management-Plan-2019.pdf

- Applying for and receiving Neighborhood Development Area (NDA) designation for the Town Common area in 2019, which included securing conceptual site approval[12] for a soil-based community wastewater system at the Maple Shade Town Forest site.

In 2019-2020, two new projects pose both opportunities and challenges, giving new urgency to the Town's need for a community wastewater treatment system.

The former **Spiller Lot**, at 26 Common Road, has been adaptively redeveloped into the Westford Country Store and Café, using the property's existing leachfield to support a new and vibrant use—but with very limited café seating and no current options for expanding seats or diversifying uses in the absence of additional wastewater capacity.

The Town is now investigating how the property located at **1705 VT Route 128**, also known as the Pigeon property, may be redeveloped by working with the landowner, public agencies and private developers[13]. Adaptive redevelopment of this parcel can offer the Town the opportunity to obtain many community benefits and will help set the tone for future development around the Town Common. Benefits for Westford's residents can include permanent public recreational access to the Browns River, an option for a new Town office, options for affordable housing and economic development, improved parking and pedestrian safety, potable drinking water supply, and remediation of contaminated soils. The Town has been awarded a $60,000 VCDP planning grant[14] to advance work on the 1705 VT Route 128 project. If the Town is able to move forward with this project and the Westford Community Wastewater Disposal System, the community wastewater system will have immediate paying users once it is constructed, and the 1705 VT Route 128 property will have its required wastewater capacity. While there is not yet a set number of new customers that may be committed to the community system from this project, no development of the 1705 VT Route 128 property can occur without a wastewater disposal solution – so any improvement of the 1705 VT Route 128 property is dependent on the Town constructing a wastewater disposal system.

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[12] https://accd.vermont.gov/sites/accdnew/files/documents/CD/CPR/DTBoard/NDAProccessforANRWastewaterApproval.pdf

[13] https://westfordvt.us/1705-route128-ad-hoc-steering-committee/

[14] https://westfordvt.us/vermont-community-development-program-vcdp-planning-grant/

IV. ALTERNATIVES CONSIDERED

The 2007-8 alternatives study evaluated various wastewater collection, treatment, and disposal options for the Town Center. The report included desktop analysis for replacement systems on each parcel within the defined designated study area (Section II.c.iii), as well as evaluating potential off-site disposal areas for a community based decentralized disposal system(s) (Appendix C). The report concluded that replacement of individual disposal systems on each parcel was technically infeasible; the majority of the parcels have severely limited soil capacities (shallow depth to groundwater, shallow bedrock or poorly drained soils or combinations of each), insufficient isolation distances from individual water supplies, and spatial limitations to construct properly sized disposal systems. This alternative is not further examined in this report.

Four community wastewater collection, treatment, and disposal alternatives were developed and are evaluated below. The service area for all alternatives is limited to the Common zoning district, and more specifically to the Designated Village portion of the that zoning district and the route of the collection system along Brookside Road to the wastewater disposal system (Appendix A, Figure 1). Much of the required information supporting each of the alternatives is identical. Thus, the facilities associated with each feasible alternative are detailed individually in Section IV.a and cost estimates for each alternative are presented individually in Section IV.h. Information that is consistent across all alternatives considered is only provided once.

IV.a. Description

IV.a.i. Alternative No. 1: Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel

Alternative No. 1 includes the installation of STEP tanks at each parcel and conveyance in a common 2-inch low pressure forcemain to the dosing pump station located on Brookside Road (Figure 3 – Alternative No. 1 Site Plan). The pump station will dose the community disposal field at calculated intervals. The major Alternative No. 1 components are:

Collection and Treatment System (See Alternative #1 Site Plan)

- Construction of 23 STEP tanks with electrical connections (1,500-2,000 gal)
- Construction of approximately 2,700’ of 1 ¼” low pressure force main (service pipes)
- Construction of approximately 4,600 feet of 2” low pressure force main
- Construction of approximately 500’ of 4” sewer services
- Construction of cleanout and air release manholes (8 total est.)
- Construction of concrete valve vault
- Construction of estimated 5,500-gallon precast concrete dosing pump station

Disposal System (See Alternative #1 Site Plan)

- Construction of the Maple Shade Forest in-ground wastewater disposal system (12,600 gpd)
  - Field #1 - (17 trenches) x (4’ wide) x (100’ long)
  - Field #2 - (19 trenches) x (4’ wide) x (100’ long)
  - Field #3 – (11 trenches) x (4’ wide) x (174’ long)
  - Field #4 – (17 trenches) x (4’ wide) x (100’ long)

- Construction of isolation gate valves
- Construction of all valving, piping, electrical panels and required appurtenances

See estimates (Section IV.h) and site plans for more details.

Evaluations of each parcel will be performed during final design of the system to determine if improvements to the interior plumbing are required to optimize STEP tank installations. Inspections of existing disposal systems will be performed and the proper decommissioning course for each connection will be determined.

IV.a.ii. <u>Alternative No. 2 – Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel with Pre-Treatment of Effluent prior to disposal</u>

Alternative No. 2 includes the installation of STEP tanks at each parcel and conveyance in a common 2-inch low pressure forcemain to an Advantex® (or equal) pre-treatment system located off Brookside Road (Figure 4 – Alternative No. 2 Site Plan). Effluent will enter the treatment units and recirculate within the system until the desired treatment quality is achieved, after which the effluent will be released to a 4,000-gallon pump station that will dose the community disposal field at calculated intervals. The major Alternative No. 2 components are:

Collection and Treatment System

- Construction of 23 STEP tanks with electrical connections (1,500-2,000 gal)
- Construction of 2,700' of 1 ¼" low pressure force main (service pipes)
- Construction of approximately 4,600 feet of 4" low pressure force main
- Construction of approximately 500' of 4" sewer services
- Construction of cleanout and air release manholes (8 total est.)
- Construction of concrete valve vault

Pre-Treatment System

- First Stage Treatment Units – (4) AX100 Pods
- 15,000-gallon recirculation tank with duplex recirculation pumping system
- 4,000-gallon precast concrete dosing pump station
- 10' x 10' control building

Disposal System

- Construction of the Maple Shade Forest in-ground wastewater disposal system (12,600 gpd)
  - Field #1 - (17 trenches) x (4' wide) x (100' long)
  - Field #2 - (19 trenches) x (4' wide) x (100' long)
  - Field #3 – (11 trenches) x (4' wide) x (174' long)
  - Field #4 – (17 trenches) x (4' wide) x (100' long)
- Construction of isolation gate valves
- Construction of all valving, piping, electrical panels and required appurtenances

See cost estimates (Section IV.h) and site plans for more details.

IV.a.iii. Alternative No. 3 – Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel with collection Pump Station

Alternative No. 3 includes the installation of STEP tanks at each parcel and conveyance in a common 2-inch low pressure forcemain to a 10,000-gallon precast pump station located near the Town Common, off Brookside Road (Figure 5– Alternative No. 3 Site Plan). Additionally, a 2-inch low pressure forcemain will be constructed adjacent to the 3-inch collection forcemain to convey effluent from the upper five parcels located on Brookside Road to the dosing pump station. Effluent will then be pumped to a 3,500-gallon dosing pump station adjacent to Brookside Road, which will dose the community disposal field at calculated intervals. The major Alternative No. 3 components are:

Collection and Treatment System

- Construction of 23 STEP tanks with electrical connections (1,500-2,000 gal)
- Construction of 2,700' of 1 ¼" low pressure force main (service pipes)
- Construction of approximately 4,600 feet of 2" low pressure force main
- Construction of 10,000-gallon precast concrete duplex pump station
- Construction of 2,200 feet of 3" low pressure forcemain
- Construction of cleanout and air release manholes (8 total est.)
- Construction of concrete valve vault
- See estimates and site plans for more details

Disposal System

- Construction of the Maple Shade Forest in-ground wastewater disposal system (12,600 gpd)
  - Field #1 - (17 trenches) x (4' wide) x (100' long)
  - Field #2 - (19 trenches) x (4' wide) x (100' long)
  - Field #3 – (11 trenches) x (4' wide) x (174' long)
  - Field #4 – (17 trenches) x (4' wide) x (100' long)
- Construction of isolation gate valves
- Construction of all valving, piping, electrical panels and required appurtenances

See cost estimates (Section IV.h) and site plans for more details.

IV.a.iv. Alternative No. 4 – Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel, Collection Pump Station, and Pre-Treatment of Effluent prior to disposal

Alternative No. 4 includes the installation of STEP tanks at each parcel and conveyance in a common 2-inch low pressure forcemain to a 10,000-gallon precast pump station located near the Town Common, off Brookside Road (Figure 6– Alternative No. 4 Site Plan). Additionally, a 2-inch low pressure forcemain will be constructed adjacent to the 4-inch collection forcemain to convey effluent from the upper five parcels located on Brookside Road to the dosing pump station. Effluent will then be pumped in a 3-inch low pressure forcemain to an Advantex® (or equal) pre-treatment system located off Brookside road. Effluent will enter the treatment units and recirculate within the system until the desired treatment quality is achieved, after which the effluent will be released to a 4,000-gallon pump station that will dose the community disposal field at calculated intervals. . The major Alternative No. 4 components are:

Collection and Treatment System

- Construction of 23 STEP tanks with electrical connections (1,500-2,000 gal)
- Construction of 2,700’ of 1 ¼” low pressure force main (service pipes)
- Construction of approximately 4,600 feet of 2” low pressure force main
- Construction of 10,000-gallon precast concrete duplex pump station
- Construction of 2,200 feet of 3” low pressure forcemain
- Construction of cleanout and air release manholes (8 total est.)
- Construction of concrete valve vault

Pre-Treatment System (See Alternative #4 Site Plan)

- First Stage Treatment Units – (4) AX100 Pods
- 15,000-gallon recirculation tank with duplex recirculation pumping system
- 4,000-gallon precast concrete dosing pump station
- 10’ x 10’ control building

Disposal System

- Construction of the Maple Shade Forest in-ground wastewater disposal system (12,600 gpd)
  - Field #1 - (17 trenches) x (4’ wide) x (100’ long)
  - Field #2 - (19 trenches) x (4’ wide) x (100’ long)
  - Field #3 – (11 trenches) x (4’ wide) x (174’ long)
  - Field #4 – (17 trenches) x (4’ wide) x (100’ long)
- Construction of isolation gate valves
- Construction of all valving, piping, electrical panels and required appurtenances

See cost estimates (Section IV.h) and site plans for more details.

IV.b. <u>Design Criteria</u>

Design considerations for individual onsite and small and large community cluster wastewater collection, treatment, and disposal systems appropriate to the project area were summarized in the 2007-8 alternatives study. Vermont’s Wastewater System and Potable Water Supply Rules (WSPWSRs) (effective September 29, 2007) and Indirect Discharge Rules (effective April 30, 2003) were used to estimate wastewater flows from the study area based on available information and the results of the needs analysis discussed in Section II. Analyses, design flow calculations, and other work completed since the 2007-8 alternatives study have progressed according to the regulations effective at the time.

IV.b.i. <u>Initial Year Design Flow</u>

Each alternative examined in this PER utilizes the same initial year design flows, resulting in 23 initial connections to the system and 42 equivalent users (Table 1).

Table 1. Wastewater Initial Year Project Summary

Street	Use & Design Flow (gpd)	Initial Year Flow (gpd)	Equivalent Users
Brookside Road	4 SFR x 245 gpd/SFR = 980 Common Hall 150 seats x 4 gpd/seat = 600	1,580	7
Cambridge Road	1 SFR x 245 gpd/SFR = 245	245	1
Common Road	3 SFR x 245 gpd/SFR = 735 1 Store x 90 gpd/store = 90 Restaurant (17 seats x 27 gpd/seat) = 459	1,284	6
VT Route 128	9 SFR x 245 gpd/SFR = 2,205 7 Apt. x 245 gpd/Apt. = 1,715 Town Office & Library 10 employees x 15 gpd/employee = 150 140 patrons x 4 gpd/patron = 560 Brick Meeting House 115 seats x 14 gpd/seat = 1,610	6,240	28
Initial Year Totals		**9,349**	**42**
ERUs *not* owned by Town of Westford			**32**

IV.b.ii. Collection and Treatment System Design Criteria

For all feasible alternatives considered, and as described in the 2017 *Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site*, the lowest cost wastewater collection and treatment system was anticipated to be a Septic Tank Effluent Pump (STEP) system (Appendix B). In the preparation of this PER, GME worked with Orenco® on sizing and design criteria for pre-treatment using the Advantex® AX100 treatment system. Assumptions on the BOD and TSS loading of 180 mg/L with a 20,000 gallon per day were used in the sizing of the proposed setup. The proposed system is the same size for Alternatives #2 and 4. The preliminary evaluation report prepared by Orenco® is in Appendix C.

IV.b.iii. Disposal Field Design Criteria

In 2017, Stone Environmental and Green Mountain Engineering completed field and desktop analysis of the soil-based wastewater treatment capacity of the Maple Shade Town Forest site, then known as the Jackson Farm property, located at 123 Brookside Road (Appendix B). This work determined that a 12,600 gpd wastewater disposal system applying septic tank effluent could be constructed at the site. An evaluation of the capacity of the Browns River to assimilate renovated effluent from the proposed community wastewater disposal field while meeting the Aquatic Permitting Criteria (APC) under Vermont's Indirect Discharge Rules was completed in 2019 (Appendix B). This assessment determined that the design flow proposed can be treated and dispersed while meeting the nutrient-based APC for nitrate-nitrogen (nitrate-N) and total dissolved phosphorus (TDP) in the Browns River. The Vermont Indirect Discharge Program issued a preliminary capacity determination concurring with the assessment in March 2019 (Appendix B). This disposal site is included in each of the alternatives examined in this PER.

In order to increase overall design capacity of the disposal fields, Alternatives 2 and 4 introduce pre-treatment prior to disposal. Pre-treatment can be a cost-effective approach to expanding a disposal field's capacity by reducing the waste strength prior to disposal, allowing application of effluent to the disposal field at higher rates. The potential increase in capacity can be affected by factors including soil conditions, slopes, and depths to ground water and bedrock. Per the Indirect Discharge Rules, effluent loading rates for with pre-treatment can be up to two times than that of septic tank effluent. Thus, the capacity of the proposed disposal field could increase to a total capacity of 25,200 gpd if the hydraulic capacity of the site is proven and if the pre-treatment system can consistently produce effluent that meets the required effluent quality standards.

Additional hydrogeologic evaluation, expanding upon the information in the 2017 capacity evaluation to determine depths to restrictive features and bedrock and to update the existing disposal field capacity analysis, is required to determine whether enhanced pre-treatment is a reasonable alternative to consider. This evaluation will be completed as early in the final design process as possible, expected in the spring of 2021. Based on the available information, it is likely that an increase in capacity can be achieved using pre-treatment, but that increase is unlikely to be a doubling of capacity. This unknown should be considered in evaluating each alternative presented in this PER.

IV.c. Maps

Schematic layout maps are provided for each alternative.

- Figure 3 – Alternative #1 Site Plan
- Figure 4 – Alternative #2 Site Plan
- Figure 5 – Alternative #3 Site Plan
- Figure 6 – Alternative #4 Site Plan

IV.d. Environmental Impacts

There are no known major environmental impacts for any of the alternatives considered, and few minor impacts are anticipated at this time. The Environmental Information Document for this project contains additional details and documentation.

IV.e. Land Requirements

The Town has the right to place a community wastewater system on the protected Maple Shade Town Forest property in the area depicted on the property survey[15], which is the location of the proposed wastewater disposal system in all alternatives considered. The Town Common parcel, where a pump station is proposed in Alternatives 3 and 4, is owned by the Town, and the collection system for each alternative will be constructed within Town of Westford's right-or-way area along

[15] https://westfordvt.us/wp-content/uploads/2019/08/WTL-Long-Term-Mgmt-Plan-%E2%80%8CFinal-8.30.19.pdf, page 16.

Common Road, Brookside Road, and Cambridge Road. The Town will coordinate with the Vermont Agency of Transportation regarding construction of collection system improvements and connections to the system along Vermont Route 128. With respect to the land required for connection to the collection system, the Town will need to secure individual easements from private property owners who connect. The Town has not yet determined whether its wastewater ordinance will make connection mandatory or voluntary. Once a determination has been made and the ordinance is adopted, the Town will proceed with securing easements for individual connections.

IV.f. Potential Construction Problems

Shallow depth to bedrock is likely the most concerning potential construction problem for all alternatives considered. To mitigate this issue, all alternatives utilize low pressure sewer force mains, which allow for a consistent conveyance piping depth of 5.5 feet below ground surface. This design automatically reduces the potential bedrock volume removal below what a gravity collection system would require.

Configuration of the sewer services exiting residential and other private properties is not known and will be determined during final design. Owners may be asked to complete interior plumbing changes to lessen potential construction issues. If owners are not willing to allow this, site construction challenges for individual connections to the system will increase.

IV.g. Sustainability Considerations

The Town of Westford maintains strong policies promoting environmental, social, and economic sustainability in its public operations and in the community as a whole. As detailed in Section III, this project is anticipated to yield substantial economic and social benefits to the Town of Westford and its residents. Wastewater capacity will enhance the ability of Town Center landowners to expand and diversify land uses and economic activities, notably restaurant and food-related uses, which provide economic resilience and adaptability. The availability of new capacity will create opportunities for additional accessory apartments and other smaller housing units than conventional large-lot single family dwellings, addressing an unmet social need and providing economic flexibility and opportunity for landowners. Over time, social vibrancy and resilience will be supported by the combination of new housing opportunities, new or adapted economic activities, and prospectively new or expanded public facilities such as a relocated post office. Finally, the Town's economic resilience will be supported by increased taxable grand list value, and by the potential to partner on redevelopment of the Pigeon property, which can create affordable housing and "main street" enhancements including improved walkability and bike-pedestrian safety.

IV.g.i. Water and Energy Efficiency

With respect to the Westford Community Wastewater Disposal System, sustainability considerations relate principally to ensuring energy efficiency in the design and operation of any pre-treatment systems and effluent and/or low-pressure sewer pumps. Water efficiency may be enhanced by adopting an ordinance that requires water-saving devices for properties connected to the community wastewater disposal system. It has not been determined whether connected properties will be required to retrofit fixtures, or if requirements related to water saving devices will be limited to new construction or additions. Both water and energy efficiency will be addressed in the final design process and in development of the wastewater ordinance.

IV.g.ii. Green Infrastructure

Not needed or applicable (per review by Lynnette Claudon dated June 20, 2019).

IV.g.iii. Other

The alternatives evaluated involve different levels of operational complexity related to pre-treatment and maintenance of pumping facilities. In considering these options the potential gain in economic, environmental, and social value from adding more energy- and operations-intensive measures should be balanced against the tradeoffs if options with lower energy or operating footprints are selected.

IV.h. Cost Estimates

The Opinion of Probable Construction Cost estimates for the four alternatives, which range from a low of $1,217,000 for Alternative No. 1 to $1,595,000 for Alternative No. 4, are presented in Table 2 below and discussed in turn. Since the service area and other basic features of the project, including construction of the disposal field, are the same across all four alternatives, the principal cost difference relates to whether project includes a pre-treatment system and/or a collection pump station. Importantly, the cost of the Maple Shade Forest disposal field(s) construction (estimated at $324,000) is included within and is identical across all four project alternatives. Detailed tables of the Engineer's Opinion of Probable Cost are included as Appendix B.

Table 2. Project Alternative Construction Cost Estimate Summary

	Alternative No. 1	**Alternative No. 2**	**Alternative No. 3**	**Alternative No. 4**
Description	Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel, in-ground wastewater disposal trenches	Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel with Pre-Treatment of Effluent prior to disposal, in-ground wastewater disposal trenches	Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel with collection Pump Station, in-ground wastewater disposal trenches	Low-Pressure Sewer Collection with STEP (Septic Tank & Effluent Pump Station) tanks at each parcel with collection Pump Station and Pre-Treatment of Effluent prior to disposal, in-ground wastewater disposal trenches
Opinion of Probable Construction Cost	$1,541,000	$1,817,000	$1,631,000	$1,919,000
Pre-Treatment	No	**Yes**	No	**Yes**
Collection Pump Station	No	No	**Yes**	**Yes**

The estimated CWSRF-Eligible Total Project Cost for each of the four alternatives is presented in Table 3. The Other Costs category for each alternative includes a short-term interest charge, estimated at one percent of construction cost, to enable the Town to establish a line of credit during the project and meet cash flow needs prior to final loan closing.

Table 3. Comparison of Project Cost Components among Alternatives

	Alternative No. 1	**Alternative No. 2**	**Alternative No. 3**	**Alternative No. 4**
STEP 1 Preliminary Engineering	$54,050	$54,050	$54,050	$54,050
STEP 2 Final Design	$109,000	$119,000	$115,000	$135,000
STEP 3 Construction Engineering	$190,000	$216,000	$198,000	$228,000
Other Costs	$37,850	$39,410	$38,370	$40,060
Maple Shade Disposal Field(s) Construction	$324,000	$324,000	$324,000	$324,000
Opinion of Probable Construction Cost	$1,217,000	$1,493,000	$1,307,000	$1,595,000
Total CWSRF-Eligible Project Cost	**$1,931,900**	**$2,245,460**	**$2,036,420**	**$2,376,110**
Annual Operation & Maintenance	$20,660	$26,660	$22,360	$29,160

In evaluating the alternatives, it is instructive to assess the difference among project elements that contribute to the different total project costs, and to the difference in projected annual Operation and Maintenance. While minor, the Operation and Maintenance cost difference reflects the more active maintenance required if a pre-treatment system is implemented. Table 4 below, which is derived from the Engineer's Opinion of Probable Construction Cost sheets in Appendix D, highlights elements that differ among and between the Alternatives.

Table 4. Comparison of Project Cost Components among Collection and Treatment Alternatives

Construction Cost Detail:	Alternative No. 1	Alternative No. 2	Alternative No. 3	Alternative No. 4
A - Sewers	$253,000	$253,000	$317,000	$317,000
			*Alternatives 3 & 4 include a force main	
B - Sewerline Appurtenances	$183,500	$183,500	$183,500	$183,500
C - Earthwork	$52,200	$52,200	$56,400	$56,400
			More earthwork is involved in the collection system alternative	
D - Roadwork	$44,800	$44,800	$44,800	$44,800
E - Incidental Work: Common Elements among Alternatives	$49,900	$49,900	$49,900	$49,900
E - Incidental Work: STEP Tanks	$307,000	$307,000	$261,000	$261,000
	*Alternatives 1 and 2 utilize STEP tanks at each property			
E - Incidental Work: Pre-Treatment System	$0	$304,585	$0	$304,585
	*Equipment for the pre-treatment system in Alternatives 3 and 4			
E - Incidental Work: Pump Station, Vault & Electrical	$83,500	$7,500	$136,000	$70,000
	*Pump station configurations and costs differ among the four alternatives			
E - Incidental Work: House replumbs and septic tank deactivation	$35,000	$35,000	$35,000	$35,000
F - Lump Sum Items - Site Work (8%)	$80,712	$98,999	$86,688	$105,775
F - Lump Sum Items - Bonds (1.5%)	$16,344	$20,047	$17,554	$21,419
F - Lump Sum Items - Contingency (10%)	$110,596	$135,653	$118,784	$144,938
Opinion of Probable Construction Cost Total	**$1,216,552**	**$1,492,184**	**$1,306,626**	**$1,594,317**

V. SELECTION OF AN ALTERNATIVE

Alternative 4, with a pump station and pre-treatment, represents the Preferred Alternative for the Town of Westford. Alternative 3 is a viable alternative if there are *no* hydrogeologic limitations on the dispersal field. Alternative 4, which includes pre-treatment, provides many potential advantages to economic and land use flexibility that support the Town's resilience and economic development goals, as discussed in this PER. The construction and annual operation and maintenance difference between Alternative 3 and Alternative 4 is approximately 16% (i.e., $2.037 million for Alternative 3 and $2.377 million for Alternative 4). Alternative 4 is estimated to require roughly $6,800 more annually in operation and maintenance cost. The potential availability of grant funding, including the prospect of either or both of a Congressional appropriation in FY22, or Northern Borders Regional Commission funding to support the economic resilience that is a core purpose of this wastewater project, will affect the ultimate decision on whether the higher project costs associated with Alternative 4 can be justified.

At this time, **it is recommended that the Town move ahead with Alternative 4 as the preferred alternative**; commence hydrogeologic studies to determine any limitations on the dispersal field; pursue other potential options for pre-treatment systems as part of Alternative 4, to see whether cost savings or operational enhancements can be gained; and evaluate the benefits of pre-treatment to the Town's economic and housing goals in light of the estimated project cost, impact on Town tax payers and system users, and available grant funding.

V.a. Life Cycle Cost Analysis

The fundamental difference among and between the alternatives for the Town of Westford concerns the conveyance system to the principal dispersal field, and the use of pre-treatment. The project has two options for conveyance to the same dispersal field, and each conveyance option can include pre-treatment or not. Therefore, the Life Cycle Cost Analysis for the alternatives (Table 5) fundamentally concerns the addition of pre-treatment and differences in pumping (low-pressure sewer to a common pump station versus low-pressure sewer from each user).

Table 5. Life Cycle Cost Analysis

Alternative	Capital Cost[1]	O&M Cost[2]	PW of O&M (20 yrs, 0.3%)[3]	Salvage Value[4]	PW of Salvage Value[5] (20 yrs, 0.3%)	NPV[6] =B+D-F
1	$1,217,000	$20,660	$400,486	$5,000	$4,711	$1,612,775
2	$1,493,000	$26,660	$516,793	$5,000	$4,711	$2,005,083
3	$1,307,000	$22,360	$433,440	$5,000	$4,711	$1,735,729
4	$1,595,000	$29,160	$565,255	$5,000	$4,711	$2,155,544

Notes:

1 - Capital Costs based on estimated construction cost in report
2 – Operation and Maintenance (O&M) costs based on estimated O&M cost in report
3 - Present Worth (PW) of O&M is based on 0.3% latest OMB Circular No. A-94
4 - Estimated Salvage Value estimated at 5,000 each
5 - Present Worth of Salvage Value based on OMB Circular No. A-94 rate
6 – Net Present Value (NPV): the sum of money that, if invested now at a given interest (discount) rate, would provide exactly the funds required to pay all present and future costs of the project over the planning period. It considers initial capital cost, O&M costs, and salvage value at the end of the planning period.

V.b. Non-Monetary Factors

As discussed under Section IV.g, Sustainability Considerations, the principal consideration in selecting a preferred alternative concerns the trade-off between greater system cost and complexity in adding pre-treatment, and the potential benefits to the Town of additional capacity for higher waste-strength uses, such as restaurants and other food-related businesses. Because of the value of these to the Town, and the expressed preference of citizens through the 2015 Town Plan survey to have these types of uses concentrated in the Town Center, the ability of the system to support a greater range of uses argues for using pre-treatment and thus for selecting Alternative 4 as the preferred alternative.

Operator training and O&M cost is an important consideration as well. As the Town will need to contract with an outside operator regardless of the alternative selected, the addition of pre-treatment responsibilities to an annual O&M contract is not expected to be a burdensome cost or responsibility.

VI. PROPOSED PROJECT (RECOMMENDED ALTERNATIVE)

It is recommended that the Town move ahead with studies to evaluate Alternative 4 at this time. These studies, with Alternative 4 as the Preferred Alternative, will be applicable to any of the Alternatives developed. A prospective bond vote in March 2022 would include language authorizing the Town to evaluate and move forward with the final selected alternative, with bonding authority not to exceed the estimated indebtedness required to implement Alternative 4. The preliminary project designs and financial impacts of Alternative 4, and comparison to Alternative 3 (i.e., the same collection system approach but without pre-treatment), are discussed in this section.

VI.a. Preliminary Project Design (Wastewater/Reuse)

Collection System/Reclaimed Water System Layout. Both Alternative 3 and Alternative 4 utilize the same conveyance to either the dosing pump station (Alternative 3) or pre-treatment system (Alternative 4) (see section *4.B Alternative Descriptions* for Alternative 3 and 4 which identify the key components of each alternative). Both alternatives use the same conveyance piping and manhole alignments and locations which are located within existing town and State roadway rights of ways.

Pumping Stations. Both alternatives utilize individual STEP tanks on each property (either 1,500- or 2,000-gallon capacity). A 10,000-gallon pump station located at the bottom of the hill of Brookside Road will convey the wastewater to either the dosing pump station or pre-treatment system. The pump stations estimated operating point of 50-60 gpm at 80-90 feet of head should not need any special power requirements. Initial review of effluent pump curves, both single and three phase effluent pumps can provide the capacities needed. The dosing chamber and pre-treatment system can both run off single phase power which overhead power runs by the proposed site. A new service for each pump station is included in the project.

Storage. The dosing pump station will attempt to dose the disposal fields at no less than 5 times a day but for the initial phase it will likely be 2-3 times a day. Rough calculations of the volume to be dosed (as required by the WW rules of 5x distribution volume) = 3,400 gallons per dose. Alternative 3 carries a 3,500-gallon dosing pump station and Preferred Alternative 4 carries a 4,000-gallon dosing pump station.

The 10,000-gallon pump station is sized to provide one day of emergency storage for the 18 proposed connections.

Treatment. Alternative 3 does not include any pre-treatment. Alternative 4 includes pre-treatment for up to 20,000 gpd at roughly normal domestic waste levels. This is outlined the Orenco report (Appendix C).

VI.b. Project Schedule

The project is potentially feasible to complete by the second quarter of calendar year 2023, provided a positive bond vote is achieved at Town Meeting 2022. Final design engineering can be completed through the first and second quarters of 2021, along with community outreach and

Select Board meetings leading up to a warning to advertise the vote for Town Meeting 2022. The latest date for a Select Board public hearing to warn the bond vote for Town Meeting would be January 13, 2022. This timeframe, while aggressive, is recommended in order to maximize funding opportunities. The schedule for this approach is shown in Table 6 below.

Table 6. Project Schedule

	2020	2021				2022				2023	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Administrative/ Legal:											
Accept PER											
Community outreach											
Select Board hearing to warn bond vote											
Town Meeting bond vote											
Develop Ordinance & rate structure											
Adopt Ordinance											
Engineering:											
Design & exploration of pre-treatment options											
Hydrogeologic investigation											
Environmental Permitting											
Final Design											
Construction:											
Bid Advertisement											
Bid Opening/Bid Award											
Construction											
Certification & Closeout											

VI.c. Permit Requirements

The following permits are anticipated to be required for the project:

- Indirect Discharge Permit for System with New Indirect Discharge to Class B Waters

- Construction General Permit (CGP) for Stormwater (Permit 3-9020) if disturbance exceeds 1 acre
- Act 250: At minimum, a sign-off on Act 250 will be needed. It is possible at least a minor permit will be required, as the project is constructing a new system and at least minimally increasing sewer capacity for the village. Demonstration may be required that the resulting development will not over-extend school, law enforcement, and firefighting capabilities. Demonstration of conformance with the Town Plan may also be required.

VI.d. <u>Sustainability Considerations</u>

VI.d.i. <u>Water and Energy Efficiency</u>

As noted under Section IV.g, Sustainability Considerations, the Town of Westford has not developed an ordinance for the wastewater system but will do so as part of the Final Design process. The ordinance will address water conservation and water efficiency for properties that are connected. It has not been determined whether properties will be required to retrofit to water efficient features when connecting, or if this requirement will apply to new construction and renovations only.

VI.d.ii. <u>Green Infrastructure</u>

Not needed or applicable (per review by Lynnette Claudon dated June 20, 2019).

VI.d.iii. <u>Other</u>

As described in Sections IV.g and IV.h, the preferred alternative reflects a balance between the operational complexity, capital cost, and energy use involved in adding a pre-treatment component and the attendant benefits to the Town of supporting higher waste strength uses. This consideration has been factored into the selection of the preferred alternative.

VI.e. <u>Total Project Cost Estimate (Engineer's Opinion of Probable Cost)</u>

The Total Project Cost estimates for Alternative 3 and Preferred Alternative 4 are shown in Appendix B. As outlined under Section 4.h, the chief difference in cost is related to the pre-treatment system proposed in Alternative 4, which is the Preferred Alternative. The cost estimates provided include standard percentage allowances for site work (8%), bonds, (1.5%), and a 10% contingency; in addition, an allowance has been added to Other Costs for short-term interest in the likely event the Town chooses to utilize a line of credit to cover cash flow needs during the project. A factor of 0.5% of the Total Project Cost has been carried for this purpose.

VI.f. <u>Annual Operating Budget</u>

Operating budgets are included in Appendix B.

VI.f.i. <u>Income</u>

User rates, and thus system income, will depend on multiple cost factors and decisions that the Select Board will consider as this project advances. These factors are:

- The bond repayment term selected (20 vs. 30 year)

- Whether a grant from the Northern Borders Regional Commission is secured
- The percentage of Clean Water State Revolving Fund grant funds that are ultimately allocated by the State; illustrations with 0%, 28%, 50%, and 75% are provided; and
- The Town's policies in its adopted Wastewater Ordinance regarding voluntary vs. mandatory connections;
- Any additional funding able to be secured through other grant sources; and
- The Town's policies in its adopted Ordinance regarding financial responsibility for future capacity in the system that is not allocated to connected users when the system is constructed.

For purposes of illustration, rate analyses are shown in Table 7 and Table 8 for Preferred Alternative 4, with two different options for how the ultimate Town of Westford Wastewater Ordinance is structured and two grant scenarios. Both of the scenarios assume that a 30-year SRF loan repayment term is used. The scenarios assume that all Town of Westford facilities and all existing ERUs will be connected to the system, yielding 42 ERUs. Both "future capacity" and "cost/gallon" included here will vary based on additional capacity enabled by pre-treatment, which will be determined through the hydrogeologic investigations. The illustration also assumes that the Town has a present need equivalent to 20.3% of the system capacity (2,556 gallons/day), with 7,515 gallons or 59.6% allocated to users who would be connected and a future capacity reserve of 2,529 gallons/day or 20.1%.

Based on these scenarios, a range of the net annual income from user fees, and the resulting net amount of funding required from the Town of Westford General Fund, is projected for each case. The Net Annual Town Financial Obligation represents the net amount of funding from the Town of Westford general fund needed to support the community wastewater system annually (including both debt service and Operation & Maintenance costs). The Net Annual Town Financial Obligation reflects income to the Town from user fees. This amount varies based on whether users versus the Town as a whole pay for the share represented by future capacity; whether Congressional or NBRC funding is received; and by the amount of CWSRF grant funding provided.

Table 7. Prospective User Fees and Town Fiscal Impact: Alternative 4, 30 year loan term, no supplemental funding

Prospective User Fees and Town Fiscal Impact - ALTERNATIVE 4, 30 year loan term, NRBC funding						
			CWSRF Grant: 0%	35% Grant	50% Grant	75% Grant
Annual Town Financial Obligation			($117,393)	($80,261)	($64,347)	($37,823)
Town - Present Need	2,556	20.3%	($23,814)	($16,281)	($13,053)	($7,673)
Town - Future Capacity	2,529	20.1%	($23,562)	($16,109)	($12,915)	($7,592)
Connected Users (non-Town)	7,515	59.6%	($70,017)	($47,870)	($38,378)	($22,559)
	12,600	cost/gal	($9.32)	($6.37)	($5.11)	($3.00)
# of Anticipated ERUs:	42					
# of ERUs Excluding Town of Westford Need:	31					
# of Parcels:	936					
Users pay only user share, Town pays Town + future capacity shares						
User fee per non-Town ERU per year			$2,283	$1,561	$1,251	$735
User fee per non-Town ERU per month			**$190.22**	**$130.05**	**$104.27**	**$61.29**
Town-wide: share per parcel per year			($50.62)	($34.61)	($27.74)	($16.31)
Town-wide: share per parcel per month			($4.22)	($2.88)	($2.31)	($1.36)
***Net Annual Town Financial Obligation**			**($47,377)**	**($32,391)**	**($25,968)**	**($15,264)**

Table 8. Prospective User Fees and Town Fiscal Impact: Alternative 4 (Preferred Alternative), 30 year loan term, Congressional Appropriation and NBRC Grant Applied

PROJECT ALTERNATIVE 4		CWSRF Grant: 0%	35% Grant	50% Grant	75% Grant
WITH Northern Borders Regional Commission Grant:					
Total Project Cost (SRF Eligible)		$2,376,110	$1,544,472	$1,188,055	$594,028
Northern Borders Regional Commission Grant	$400,000	($400,000)	($400,000)	($400,000)	($400,000)
Net Amount Financed		$1,976,110	$1,144,472	$788,055	$194,028
30 YEAR TERM					
Annual bond payment (CWSRF, 2% Administrative Fee)	2%	($88,233)	($51,101)	**($35,187)**	($8,663)
Annual Operation & Maintenance		($29,160)	($29,160)	($29,160)	($29,160)
Total Annual Town Financial Obligation		**($117,393)**	**($80,261)**	**($64,347)**	**($37,823)**

Finally, while it is possible that the Town could complete a household income survey within the Town Center service area, the Town must weigh the potential financial benefit against concerns from property owners and the very small sample size of Town Center households. The idea of completing an income survey has been discussed by the Planning Commission and the engineering team and, at the time of this PER, limited benefit to completing the survey has been established.

VI.f.ii. Annual O&M Costs

The estimated annual Operation and Maintenance costs are detailed in Appendix B. These estimates include allowances for incidental repairs, billing, legal fees, and other applicable costs. Roughly $6,800 per year separates the estimates for Alternative 3 ($22,360/year) and preferred Alternative 4 ($29,160), reflecting the increased O&M cost with the use of pre-treatment in Alternative 4 (i.e., the associated service contract and energy costs).

VI.f.iii. Debt Repayments

Financing and debt repayment are shown in Table 7 and Table 8 above. With respect to funding sources, the Town anticipates utilizing a Vermont Clean Water State Revolving Fund (CWSRF) loan for the bulk of the cost. A 30-year repayment schedule is assumed, though the Town could, if it chose to do so, select a shorter period. Debt repayment would be made through a combination of system user fees and Town of Westford general funds, backed by General Obligation Bonds. The Total Town Annual Financial Obligation figure reflects the total cost of system Operation and Maintenance and total debt service to be backed by the full faith and credit of the municipality.

While a “worst-case” scenario in Table 7 shows 0% CWSRF grant funds and no other external funding source, the schedules also show the total debt load that would accrue under three levels of CWSRF loan forgiveness or grant funding (35%, 50%, and 75%), as well as a scenario in which the Town receives $400,000 in Northern Borders Regional Commission funding.

VI.f.iv. Reserves

General Obligation bonds are intended to be used as loan security. With respect to the short-lived asset reserve, with the very small size of this system, it is anticipated that these costs can be covered from the annual Operation & Maintenance costs. A dedicated fund will be established at the Town of Westford so that balances can accrue over time and provide a modest reserve fund for these purposes.

VII. CONCLUSIONS AND RECOMMENDATIONS

The alternatives analyzed are all very similar in scope. Alternative 4, because of the greater benefit to the Town's land use and economic development goals, is the Preferred Alternative.

The Maple Shade Forest disposal field is the disposal site for the community system. The results of the hydrogeologic study that needs to be performed on the disposal site will determine what the specific benefits of pre-treatment of the wastewater will be, and thus will have some bearing on whether it is included in the final design or not. If the results show a significant allowable capacity increase of the disposal fields, Alternative 4 with pre-treatment will continue to be the recommended alternative for the project.

APPENDIX A
EXHIBITS

- 1. PROJECT AREA MAP
- 2. ENVIRONMENTAL SENSITIVITIES
- 2. ALTERNATIVE 1 SITE PLAN
- 3. ALTERNATIVE 2 SITE PLAN
- 4. ALTERNATIVE 3 SITE PLAN
- 5. ALTERNATIVE 4 SITE PLAN

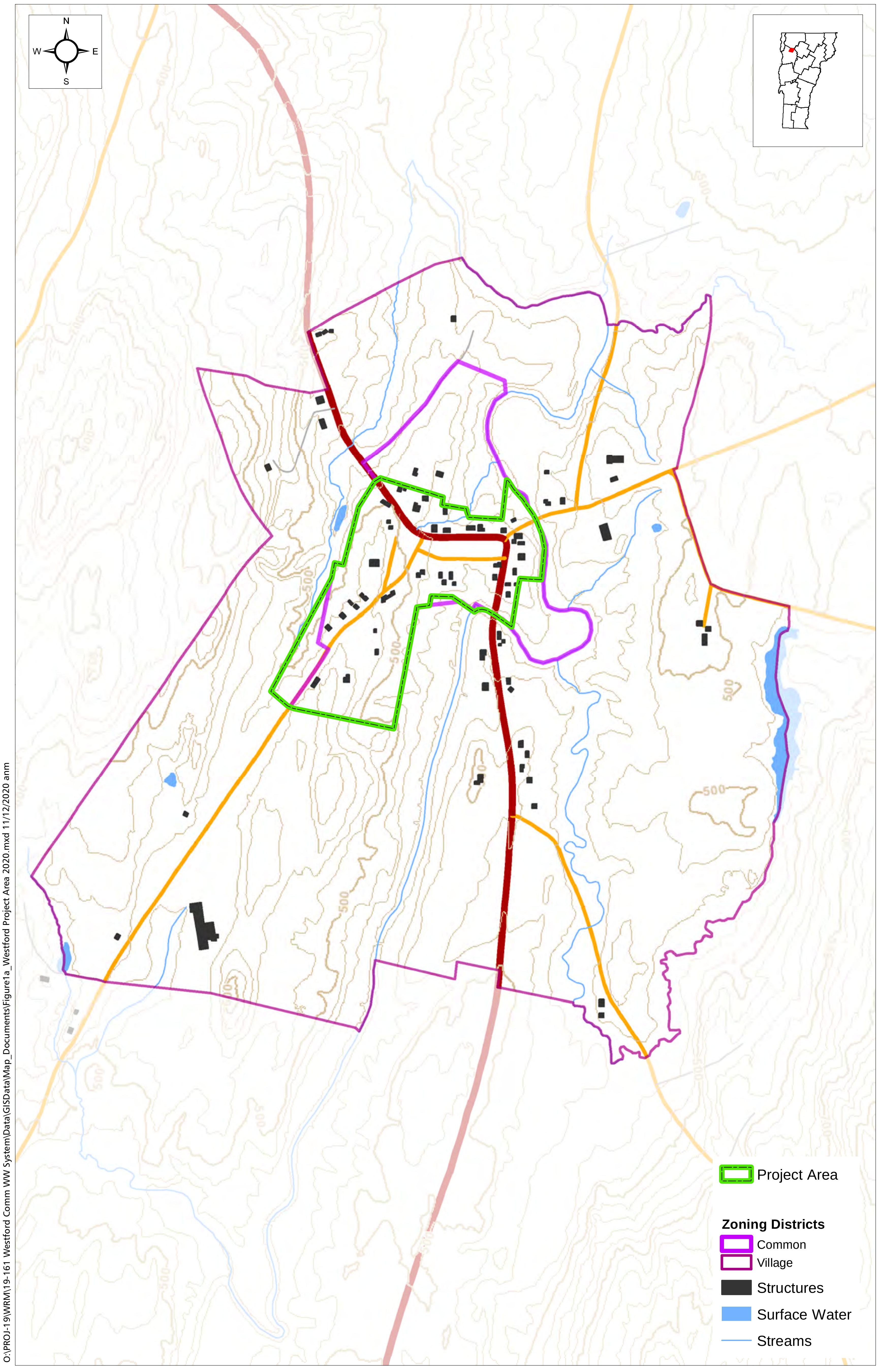
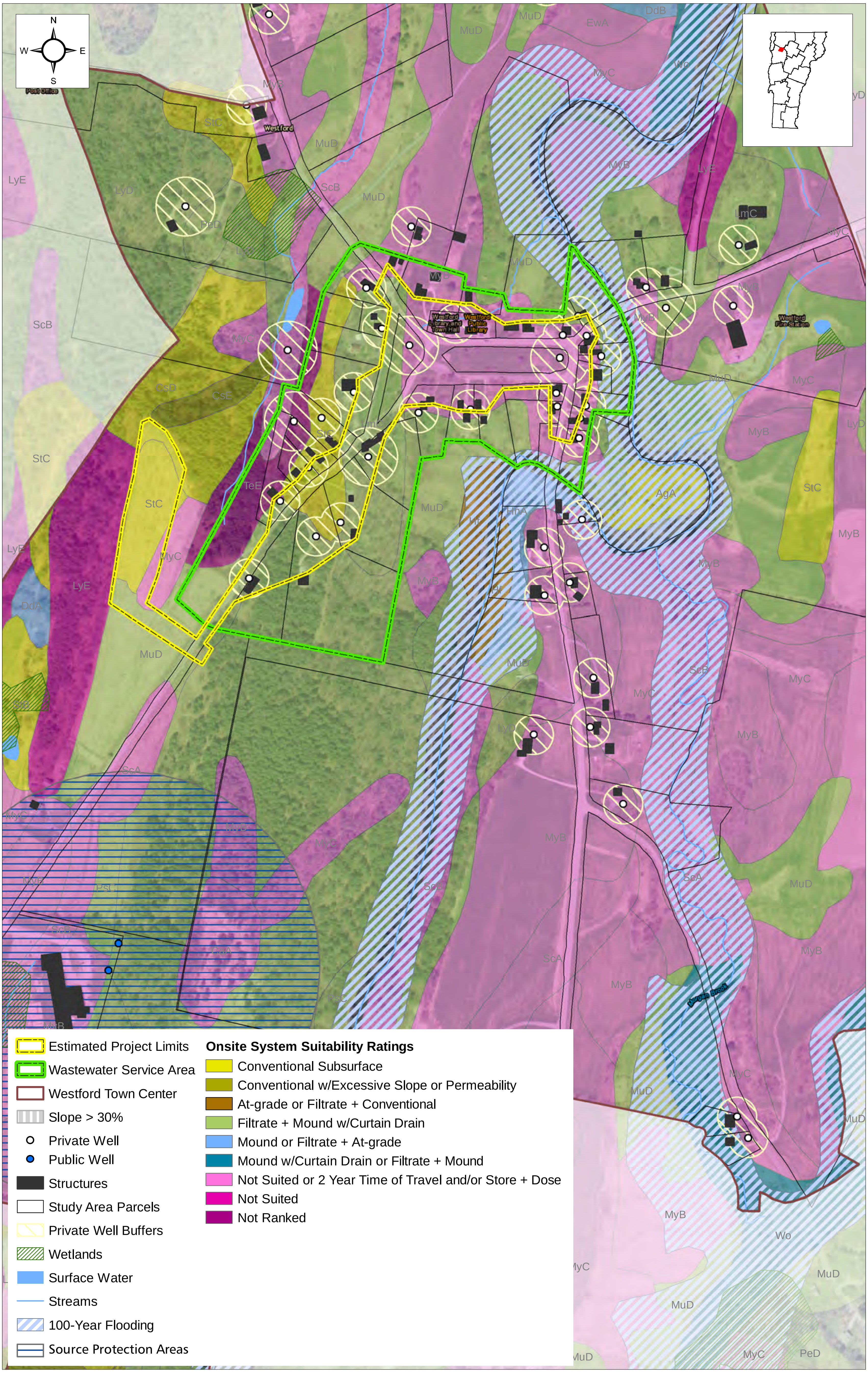


FIGURE 1: PROJECT AREA OVERVIEW, 2020
Westford Community Wastewater Disposal System
Westford, Vermont

0 0.25 0.5 Miles
Scale

STONE ENVIRONMENTAL



O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\GISData\Map_Documents\Figure2_Westford Enviro Sensitivity Map - 2020.mxd 12/08/2020 anm

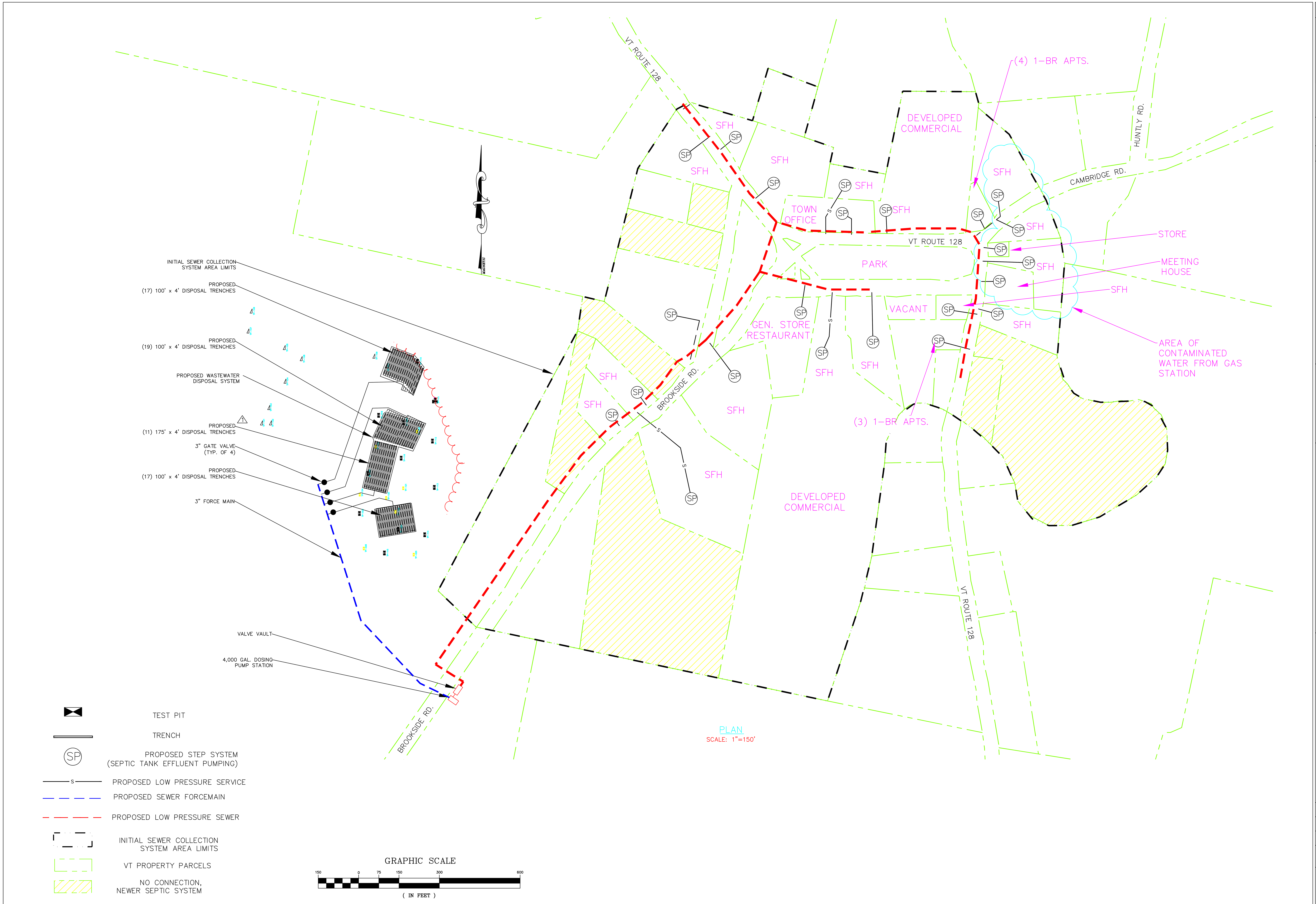
FIGURE 2: ENVIRONMENTAL SENSITIVITIES

Westford Community Wastewater Disposal System
Westford, Vermont

0 0.25 0.5 Miles
Scale

Sources: Hydrography, VCGI, 2003; Roads, VCGI, 2003; Digital Elevation Model, VCGI, 2001; Parcel Boundaries, IVS, 2002; Onsite System Suitibility, SEI, 2007; Map Unit Symbols, NRCS, 2004.

STONE ENVIRONMENTAL



REV.	DATE	DESCRIPTION	BY
1	3/20/19	REVISED DISPOSAL FIELD LAYOUT	BPC

GREEN MOUNTAIN ENGINEERING
CIVIL WATER WASTEWATER
1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

DRAFT

DRAWING TITLE: ALTERNATIVE 1 COMMUNITY WASTEWATER DISPOSAL SYSTEM

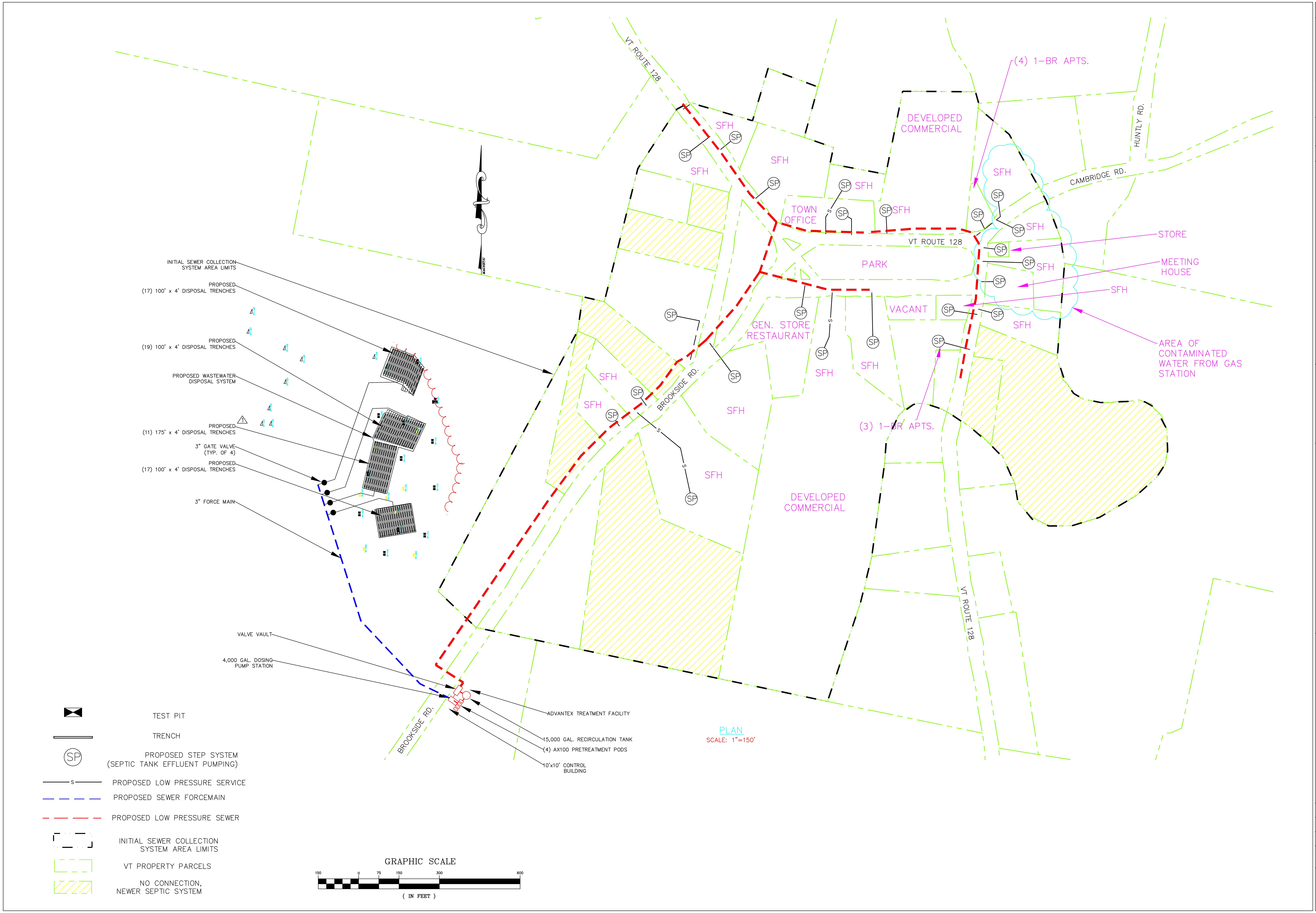
PROJECT: WESTFORD WASTEWATER PRELIMINARY ENGINEERING REPORT

CLIENT: TOWN OF WESTFORD, VERMONT

DESIGNED	BMW	PLOT DATE	11/11/20
DRAWN	JJB	SCALE	1" = 150'
CHECKED	AH	DATE	NOV. 2020

PROJECT NO. 28-006

FIGURE NO. 3



REV.	DATE	DESCRIPTION	BY
1	3/20/19	REVISED DISPOSAL FIELD LAYOUT	BPC

GREEN MOUNTAIN ENGINEERING
CIVIL WATER WASTEWATER
1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

DRAFT

DRAWING TITLE: ALTERNATIVE 2 COMMUNITY WASTEWATER DISPOSAL SYSTEM

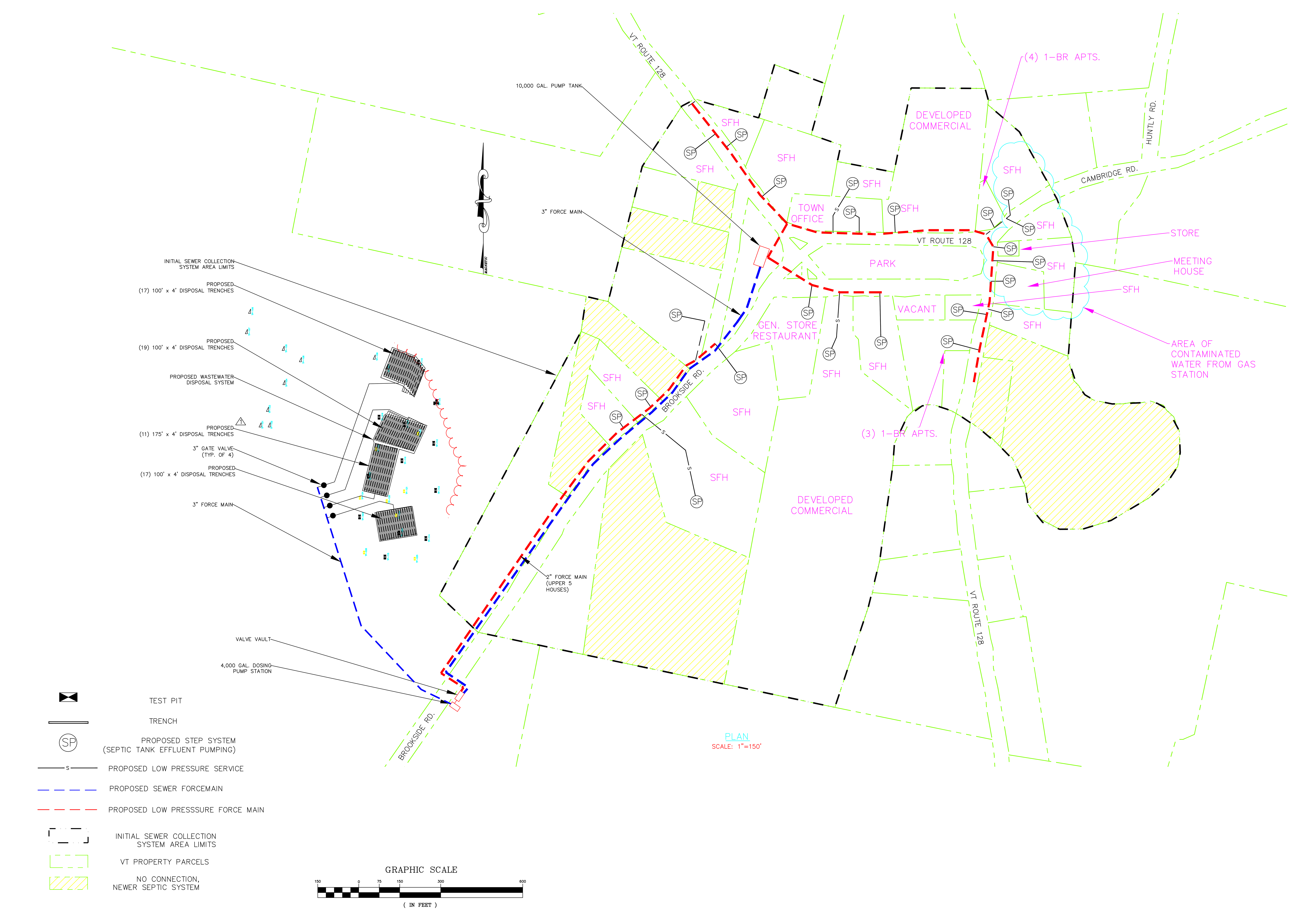
PROJECT: WESTFORD WASTEWATER PRELIMINARY ENGINEERING REPORT

CLIENT: TOWN OF WESTFORD, VERMONT

DESIGNED BMW	PLOT DATE 11/11/20
DRAWN JJB	SCALE 1" = 150'
CHECKED AH	DATE NOV. 2020

PROJECT NO. 28-006

FIGURE NO. 4



REV.	DATE	DESCRIPTION	BY
1	3/20/19	REVISED DISPOSAL FIELD LAYOUT	BPC

GREEN MOUNTAIN ENGINEERING
CIVIL WATER WASTEWATER
1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

DRAFT

DRAWING TITLE: ALTERNATIVE 3 COMMUNITY WASTEWATER DISPOSAL SYSTEM

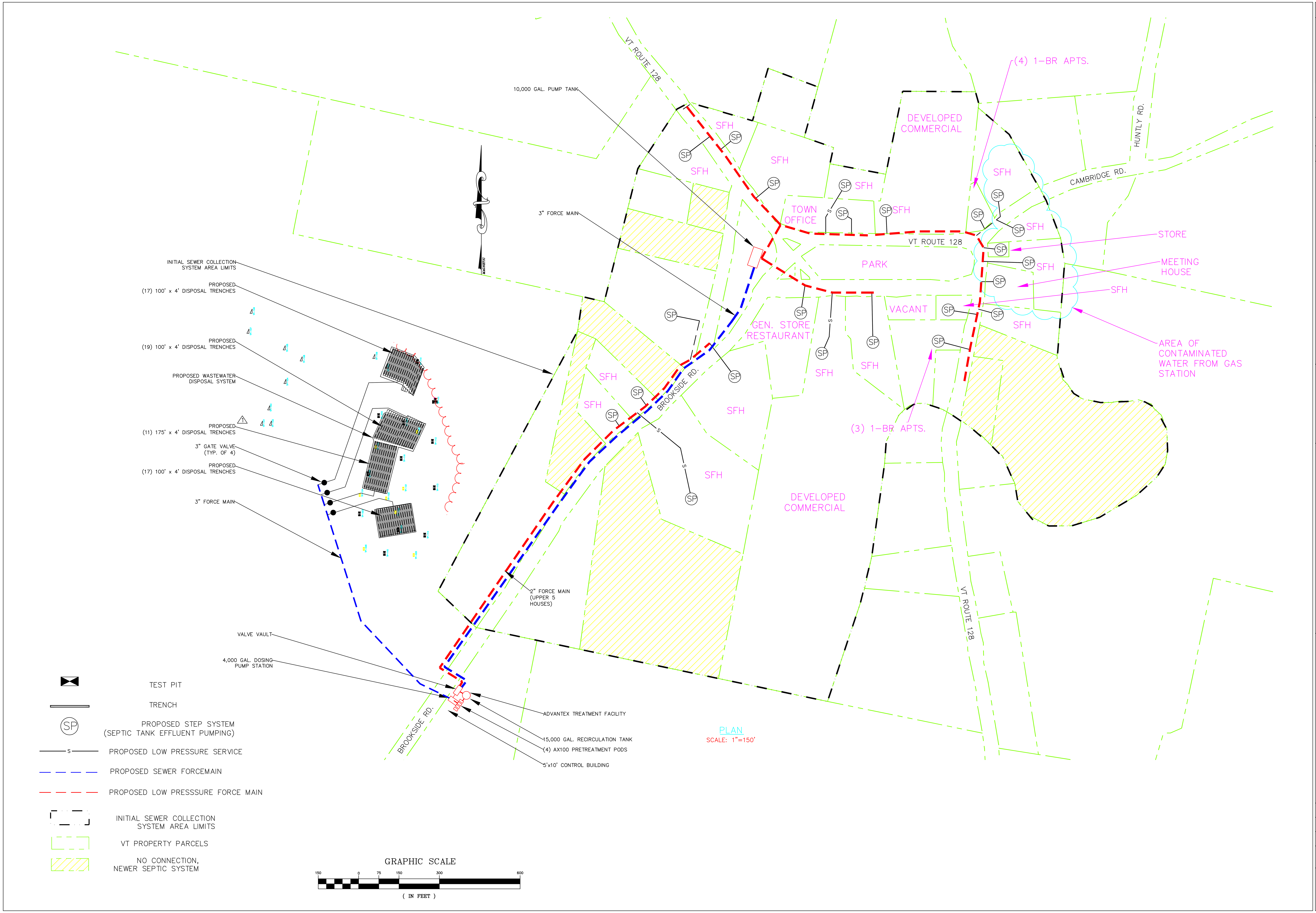
PROJECT: WESTFORD WASTEWATER PRELIMINARY ENGINEERING REPORT

CLIENT: TOWN OF WESTFORD, VERMONT

DESIGNED	BMW	PLOT DATE	11/11/20
DRAWN	JJB	SCALE	1" = 150'
CHECKED	AH	DATE	NOV. 2020

PROJECT NO. 28-006

FIGURE NO. 5



REV.	DATE	DESCRIPTION	BY
1	3/20/19	REVISED DISPOSAL FIELD LAYOUT	BPC

1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

GREEN MOUNTAIN ENGINEERING
CIVIL
WATER
WASTEWATER

DRAFT

DRAWING TITLE
ALTERNATIVE 4
COMMUNITY WASTEWATER
DISPOSAL SYSTEM

PROJECT
WESTFORD WASTEWATER
PRELIMINARY ENIGINEERING REPORT

CLIENT
TOWN OF WESTFORD, VERMONT

DESIGNED	PLOT DATE
BMW	11/11/20
DRAWN	SCALE
JJB	1" = 150'
CHECKED	DATE
AH	NOV. 2020

PROJECT NO.
28-006

FIGURE NO.
6

FILE: S:\GME PROJECT FILES\28-000\28-006 WESTFORD STUDY UPDATE\STUDY UPDATE DRAWING.DWG

APPENDIX B
PRELIMINARY OPINIONS OF PROBABLE PROJECT COST

- SEPTIC TANK EFFLUENT PUMPING (STEP) COLLECTION SYSTEM, OPINION OF PROBABLE CONSTRUCTION COST - ALTERNATIVE NO.1
- SEPTIC TANK EFFLUENT PUMPING (STEP) COLLECTION SYSTEM, OPINION OF PROBABLE CONSTRUCTION COST - ALTERNATIVE NO.2
- SEPTIC TANK EFFLUENT PUMPING (STEP) COLLECTION SYSTEM, OPINION OF PROBABLE CONSTRUCTION COST - ALTERNATIVE NO.3
- SEPTIC TANK EFFLUENT PUMPING (STEP) COLLECTION SYSTEM, OPINION OF PROBABLE CONSTRUCTION COST - ALTERNATIVE NO.4
- MAPLE SHADE FOREST DISPOSAL FIELD(S) CONSTRUCTION, OPINION OF PROBABLE CONSTRUCTION COST - (SAME ALL ALTERNATIVES)
- TOTAL PROJECT COST SUMMARY - RECOMMENDED ALTERNATIVE #1
- TOTAL PROJECT COST SUMMARY - RECOMMENDED ALTERNATIVE #2
- TOTAL PROJECT COST SUMMARY - RECOMMENDED ALTERNATIVE #3
- TOTAL PROJECT COST SUMMARY - RECOMMENDED ALTERNATIVE #4
- YEARLY ESTIMATED OPERATION & MAINTENANCE COSTS – ALT. #1
- YEARLY ESTIMATED OPERATION & MAINTENANCE COSTS – ALT. #2
- YEARLY ESTIMATED OPERATION & MAINTENANCE COSTS – ALT. #3
- YEARLY ESTIMATED OPERATION & MAINTENANCE COSTS – ALT. #4
- 2020 DISCOUNT RATES FOR OMB CIRCULAR NO. A-94

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Septic Tank Effluent Pumping (STEP) Collection System Opinion of Probable Construction Cost - ALTERNATIVE NO.1				
DESCRIPTION	**Unit**	**Quantity**	**Unit Price**	**Total Amount**
A- Sewers				
A-1 2" HDPE LPS	LF	4,600	$55	$253,000
B- Sewerline Appurtenances				
B-1 5' Diameter Air Release/CO Manholes	EA	4	$8,500	$34,000
B-2 5' Dia, C.O. Manholes	EA	4	$8,500	$34,000
B-3 1 1/4" Low PressureSewer Services	LF	2,700	$35	$94,500
B-4 4" Gravity Sewer Services	LF	500	$42	$21,000
C- Earthwork				
C-1 Rock Excavation	CY	380	$120	$45,600
C-2 Boulder Excavation	CY	50	$100	$5,000
C-3 Misc. Extra and Below Grade Excavation	CY	20	$40	$800
C-4 Excavation & Replace Unsuitable	CY	20	$40	$800
D- Roadwork				
D-1 Permanent Bit. Pavement Repair	SY	80	$60	$4,800
D-2 Permanent Gravel Road & Drive Repair	SY	800	$50	$40,000
E-Incidental Work				
E-1 Class B Concrete	CY	10	$175	$1,750
E-2 Calcium Chloride	TON	2	$600	$1,200
E-3 Rigid Insulation	LF	300	$8	$2,400
E-4 Uniform Traffic Officers	HRS	50	$80	$4,000
E-5 Traffic Control	HRS	350	$65	$22,750
E-6 Silt Fence	LF	1,000	$4	$4,000
E-7 Degradable Erosion Control Blankets	SY	1,200	$4	$4,800
E-8 Temporary Stone Check Dams	EA	15	$600	$9,000
E-9 1,500 Gallon STEP Tanks (Includes Electrical and Panels)	EA	19	$13,000	$247,000
E-10 2,000 Gallon STEP Tanks (Includes Electrical and Panels)	EA	4	$15,000	$60,000
E-11 5,500 Gallon Dosing Pump Station (duplex)	EA	1	$50,000	$50,000
E-12 Concrete Valve Vault and Appurtenances	EA	1	$26,000	$26,000
E-13 New Electrical Service (new pump station)	EA	1	$7,500	$7,500
E-14 House Replumbs	EA	12	$1,000	$12,000
E-15 Septic Tank Deactivation	EA	23	$1,000	$23,000
F- Lump Sum Items				
F-1 Preparation of Site and Miscellaneous Work (8%)	LS	1	$80,712	$80,712
F-2 Bonds (1.5%)	LS	1	$16,344	$16,344
F-3 Contingency (10%)	LS	1	$110,596	$110,596
SUBTOTAL				**$1,216,552**
USE				**$1,217,000**

Notes: The estimate is based on PRELIMINARY phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the preliminary phase. The quantities and unit prices will likely vary based on the actual design, site conditions.

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Septic Tank Effluent Pumping (STEP) Collection System Opinion of Probable Construction Cost - ALTERNATIVE NO.2				
DESCRIPTION	**Unit**	**Quantity**	**Unit Price**	**Total Amount**
A- Sewers				
A-1 2" HDPE LPS	LF	4,600	$55	$253,000
B- Sewerline Appurtenances				
B-1 5' Diameter Air Release/CO Manholes	EA	4	$8,500	$34,000
B-2 5' Dia, C.O. Manholes	EA	4	$8,500	$34,000
B-3 1 1/4" Low PressureSewer Services	LF	2,700	$35	$94,500
B-4 4" Gravity Sewer Services	LF	500	$42	$21,000
C- Earthwork				
C-1 Rock Excavation	CY	380	$120	$45,600
C-2 Boulder Excavation	CY	50	$100	$5,000
C-3 Misc. Extra and Below Grade Excavation	CY	20	$40	$800
C-4 Excavation & Replace Unsuitable	CY	20	$40	$800
D- Roadwork				
D-1 Permanent Bit. Pavement Repair	SY	80	$60	$4,800
D-2 Permanent Gravel Road & Drive Repair	SY	800	$50	$40,000
E-Incidental Work				
E-1 Class B Concrete	CY	10	$175	$1,750
E-2 Calcium Chloride	TON	2	$600	$1,200
E-3 Rigid Insulation	LF	300	$8	$2,400
E-4 Uniform Traffic Officers	HRS	50	$80	$4,000
E-5 Traffic Control	HRS	350	$65	$22,750
E-5 Silt Fence	LF	1,000	$4	$4,000
E-6 Degradable Erosion Control Blankets	SY	1,200	$4	$4,800
E-7 Temporary Stone Check Dams	EA	15	$600	$9,000
E-8 1,500 Gallon STEP Tanks (Includes Electrical and Panels)	EA	19	$13,000	$247,000
E-9 2,000 Gallon STEP Tanks (Includes Electrical and Panels)	EA	4	$15,000	$60,000
E-11 Control Building (10' x 10')	EA	1	$20,000	$20,000
E-12 Orenco AX -Max Treatment (see proposal)	EA	1	$198,585	$198,585
E-13 Excavation / Installation of Advantex System	EA	1	$45,000	$45,000
E-14 Controls / Wiring / Telemetry for Advantex System	EA	1	$15,000	$15,000
E-15 Concrete Valve Vault and Appurtenances	EA	1	$26,000	$26,000
E-16 New Electrical Service (new pump station)	EA	1	$7,500	$7,500
E-17 House Replumbs	EA	12	$1,000	$12,000
E-18 Septic Tank Deactivation	EA	23	$1,000	$23,000
F- Lump Sum Items				
F-1 Preparation of Site and Miscellaneous Work (8%)	LS	1	$98,999	$98,999
F-2 Bonds (1.5%)	LS	1	$20,047	$20,047
F-3 Contingency (10%)	LS	1	$135,653	$135,653
SUBTOTAL				**$1,492,184**
USE				**$1,493,000**

Notes: The estimate is based on PRELIMINARY phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the preliminary phase. The quantities and unit prices will likely vary based on the actual design, site conditions.

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Septic Tank Effluent Pumping (STEP) Collection System Opinion of Probable Construction Cost - ALTERNATIVE NO.3				
DESCRIPTION	**Unit**	**Quantity**	**Unit Price**	**Total Amount**
A- Sewers				
A-1 2" HDPE LPS (lower section to common PS)	LF	2,800	$45	$126,000
A-2 2" HDPE LPS (Upper Main with 5 houses)	LF	1,800	$45	$81,000
A-3 3" Forcemain (from common PS)	LF	2,200	$50	$110,000
B- Sewerline Appurtenances				
B-1 5' Diameter Air Release/CO Manholes	EA	4	$8,500	$34,000
B-2 5' Dia, C.O. Manholes	EA	4	$8,500	$34,000
B-3 1 1/4" Low PressureSewer Services	LF	2,700	$35	$94,500
B-4 4" Gravity Sewer Services	LF	500	$42	$21,000
C- Earthwork				
C-1 Rock Excavation	CY	400	$120	$48,000
C-2 Boulder Excavation	CY	60	$100	$6,000
C-3 Misc. Extra and Below Grade Excavation	CY	30	$40	$1,200
C-4 Excavation & Replace Unsuitable	CY	30	$40	$1,200
D- Roadwork				
D-1 Permanent Bit. Pavement Repair	SY	80	$60	$4,800
D-2 Permanent Gravel Road & Drive Repair	SY	800	$50	$40,000
E-Incidental Work				
E-1 Class B Concrete	CY	10	$175	$1,750
E-2 Calcium Chloride	TON	2	$600	$1,200
E-3 Rigid Insulation	LF	300	$8	$2,400
E-4 Uniform Traffic Officers	HRS	50	$80	$4,000
E-5 Traffic Control	HRS	350	$65	$22,750
E-5 Silt Fence	LF	1,000	$4	$4,000
E-6 Degradable Erosion Control Blankets	SY	1,200	$4	$4,800
E-7 Temporary Stone Check Dams	EA	15	$600	$9,000
E-8 1,500 Gallon STEP Tanks (Includes Electrical and Panels)	EA	19	$11,000	$209,000
E-9 2,000 Gallon STEP Tanks (Includes Electrical and Panels)	EA	4	$13,000	$52,000
E-10 10,000 Gallon Duplex Pump Station (lower)	EA	1	$55,000	$55,000
E-11 3,500 Gallon Dosing Pump Station (duplex)	EA	1	$40,000	$40,000
E-12 Concrete Valve Vault and Appurtenances	EA	1	$26,000	$26,000
E-13 New Electrical Service (2) (new pump stations)	EA	2	$7,500	$15,000
E-14 House Replumbs	EA	12	$1,000	$12,000
E-15 Septic Tank Deactivation	EA	23	$1,000	$23,000
F- Lump Sum Items				
F-1 Preparation of Site and Miscellaneous Work (8%)	LS	1	$86,688	$86,688
F-2 Bonds (1.5%)	LS	1	$17,554	$17,554
F-3 Contingency (10%)	LS	1	$118,784	$118,784
SUBTOTAL				**$1,306,627**
USE				**$1,307,000**

Notes: The estimate is based on PRELIMINARY phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the preliminary phase. The quantities and unit prices will likely vary based on the actual design, site conditions.

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Septic Tank Effluent Pumping (STEP) Collection System Opinion of Probable Construction Cost - ALTERNATIVE NO.4				
DESCRIPTION	**Unit**	**Quantity**	**Unit Price**	**Total Amount**
A- Sewers				
A-1 2" HDPE LPS (lower section to common PS)	LF	2,800	$45	$126,000
A-2 2" HDPE LPS (Upper Main with 5 houses)	LF	1,800	$45	$81,000
A-3 3" Forcemain (from common PS)	LF	2,200	$50	$110,000
B- Sewerline Appurtenances				
B-1 5' Diameter Air Release/CO Manholes	EA	4	$8,500	$34,000
B-2 5' Dia, C.O. Manholes	EA	4	$8,500	$34,000
B-3 1 1/4" Low PressureSewer Services	LF	2,700	$35	$94,500
B-4 4" Gravity Sewer Services	LF	500	$42	$21,000
C- Earthwork				
C-1 Rock Excavation	CY	400	$120	$48,000
C-2 Boulder Excavation	CY	60	$100	$6,000
C-3 Misc. Extra and Below Grade Excavation	CY	30	$40	$1,200
C-4 Excavation & Replace Unsuitable	CY	30	$40	$1,200
D- Roadwork				
D-1 Permanent Bit. Pavement Repair	SY	80	$60	$4,800
D-2 Permanent Gravel Road & Drive Repair	SY	800	$50	$40,000
E-Incidental Work				
E-1 Class B Concrete	CY	10	$175	$1,750
E-2 Calcium Chloride	TON	2	$600	$1,200
E-3 Rigid Insulation	LF	300	$8	$2,400
E-4 Uniform Traffic Officers	HRS	50	$80	$4,000
E-5 Traffic Control	HRS	350	$65	$22,750
E-5 Silt Fence	LF	1,000	$4	$4,000
E-6 Degradable Erosion Control Blankets	SY	1,200	$4	$4,800
E-7 Temporary Stone Check Dams	EA	15	$600	$9,000
E-8 1,500 Gallon STEP Tanks (Includes Electrical and Panels)	EA	19	$11,000	$209,000
E-9 2,000 Gallon STEP Tanks (Includes Electrical and Panels)	EA	4	$13,000	$52,000
E-10 10,000 Gallon Duplex Pump Station (lower)	EA	1	$55,000	$55,000
E-11 Control Building (10' x 10')	EA	1	$20,000	$20,000
E-12 Orenco AX -Max Treatment (see proposal)	EA	1	$198,585	$198,585
E-13 Excavation / Installation of Advantex System	EA	1	$45,000	$45,000
E-14 Controls / Wiring / Telemetry for Advantex System	EA	1	$15,000	$15,000
E-15 Concrete Valve Vault and Appurtenances	EA	1	$26,000	$26,000
E-16 New Electrical Service (2) (new pump stations)	EA	2	$7,500	$15,000
E-17 House Replumbs	EA	12	$1,000	$12,000
E-18 Septic Tank Deactivation	EA	23	$1,000	$23,000
F- Lump Sum Items				
F-1 Preparation of Site and Miscellaneous Work (8%)	LS	1	$105,775	$105,775
F-2 Bonds (1.5%)	LS	1	$21,419	$21,419
F-3 Contingency (10%)	LS	1	$144,938	$144,938
SUBTOTAL				**$1,594,317**
USE				**$1,595,000**

Notes: The estimate is based on PRELIMINARY phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the preliminary phase. The quantities and unit prices will likely vary based on the actual design, site conditions.

Town of Westford
Westford Community Wastewater Disposal System - Preliminary Engineering Report
Jackson Farm Disposal Field(s) Construction
Opinion of Probable Construction Cost - (SAME ALL ALTERNATIVES)

DESCRIPTION	Unit	Quantity	Unit Price	Total Amount
Mobilization/Demobilization	LS	1	$3,000	$3,000
Silt Fence	LF	600	$3	$1,800
Excavate Leachfield Trenches	CY	2,450	$8	$19,600
Leachfield Stone	CY	1,450	$25	$36,250
1 1/2" Laterals	LF	7,100	$6	$42,600
Filter Fabric	SY	3,200	$2	$6,400
Topsoil	CY	80	$25	$2,000
3" Forcemains (Disposal Field Services & Header)	LF	1,900	$25	$47,500
3" Forcemains	LF	1,000	$30	$30,000
3" Gate Valves	Ea	4	$1,200	$4,800
Temporary Road				
Excavation	CY	445	$8	$3,560
Filter Fabric	SY	1,350	$2	$2,700
Gravel	CY	445	$25	$11,125
Fine Grade, Seed and Mulch	SY	18,000	$3	$54,000
Start-Up/Testing	LS	1	$3,000	$3,000
Preparation of Site and Miscellaneous Work (8%)	LS	1	$21,467	$21,467
Bonds (1.5%)	LS	1	$4,347	$4,347
Contingency (10%)	LS	1	$29,415	$29,415
SUBTOTAL				**$323,564**
USE				**$324,000**

Notes: The estimate is based on PLANNING phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The quantities and unit prices will likely vary based on the actual design, site conditions..

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Total Project Cost Summary - Alternative #1	
DESCRIPTION	**Total Cost**
Construction	
Wastewater Collection System	$1,217,000
Wastewater Disposal System	$324,000
Construction Subtotal	**$1,541,000**
STEP I- Preliminary Engineering	
STEP I- Preliminary Engineering Subtotal	**$54,050**
STEP II- Final Design Engineering	
Final Design Allowance	$109,000
STEP II- Final Design Subtotal	**$109,000**
STEP III- Construction Engineering Services	
Construction Engineering	$190,000
STEP III- Construction Engineering Subtotal	**$190,000**
Other Costs	
Administrative	$10,000
Land Acquisition / Current Use / Easements	$10,000
Permitting Fees	$2,463
Easement Assistance	$10,000
Legal & Fiscal	$10,000
Short Term Interest (0.05% of SRF eligble engineering + construction costs)	$9,470
Other Costs Subtotal	**$51,933**
SUBTOTAL	**$1,945,983**
USE	**$1,946,000**

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Total Project Cost Summary - Alternative #2	
DESCRIPTION	**Total Cost**
Construction	
Wastewater Collection System	$1,493,000
Wastewater Disposal System	$324,000
Construction Subtotal	**$1,817,000**
STEP I- Preliminary Engineering	
STEP I- Preliminary Engineering Subtotal	**$54,050**
STEP II- Final Design Engineering	
Final Design Allowance	$119,000
STEP II- Final Design Subtotal	**$119,000**
STEP III- Construction Engineering Services	
Construction Engineering	$216,000
STEP III- Construction Engineering Subtotal	**$216,000**
Other Costs	
Administrative	$10,000
Land Acquisition / Current Use / Easements	$15,000
Permitting Fees	$3,055
Easement Assistance	$10,000
Legal & Fiscal	$10,000
Short Term Interest (0.05% of SRF eligble engineering + construction costs)	$11,030
Other Costs Subtotal	**$59,085**
SUBTOTAL	**$2,265,135**
USE	**$2,266,000**

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Total Project Cost Summary - Alternative #3	
DESCRIPTION	**Total Cost**
Construction	
Wastewater Collection System	$1,307,000
Wastewater Disposal System	$324,000
Construction Subtotal	**$1,631,000**
STEP I- Preliminary Engineering	
STEP I- Preliminary Engineering Subtotal	**$54,050**
STEP II- Final Design Engineering	
Final Design Allowance	$115,000
STEP II- Final Design Subtotal	**$115,000**
STEP III- Construction Engineering Services	
Construction Engineering	$198,000
STEP III- Construction Engineering Subtotal	**$198,000**
Other Costs	
Administrative	$10,000
Land Acquisition / Current Use / Easements	$25,000
Permitting Fees	$2,463
Easement Assistance	$10,000
Legal & Fiscal	$10,000
Short Term Interest (0.05% of SRF eligble engineering + construction costs)	$9,990
Other Costs Subtotal	**$67,453**
SUBTOTAL	**$2,065,503**
USE	**$2,066,000**

Town of Westford Westford Community Wastewater Disposal System - Preliminary Engineering Report Total Project Cost Summary - Recommended Alternative #4	
DESCRIPTION	**Total Cost**
Construction	
Wastewater Collection System	$1,595,000
Wastewater Disposal System	$324,000
Construction Subtotal	**$1,919,000**
STEP I- Preliminary Engineering	
STEP I- Preliminary Engineering Subtotal	**$54,050**
STEP II- Final Design Engineering	
Final Design Allowance	$135,000
STEP II- Final Design Subtotal	**$135,000**
STEP III- Construction Engineering Services	
Construction Engineering	$228,000
STEP III- Construction Engineering Subtotal	**$228,000**
Other Costs	
Administrative	$10,000
Land Acquisition / Current Use / Easements	$30,000
Permitting Fees	$3,055
Easement Assistance	$10,000
Legal & Fiscal	$10,000
Short Term Interest (0.05% of SRF eligble engineering + construction costs)	$11,680
Other Costs Subtotal	**$74,735**
SUBTOTAL	**$2,410,785**
USE	**$2,411,000**

Town of Westford
Westford Community Wastewater Disposal System - Preliminary Engineering Report
Yearly Estimated Operation & Maintenance Costs - Alternative #1

Cost Category	**O&M Cost**
Contract Operations	$9,360
Electrical	$2,500
Septage Pumping	$2,500
Annual Engineering Inspection	$1,800
IDP Inspection & Report	$1,500
State IDP Operating Fee	$756
Capital Replacement	$1,000
Insurance	$500
Misc. Repairs	$1,000
Billing	$500
O&M Cost Total	**$21,416**

Notes: The estimate is based on PLANNING phase estimates for O&M Costs. The estimate is based on scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The costs will likely vary based on the actual design, site conditions. Contract Operations is based on $45/hour x 208 hr/yr. Electrical is based on $0.14/kw-hr. Each homeowner pays for their own STEP system electrical cost. Septage pumping is based on 1/4 systems pumped each year at a cost of $300/pump out.

Town of Westford
Westford Community Wastewater Disposal System - Preliminary Engineering Report
Yearly Estimated Operation & Maintenance Costs - Alternative #2

Cost Category	O&M Cost
Contract Operations	$11,160
Electrical	$4,500
Septage Pumping	$2,500
Annual Engineering Inspection	$2,500
IDP Inspection & Report	$1,500
Pre-Treatment System Inspection	$1,500
IDP Operating Fee (based on 20,000 gpd design flow)	$872
Capital Replacement	$1,000
Insurance	$500
Misc. Repairs	$1,000
Billing	$500
O&M Cost Total	**$27,532**

Notes: The estimate is based on PLANNING phase estimates for O&M Costs. The estimate is based on scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The costs will likely vary based on the actual design, site conditions. Contract Operations is based on $45/hour x 248 hr/yr. Electrical is based on $0.14/kw-hr. Each homeowner pays for their own STEP system electrical cost. Septage pumping is based on 1/4 systems pumped each year at a cost of $300/pump out.

Town of Westford
Westford Community Wastewater Disposal System - Preliminary Engineering Report
Yearly Estimated Operation & Maintenance Costs - Alternative #3

Cost Category	O&M Cost
Contract Operations	$9,360
Electrical	$3,500
Septage Pumping	$2,500
Annual Engineering Inspection (includes operator inspection of STEP tanks)	$2,500
IDP Inspection & Report	$1,500
IDP Operating Fee	$756
Capital Replacement	$1,000
Insurance	$500
Misc. Repairs	$1,000
Billing	$500
O&M Cost Total	**$23,116**

Notes: The estimate is based on PRELIMINARY phase estimates for O&M Costs. The estimate is based on scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the preliminary phase. The costs will likely vary based on the actual design, site conditions. Contract Operations is based on $45/hour x 208 hr/yr. Electrical is based on $0.14/kw-hr. Each homeowner pays for their own STEP system electrical cost. Septage pumping is based on 1/4 systems pumped each year at a cost of $300/pump out.

Town of Westford
Westford Community Wastewater Disposal System - Preliminary Engineering Report
Yearly Estimated Operation & Maintenance Costs - Recommended Alternative #4

Cost Category	O&M Cost
Contract Operations	$11,160
Electrical	$5,500
Septage Pumping	$2,500
Annual Engineering Inspection (includes operator inspection of STEP tanks)	$2,500
IDP Inspection & Report	$1,500
Pre-Treatment System Inspection	$1,500
IDP Operating Fee	$872
Capital Replacement	$1,500
Insurance	$500
Misc. Repairs	$2,000
Billing	$500
O&M Cost Total	**$30,032**

Notes: The estimate is based on PRELIMINARY phase estimates for O&M Costs. The estimate is based on scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the preliminary phase. The costs will likely vary based on the actual design, site conditions. Contract Operations is based on $45/hour x 248 hr/yr. Electrical is based on $0.14/kw-hr. Each homeowner pays for their own STEP system electrical cost. Septage pumping is based on 1/4 systems pumped each year at a cost of $300/pump out.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

December 17, 2019

M-20-07

MEMORANDUM FOR THE HEADS OF DEPARTMENTS AND AGENCIES

FROM: Russell T. Vought
Acting Director

SUBJECT: 2020 Discount Rates for OMB Circular No. A-94

On October 29, 1992, OMB issued a revision to OMB Circular No. A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." That revision established new discount rate guidelines for use in benefit-cost and other types of economic analysis.

The current revision to the Circular specifies certain discount rates that will be updated annually when the interest rate and inflation assumptions in the budget are changed. These discount rates are found in Appendix C of the revised Circular, which is included as an attachment to this memorandum and provides for discount rates that will be in effect for the calendar year 2020.

The rates presented in Appendix C do not apply to regulatory analysis or benefit-cost analysis of public investment. They are to be used for lease-purchase and cost-effectiveness analysis, as specified in the Circular.

Attachment

APPENDIX C
(Revised November 2019)

DISCOUNT RATES FOR COST-EFFECTIVENESS, LEASE PURCHASE, AND RELATED ANALYSES

Effective Dates. This appendix is updated annually. This version of the appendix is valid for calendar year 2020. A copy of the updated appendix can be obtained in electronic form through the OMB home page at https://www.whitehouse.gov/wp-content/uploads/2019/12/Appendix-C.pdf. The text of the Circular is found at https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A94/a094.pdf, and a table of past years' rates is located at https://www.whitehouse.gov/wp-content/uploads/2019/12/discount-history.pdf. Updates of the appendix are also available upon request from OMB's Office of Economic Policy (202-395-3585).

Nominal Discount Rates. A forecast of nominal or market interest rates for calendar year 2020 based on the economic assumptions for the 2021 Budget is presented below. These nominal rates are to be used for discounting nominal flows, which are often encountered in lease-purchase analysis.

Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
1.6	1.7	1.8	2.0	2.3	2.4

Real Discount Rates. A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2021 Budget is presented below. These real rates are to be used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
-0.4	-0.3	-0.2	0.0	0.3	0.4

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than 30 years may use the 30-year interest rate.

APPENDIX C
REPORTS

- C-1. STUDY OF COMMUNITY WASTEWATER DISPOSAL ALTERNATIVES FOR THE TOWN CENTER, WESTFORD, VERMONT, MARCH 21, 2008
- C-2. TABLE OF WASTEWATER PERMITS IN PROJECT AREA, OCTOBER 2020
- C-3. EVALUATION OF COMMUNITY WASTEWATER DISPOSAL SYSTEM OPTIONS
- C-4. SITE CAPACITY CONFIRMATION AND PROJECT FINANCING OPTIONS FOR A COMMUNITY WASTEWATER SYSTEM AT THE JACKSON FARM SITE
- C-5. PRELIMINARY AQUATIC PERMITTING CRITERIA COMPLIANCE ASSESSMENT, JACKSON FARM COMMUNITY WASTEWATER SITE
- C-6. CAPACITY DETERMINATION AND AQUATIC PERMITTING CRITERIA ASSESSMENT, JACKSON FARM SITE
- C-7. PRELIMINARY EVALUATION REPORT, DESIGN CRITERIA FOR ORENCO AX-100 TREATMENT SYSTEM
- C-8. LIST OF LINKS TO PROJECT REPORTS AND INFORMATION

March 21, 2008

Study of Community Wastewater Disposal Alternatives for the Town Center, Westford, Vermont

Final Report

Stone Project Number 061854-W

Prepared For:

Town of Westford,
Wastewater Committee
1713 VT Route 128
Westford, Vermont

Prepared By:

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EXECUTIVE SUMMARY

The Town of Westford, Vermont used a grant from the Vermont Department of Environmental Conservation to hire the consultant team of Stone Environmental Inc. (Stone) Green Mountain Engineering (GME), and Yellow Wood Associates (YWA) to conduct a wastewater feasibility study for the Town Center area, located along Route 128. Westford's Town Center is a rural residential community located between Essex Junction and Fairfax. The study area includes 78 properties, most of which are developed with single-family residences. Property sizes range from less than 0.1 acre to over 250 acres. The entire study area covers about 1,000 acres.

The Town Center's natural features pose both opportunities for and limits to the construction and successful operation of onsite wastewater disposal systems. The closeness of the Browns River to many properties is an attractive natural feature that significantly limits where nearby onsite systems can be located. The soils that underlie the study area also pose significant limitations for onsite systems, including areas of shallow groundwater and shallow bedrock. Only about 7% (70 acres) of the soils in the study area is suitable for conventional on-site wastewater treatment systems. Properties in the study area are served by individual onsite water supplies, consisting of shallow springs or drilled wells. In order to protect the drinking water, no onsite systems can be constructed within a protective buffer zone surrounding each well or spring.

The Town Center's residences and amenities are all served by individual onsite sewage disposal systems. Information on the existing sewage disposal systems was gathered from Vermont Department of Environmental Conservation (DEC) Regional Office files, property owner survey questionnaires, interviews, and area site visits.

The consultant team conducted a needs assessment for the Town Center study area to determine whether each individual property could support an onsite septic system under the current local zoning ordinances and state wastewater disposal rules. **The assessment was conducted using planning level information; no access to private property was requested or granted during the study, and no private properties were entered upon to gather data or confirm study results.** This assessment combined spatial information, such as topography and soils information, with local information like parcel boundaries, building footprint areas, locations of water supplies, and building uses, to determine what constraints each property might contain for onsite wastewater treatment and disposal. The needs assessment results were confirmed by reviewing other sources of information collected during the study. This review resulted in an overall recommendation for each property of either maintaining and upgrading a system onsite, or connecting to an offsite solution.

Of the 78 parcels in the study area, there are 42 parcels that can support an onsite wastewater disposal system under the assumptions used in this report and under current zoning ordinances and State wastewater disposal rules. These parcels met all the environmental setbacks required by the Town and the state, as well as depth to groundwater and bedrock criteria. The GIS analysis

estimated that 36 parcels could not support an onsite wastewater disposal system. Of these parcels, 5 were constrained by only environmental setbacks and 19 parcels were constrained only by shallow groundwater. The remaining 12 parcels had a combination of setback and groundwater constraints. Although water supply setbacks had the greatest impact on onsite systems' suitability that was related to the area available on a parcel, many area-limited parcels also had shallow groundwater restrictions. Thus, a community wastewater treatment solution that maintains existing septic systems and replaces individual water supplies with a community well is unlikely to alleviate wastewater capacity issues in the study area.

Slightly less than half (46%) of the properties within the study area could benefit from an offsite wastewater treatment solution. Parcels with both groundwater and available area limitations are clustered primarily in the immediate vicinity of the Town Common. Some form of small community system may be needed in the future to meet the needs of these properties. However, comparing the results of the GIS assessment to wastewater permits issued in the study area indicates that property owners are already taking steps to responsibly dispose of wastewater on their own properties.

Six areas were identified within the Town Center zoning district that appeared to have some potential as sites for community wastewater disposal systems. Upon closer investigation, however, all of the sites have significant limitations. Some sites have good soils for wastewater treatment but are located in floodway fringe areas, while others require stream crossings that are prohibited by the Town's current zoning ordinance. The remaining site with good potential is located half a mile away from the Town Common and the route for the wastewater pipe would go through areas of shallow bedrock, necessitating significant and expensive ledge removal.

In light of the limited feasibility that a community wastewater disposal solution could be designed at a cost that the Town would find reasonable, several alternative strategies for managing wastewater and supporting the Town's land use goals in the Town Center zoning district are offered, specifically:

- Encourage the proper maintenance of existing wastewater treatment systems in the study area;
- Encourage creative solutions, like easements or water supply relocations, between neighboring landowners to solve problems related to available-area related restrictions; and
- Investigate sharing existing wastewater treatment capacity, both for Town owned properties and between individual landowners.

1. INTRODUCTION

The Town of Westford, Vermont received a grant from Vermont Department of Environmental Conservation to conduct a wastewater feasibility study for the Town Center area located along Route 128 near the center of the Town (Figure 1).

The objectives of the study are to:

- Determine whether each parcel can support an onsite wastewater system that conforms to Town and State regulations;
- Identify areas where construction of new onsite or offsite systems are needed, or would be necessary if new development occurs;
- Identify potential cluster system sites;
- Develop and analyze engineering system and/or management alternatives;
- Prepare preliminary conceptual plans and cost estimates;
- Develop preliminary funding and user fees;
- Make recommendations on structural or management options; and
- Provide information to the residents and local officials on current and potential future conditions.

Stone Environmental Inc. (Stone) and Green Mountain Engineering, Inc. (GME), with Yellow Wood Associates (YWA), were hired to conduct this study. This report provides information on each of the objectives above.

1.1. Education and Outreach

Education and outreach efforts are important in this study for several reasons. Many owners with onsite water supply and sewage disposal systems are typically aware of what type of system they might have, and what they may need to know about how to properly use and maintain it. Beyond that, they may not understand that since older properties were developed, scientists, engineers, and regulators have learned more about how these systems function and about how, if installed in the wrong conditions or under the wrong design specifications, they can negatively affect groundwater and surface water quality.

An initial public meeting was held (September 20, 2007) on the basics of how systems work, how to maintain them, and how they can impact the environment and water supply wells. A handout describing this study and some basic information was developed and distributed at the meeting. (Appendix B). A property owner survey questionnaire was also developed and distributed to the study area property owners along with the handout. The results of the survey are summarized in Table 1. The response rate for the surveys was 52% or 32 out of 61 surveys mailed (so 3% approximately equals one response). Besides collecting important information on sewage disposal systems and water supplies, we asked whether property owners had any questions or concerns about the Town Center's wastewater needs. Most of the respondents left the question blank or had no comment (74%); 9% support development of a small community system to support current and future land use around the Town Common; 6% supported the use of approved alternative technologies; and 3% expressed concern about the cost of a possible municipal system. A second public meeting to present the results of the study will be held on April 30, 2008.

Another approach to outreach and education is a wastewater advisory committee. The committee includes a member of the Selectboard, a member of the Planning Commission, and four local residents. The members of the Westford Wastewater Committee are listed in Appendix A. The committee met several times during the course of the project to take part in more detailed discussions on the study scope and results.

2. STUDY AREA DESCRIPTION

The study area includes parcels within the Town Center zoning district, located near the center of the Town of Westford. Westford is located in Chittenden County in the northwest portion of the state. Figure 1 shows the Town and the study area in their wider geographical context. Table 2 includes a list of properties within the study area including parcel identification numbers, street addresses, owner names, property uses, and approximate parcel sizes.

2.1. Community Profile

Westford is a rural residential community located between Essex and Fairfax in northwest Vermont. The Town is bordered by Fairfax to the north, Underhill to the east, Essex to the south, and Milton to the west. The Town Center is primarily residential, with a few small businesses, and is surrounded by woods and agricultural land.

The Town of Westford's population has grown from 1,740 in 1990 to 2,086 in 2000 (US Census). There was an approximately 20% increase in Westford's population in this ten year period. While Westford's rate of population growth may be slowing somewhat, it appears that the Town's population will continue to grow into the future. The current population is an all-time high for the Town.

The Westford Town Center study area includes 78 properties and a total of about 1,000 acres. Forty-six properties contain single-family residences, 1 property contains a camp, and 16 properties are undeveloped. There is also a store with an apartment, two small apartment units, and there are several public buildings including the post office, Town offices, library, the Old Brick Meeting House, the Westford United Church, and the elementary school. Property sizes range from less than 0.1 acre to over 250 acres.

2.2. Natural Resources

Natural features can pose both opportunities for and limits to the construction and successful operation of decentralized wastewater disposal systems. These features, such as topography, surface waters, and soils, are described below with particular attention to their impact on the potential for onsite wastewater disposal in the Town Center. Figure 2 identifies environmental sensitivities within the study area.

2.2.1. Topography

The topography of the study area consists mostly of gently rolling terrain (Figure 1). Most of the developed portion of the Town Center lies in a north-south lying valley formed in part by the Browns River. Generally, elevations range from around 380 feet above mean sea level (AMSL) where the Browns River leaves the Town Center area to 800 feet AMSL on an unnamed hill west of the Town Common.

2.2.2. *Surface Water*

Most of the properties in the study area are near the Browns River, which runs from south to north through the Town Center (Figure 2). Morgan Brook runs from northeast to southwest along the eastern boundary of the study area, then turns back to the north and empties into the Browns River near the Town Common. Several small, unnamed streams run primarily from south to north through the study area, all of which discharge to the Browns River. The Browns River is listed as a “Class B” water in Vermont’s Water Quality Standards, meaning that its waters should be managed to achieve and maintain a level of quality that fully supports uses including:

- Aquatic biota, wildlife, and aquatic habitat
- Aesthetics
- Public water supply (with filtration and disinfection)
- Irrigation of crops and other agricultural uses
- Swimming and other primary contact recreation
- Boating, fishing and other recreational uses

The river is not listed on the state’s impaired waters list (also known as the “303(d) list”), meaning that it is likely currently meeting the standards required of a Class B water.

2.2.3. *Soils*

There is a range of soil types in the study area. Soils vary based on geologic material, slope, hydrology, human disturbance, and other factors. The best generalized source of soils data for this area is the Soil Survey Report of Franklin County prepared by the Natural Resource Conservation Service (NRCS). The NRCS data was derived by mapping the landscape with spot field checks to arrive at an approximate level of resolution of 3 acres, with acknowledged inclusions of other soils. This report describes the soil series, or groups of soils with common properties, found in the study area.

The NRCS soils information is planning-level data, and the 3-acre resolution means that it is not very precise for small parcels of land. Site-specific testing, including backhoe test pits and/or percolation tests, would be required to determine the proper wastewater treatment options for an individual property.

For the purposes of this assessment, we are primarily concerned with the properties of the soils that determine suitability for the siting of onsite septic systems: depth to seasonal high groundwater, depth to bedrock, soil permeability, and slope. Figure 2 shows the soils in the study area and vicinity. Soil characteristics are summarized in Table 3.

There are significant portions of the Town Center study area that have limited suitability for conventional subsurface wastewater disposal systems. Based on the NRCS soils information, it appears that only about 7% (or about 70 acres) of the land in the study area is suitable for a conventional disposal system under current State rules. Given that a football field is about an acre in area, 70 acres seems like a lot—but some of this suitable area is already used for wastewater disposal, while other parts may have slopes too steep to be used for wastewater treatment (see Section 5.4 for more discussion of these land areas).

Approximately 1% of the study area would require either mound systems or mounds with curtain drains due to the high groundwater table. A significant proportion of the land in the study area (47%) would require both some form of advanced pre-treatment and a mound disposal system, primarily to overcome limitations due to high seasonal water tables. About 38% of the land in the study area would require some form of 'best fix' solution. 'Best fix' means that if the property is already developed and its wastewater treatment system fails, it may not be possible to construct a replacement system that meets all of the conditions of Vermont's current wastewater treatment rules. If a property with these difficult soils is undeveloped, it may not be developable.

2.3. Water Supplies

Onsite wells can limit onsite wastewater capacity because of the required protective setbacks between water supply wells and wastewater disposal systems. Most properties in the study areas are served by individual onsite water supplies, consisting of shallow springs or drilled wells. The locations of water supplies in the study area were gathered from property owner surveys, from state permits, and from a walking tour of the study area. These individual water supplies with their 100 foot or 150 foot protective buffers are shown on Figure 2. Water supply information from the sources described above is also summarized on Table 5. Approximately 7 of the properties are served by shallow water supplies; at least 40 of the developed properties are served by drilled wells; and a shared drilled well serves the library and Town offices. A public drilled well serves the elementary school.

The water supply information currently available does not account for all of the developed properties within the study area. Water supply information was not available for 13 of the developed properties.

2.4. Zoning Districts

The study area is defined by the boundary for the Town Center zoning district. The purpose of the Town Center District is "to provide for a community center, a place of civic pride, and a focal point for development in the Town" (Westford zoning bylaws, January 2006). Minimum lot sizes in this district are 1.0 acre for each family dwelling unit of principal structure, or 0.5 acre for units in an elderly housing development—significantly smaller than in other districts in the Town.

The Flood Hazard District, shown on Figure 2, is meant to encourage maintenance of flood hazard areas for open space uses that complement the use and development of adjacent areas. Floodway fringe areas along the Browns River and Morgan Brook that are within the Town Center zoning district are included in this overlay district. Of potential importance to this study is the requirement that "on-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding. The lowest elevation of the wastewater distribution field shall be located at least 1 foot above the base flood elevation."

Significant land in the study area is also located within the Water Resources Overlay District. This district is meant to protect the quality and character of Westford's water related resources, including wetlands, rivers, streams, and ponds. The overlay district creates a 100-foot buffer zone around all these water resources within which new development, including placement of septic system components, is not allowed. This requirement is stricter that what is required by the state's rules for individual septic systems.

3. HISTORIC AND CURRENT WASTEWATER TREATMENT

Westford's Town Center is served by individual onsite sewage disposal systems. There are no wastewater treatment plants or sewers in the study area. Information on the existing sewage disposal systems was gathered from state Regional Office files, the property owner survey questionnaires, interviews, and area site visits.

This section includes some general information on onsite sewage disposal systems, how they function and need to be maintained, and some information on newer components, including advanced treatment systems, which can improve wastewater treatment where soils contain limitations. We will then discuss the information gathered from permit files and other sources, as well as the information collected from the surveys.

3.1. Onsite System Components and Maintenance

Onsite sewage disposal systems, when properly sited, installed, and maintained, can be a long-term effective means of wastewater treatment and disposal. However, they can negatively impact surface waters and groundwater when they malfunction or when they are placed too close to the groundwater table or surface waters.

3.1.1. Wastewater Treatment and Distribution

The traditional onsite septic system in the study area (and around Vermont) includes a 1,000 gallon concrete **septic tank**, a concrete distribution box, and a leach bed or leach trenches. The septic tank settles out the solids and provides some treatment; the distribution box splits the flows evenly between pipes or trenches, and the leach bed or trenches (made out of crushed stone or alternative materials with perforated pipe covered with filter fabric) along with the unsaturated soils below the system provide the final distribution and treatment.

Effluent filters can now be added to the outlets of septic tanks, and are required on new tanks. These filters screen solids from the effluent when it leaves the tank. If the tank is full of solids, the filters will plug and the system will slow or back up before solids leave the tank and enter the disposal field. The filters need to be hosed off usually once a year.

Pump stations can be added after the septic tank if the disposal field is higher in elevation than the building outlet, or for mounds and advanced treatment systems. Pressurizing the disposal field also allows for improved distribution of the effluent, making more efficient use of the entire field.

Advanced pre-treatment components can be added after the septic tank to improve wastewater treatment prior to disposal. Pre-treatment components may also allow for increased capacity of onsite systems, which maximizes available soil resources, or may allow for the use of sites not previously approved under the Rules. Since August 2002, the Vermont Environmental Protection Rules (Rules) have contained a process through which pre-treatment technologies can be approved for use in the state. Since the revised Rules were implemented, several different technologies have been approved by DEC and are available for designers to consider (a list of all approvals can be found at http://www.anr.state.vt.us/dec/ww/innovative.htm). A designer should think about the availability of component parts, local service providers, and ongoing operation and maintenance costs when considering or recommending any particular component. Pre-treatment technologies can add $5,000-$10,000 to the construction cost of a system, and because they need to be maintained regularly in order to operate properly, their ongoing costs are often higher than those of a conventional septic system.

3.1.2. Wastewater Dispersal Options

Traditional wastewater dispersal options in Vermont include drywells, in-ground leachfields, and mound systems. The survey responses indicated that approximately 3% of the respondents had drywells, which typically follow septic tanks and consist of concrete cylinders with open bottoms and holes in the sides, surrounded by stone, which holds the wastewater until it disperses into the ground. Two concerns with drywells are that they typically contain a small volume and can be undersized for their intended uses, and that they are usually quite deep in the soil profile, sometimes close to 10 feet. For drywells to comply with current regulations, the soil conditions must be suitable at a depth of four feet below the system. These conditions are rather unusual on many Vermont sites, including most of the soils identified in the study area.

Most people are familiar with in-ground leachfields and mound systems. These dispersal options both provide treatment within gravel trenches (or gravel beds) and in the unsaturated soil beneath the trenches. A traditional **leachfield** is usually dosed by gravity, where effluent flows from the septic tank to the leachfield based on how much water flows into the septic tank from the structure. An in-ground leachfield requires 36 inches of unsaturated soil between the bottom of the leachfield and groundwater, and 48 inches to bedrock. Since the trenches are usually 24 inches deep, this means at least 5-6 feet of good soil are needed for an in-ground leachfield to work properly.

A **mound** system is used where site conditions are more difficult. Unlike in-ground leachfields, they are dosed using pressure, usually from a pump tank or siphon placed between the septic tank and the disposal field. The "mound" is built out of sandy material, which provides additional unsaturated soil for wastewater treatment between the gravel bed or trench and the limiting condition (groundwater or bedrock). To be used without any additional pretreatment, a mound system needs at least 18 inches of undisturbed, unsaturated soil between the ground surface and the groundwater or bedrock.

Some newer wastewater dispersal options in Vermont include **at-grade systems** and **subsurface drip irrigation**. At-grade systems are dosed using pressure, like a mound system, but the gravel trenches or bed are built on the existing soil surface and then covered with native soil from another part of the site. Since the trenches are built on top of the existing ground surface, they need 4 feet of good soil (less than is needed for an in-ground system). Subsurface drip irrigation was approved in Vermont in 2007, and uses small-diameter, flexible tubing with widely spaced "emitters" to distribute treated wastewater effluent. Because of the small diameter of the emitters, wastewater must be pre-treated using an advanced treatment technology if subsurface drip dispersal is to be used. However, this technology can be installed without the use of gravel beds, making it a viable option in small spaces where earth-moving equipment cannot gain access. Since pre-treatment is required, subsurface drip irrigation can be used as a filtrate system (see below).

If advanced pre-treatment technology is used on a septic system, Vermont's Rules allow the use of a dispersal system called a **filtrate system**. The term "filtrate" acknowledges that the pre-treatment component has already done much of the work that the soil would normally do in a traditional septic system, and so less treatment is required of the soil. Filtrate systems may consist of any approved wastewater disposal technology, but smaller sizes are allowed (up to ½ the area of traditional in-ground leachfield, at-grade system, or mound system), which can be important on small lots. Pre-treatment may also eliminate the need for a mound system in situations with shallow groundwater or bedrock limitations, since reductions in the vertical separations to limiting soils are also gained when pre-treatment is used.

Vermont's Rules also allow for the design and permitting of **performance based systems** on sites with 18 inches of soil above bedrock and as little as 6 inches of soil above the seasonal high water table. These systems almost always involve advanced pre-treatment and a mound wastewater dispersal system, and the Rules require significant monitoring and reporting to ensure that the systems operate properly.

3.1.3. Operation and Maintenance of Wastewater Treatment Systems

Operation and maintenance of conventional sewage disposal systems is quite simple. Operation or use of the system can be greatly enhanced by the use of water conservation devices and developing appropriate habits, such as only doing one load of laundry a day and eliminating in-sink garbage disposals. Keeping records of the locations of buried components, tank pumpouts, and repairs can be crucial during a system inspection and is invaluable information for future owners of the system.

Maintenance on conventional systems consists of having someone check the levels in the septic tank and pumping it out when necessary. For the homeowner, this usually means calling the septic tank pumper and always paying for a pumpout, whether it is really necessary or not; homeowners can avoid this unnecessary expense by checking the tank themselves. Depending on the use of the system, it may need to be pumped every year to every seven years. The condition of the tank, particularly its baffles and access, should also be inspected. If there are multiple tanks or pump station tanks, these should be inspected regularly and pumped when necessary. Any electrical parts should be inspected yearly. The effluent filters also need to be checked and cleaned on a yearly basis.

Maintenance of tanks is a lot easier when access to the tank is not a problem, as when the tank is buried under a couple of feet of soil. If the top of the tank is deeper than 12 inches below the surface, access risers should be installed on the tank. In the past the risers were constructed of thick heavy concrete, but lightweight plastic and fiberglass materials for risers are now available, although child safety must be considered.

Another maintenance item is to check the **distribution box** and make sure all of the outlet pipes are level. If this box is not level (which can easily happen in Vermont's freezing climate), one portion of the disposal field may be overloaded while other parts go unused. There are plastic devices available that can easily be installed to make the outlet pipes level.

The disposal field itself should be checked for seepage or surfacing of effluent, or for water loving plant growth. If there is untreated wastewater surfacing or discharging into a ditch or surface waters, there is a real public health hazard that should be addressed immediately. Although not typical in Vermont, some disposal fields (leach fields) include monitoring pipes so that the stone in the disposal field can be checked for ponding. Some ponding of treated wastewater in the field can be acceptable, but if the system has a thick clogged mat or is being hydraulically overused the wastewater system may surface or back up.

As septic systems become more complex, it becomes even more important to make sure that they are operating properly. Since the more complicated systems are often installed to overcome difficult site conditions, like shallow groundwater, there is less of a 'margin of safety' if the system malfunctions before sensitive resources such as shallow groundwater are negatively impacted. Systems that use pumps to distribute wastewater effluent, like at-grade or mound systems, should be checked at least once a year to make sure that the pumps are cycling and operating properly. The maintenance requirements for pre-treatment systems vary with the individual technology, but should include at least one inspection per year. Most technology manufacturers sell maintenance contracts with their systems to ensure that the pre-treatment units keep functioning properly after they are installed.

3.2. State Permit Programs & File Reviews

Given the age of most structures in the Town Center study area, there was a surprising amount of information in the State Department of Environmental Conservation (DEC) permit files. Several properties have received permits for subdivision, or for renovations that included changes to the septic systems. Permits were found for all public buildings in the study area, except for the United Church and the general store. Stone conducted a review of the files at the District 6 Regional Office in Essex Junction. A summary of the available permit information is shown in Table 4.

3.2.1. Town Permits

The Town of Westford records State (DEC) permits in their paper files and land records. Since Town permits essentially duplicate information available in the State permits, the Town's permit files were not reviewed further.

3.2.2. State Permits

Stone reviewed the DEC permit files in the Essex Junction Regional Office for permits for public buildings (almost any occupied building except a single family residence) and for subdivisions that are less than 10 acres in size (since 1969). A total of 27 permits were found for 19 parcels in the study area. Most of these permits were for subdivisions or new construction. Several of the permits reviewed were for upgrades to existing systems, and at least one appeared to represent a "best fix" situation.

3.3. Property Owner Survey

The main goal of the property owner survey was to obtain information regarding existing water supplies and septic systems. The survey was mailed to Town Center area property owners in mid-August 2007. Of the 63 surveys sent, we received responses from 32 owners (52%). Table 1 contains a summary of the responses.

The data collected from the individual surveys were very useful to the project consultants during the assessment process. The survey provided information about ages and types of septic systems, when septic tanks were last pumped, and repairs or plans on file.

Information about types and locations of water supplies and indications of water quality were also collected.

Approximately 13% of the respondents' onsite systems were constructed prior to 1982, when the first major technical design standards for Vermont were published. Sixty-eight percent of the properties contained leach fields, and one respondent (3%) had a drywell. Five mound systems and two advanced treatment units were identified in the study area. About half of the septic tanks were two or more feet below grade, which means they are difficult to access unless they have access risers on the tanks, and it means that the leach fields may be deeper in order for gravity flow to reach the field. More than half of the responding property owners (58%) said they have a copy of the sketches, plans, or permits for their system.

Three questions were directed towards maintenance of septic tanks and system repairs. Approximately half (48%) of the respondents indicated they pumped their tanks every 1 to 5 years. Eighty-six percent indicated they pumped their tank since 1995, with 73% pumping since 2000. Twenty percent of the respondents indicated upgrades or repairs to their systems within the last ten years.

Seventy-four percent of the owners rely on individual drilled wells, 23% on a shallow well or spring, and one respondent (3%) uses a shared or community water well. Many indicated always having good quality (84%), but a small number (10%) indicated that they had problems with their water quality in the past, mostly due to bacterial contamination of shallow wells or springs.

4. NEEDS ASSESSMENT

The needs assessment portion of this study includes a data-driven Geographic Information System (GIS) analysis that combines spatial information, such as USGS topography and NRCS soils information, with local information such as parcel boundaries, building footprint areas, and building uses, to determine what, if any, constraints a property may contain for onsite wastewater treatment and disposal. The results of the GIS analysis are indicated on Figure 3 by colors summarizing the key constraint(s), if any, for each property.

The results of that analysis were confirmed by including all other sources of information collected and described in Section 3. This review resulted in an overall recommendation for each property of either maintaining and upgrading a system onsite, or potentially connecting to an offsite solution. The property-specific recommendations do not reflect the current actual conditions of the individual wastewater treatment systems in the study area, and no access to private property to inspect individual systems was requested or granted for this study. A recommendation of “connecting to an offsite solution” simply means that, if an individual system were to fail in the future and need replacement, it may be difficult to site a replacement system on the property that meets all of the setbacks and separation distances that are required by the current local zoning ordinances and State wastewater rules. The results of this assessment are summarized on Table 5 and on Figure 3.

Following is a detailed description of the Needs Analysis and a summary of the results for the study area.

4.1. Data-Driven GIS Needs Analysis

The Needs Analysis was performed to identify parcels that may not be suitable for onsite septic systems. There are two main components to the needs analysis: an “available area” analysis and a “required area” analysis, each of which is described below.

The objective of the available area analysis was to identify which developed parcels would be constrained by inadequate lot size if required to install an upgraded onsite system. There are many factors that result in areas of a parcel being unavailable for construction of an onsite system. For example, state and local regulations require that certain "setbacks" or distances from natural or artificial features be maintained in order to protect those resources. One such setback is a required separation of 100 feet from surface waters and wetlands. It is because of setback regulations that the total area on a parcel is significantly reduced when determining which areas are suitable for onsite systems. A second and equally important part of determining if a parcel has enough suitable land area to support an onsite system is the analysis of the soil conditions on the parcel to determine the area required to treat the wastewater flows from the parcel. Both the determination of available area and that of required area for onsite systems for each developed parcel were addressed by the study team. The last step identified those properties with soil conditions where the seasonal high groundwater table was 24 inches or less or where the depth to bedrock was less than 24 inches. Both of these conditions impact the type of onsite system that may be built.

The following assumptions and criteria were used to conduct the needs analysis.

4.1.1. Available Area Analysis

The first step in the assessment of suitable areas was to determine the available area on each developed parcel. This process involved both analyses of GIS data to identify areas unsuitable for onsite system development, as well as complex database operations to identify parcel features that might further limit onsite system development. The table below lists each of the setbacks of features examined in the available area analysis. Each of these features will be briefly discussed.

Area Analysis Criteria

Feature	Required Setback (ft)
Town Water Resource Overlay District	100
Top of embankment, or slope greater than 30%	25
Bedrock Escarpments	25
Property line	25
Zone 1 Source Protection Area-School Wells	1,000
Private wells-spring, dug well	150
Private wells-drilled well	100

Source: Vermont Environmental Protection Rules, Wastewater System and Potable Water Supply Rules, 2007; Westford Zoning Regulations, 2007.
3/12/04 ANM

1. Water Resource Overlay District: The Town of Westford's zoning bylaws require a 100-foot setback from all water resources (lakes, streams, rivers, and wetlands). Septic system components are not allowed within this district.
2. Top of Embankment, or Slope greater than 30%: Areas with slopes of greater than 30% were identified from the GIS Digital Elevations dataset. These areas were spatially buffered with the indicated setback distance using GIS.
3. Bedrock Escarpments: Bedrock Escarpments were obtained from the Chittenden County soils dataset. Escarpments were spatially buffered with the indicated setback distance using GIS.
4. Property Lines: Property lines were obtained from the Westford GIS parcel dataset. Property lines were spatially buffered with the indicated setback distance using GIS.
5. Private Water Supplies: Private water supply information was collected from spatial data sources, from permit files, and from property owner survey results. All known drilled and shallow wells were included in the available area

analysis. Spatial well locations were obtained from the State Water Supply GIS dataset. Each water supply point was spatially buffered with the indicated setback distance using GIS. For parcels where spatial well data was unavailable, information acquired from the property owner survey and from wastewater permits was used to identify the type of water supply. For those properties with the location of a private water supply indicated, the well location was digitized and each water supply point was spatially buffered as described above. For parcels that are developed but have no water supply information available, a well buffer equal to half the setback distance was subtracted from the parcel area. This reduction in the well setback is equivalent to assuming that a portion of the area resulting from a standard setback would overlap adjacent parcels and other buffer areas on a small lot. It is likely that overall, this method underestimates the well shield areas required by the state's Water Supply Rules for the protection of drinking water supplies. Under these rules, a shield-shaped area that extends uphill from the circular buffer shown on the maps (250 feet uphill for drilled wells, 500 feet uphill for shallow wells or springs) is required to be set aside for groundwater protection. The GIS analysis tools are not capable of drawing such shields for each water supply, so the circular "radius" buffer is used instead. This assumption may result in some properties with private wells appearing to have more area available for an onsite system than is actually the case. For undeveloped properties without water supply information, no water supply buffer was assumed to exist..

6. Building Footprints: Building footprints were digitized from the available orthophotographs, supplemented by field observations for construction completed since the photographs were taken (in 2003). The building footprints were buffered using GIS, and their areas were included in the analysis as areas unavailable for onsite systems.
7. Available Area Calculation: The total available area for a parcel was determined by subtracting an assumed building footprint area from the area of the parcel outside the required setback buffers as calculated by the GIS analysis. In addition, private well buffer areas were subtracted for those parcels whose private wells were not located in the GIS assessment. This calculation is shown in the following equation:

Area Available = Parcel Area – Required Setback Buffer – Building Footprint – Private Well Buffer

4.1.2. Required Area Analysis

The required area for construction of an onsite system was determined from two primary pieces of information: 1) Soil properties (percolation rates and long-term acceptance rates) for each parcel, 2) Design parameters for each onsite system. Assumptions made regarding the determination of each of the inputs to the required area calculation are described below.

4.1.2.1. *Soil Properties*

Percolation rates and long-term acceptance rates (LTAR) were calculated for each soil type within the study area. We assigned average percolation rates using the soil textures from the NRCS soils data and the average rates listed in the Vermont Indirect Discharge Rules. Each parcel was assigned the properties of the predominant soil type for purposes of determining the required area.

4.1.2.2. *Onsite System Design Assumptions*

Where suitable soils existed, the onsite system was assumed to be a standard trench leach field design. The standard Vermont Wastewater System and Potable Water Supply Rules long-term application rate (LTAR) effluent loading rates were used in the sizing of the leach field. A standard three-foot wide trench, with four feet separation was used as the typical layout. This resulted in a range of areas needed for the leach field depending on the soil's assumed percolation rate. For soils where only mound systems would be feasible, an estimate of the required area for a mound disposal system was calculated using the LTAR values for mounds specified in the Rules. It was assumed that if a leach field (or mound) could be successfully sited on the property there was adequate area for other system components, such as septic tanks and distribution boxes.

4.1.3. *Area Analysis Assessment*

The available area for an onsite system was compared to the required area for each parcel. The required area for a system was based on the predominant soil type on the parcel. Parcels were identified as area limited if the available area was less than the required area. Parcels were identified as being unconstrained by area when the available area was greater than or equal to the required area.

4.1.4. *Seasonal High Groundwater Analysis*

An additional GIS analysis was conducted for parcels with potential groundwater limitations. Soils with groundwater depths of less than 24 inches would require a raised system, such as a mound, and would indicate a constraint to a typical subsurface system. A parcel was identified as having a groundwater limitation if the area of the parcel with a groundwater depth of greater than 24 inches represented an area smaller than that required for a conventional onsite system. This analysis may overestimate site limitations regarding depth to groundwater, as it does not account for filtrate systems, alternative systems, or desktop hydrogeologic analyses that may be used under the EPRs.

4.1.5. *Depth to Bedrock Analysis*

Depth to bedrock was assessed to identify parcels with potential bedrock limitations. Parcels with shallow bedrock, of less than 24 inches, would require additional fill to allow an onsite system to function properly. A parcel was identified as having a bedrock limitation if the area of the parcel with a depth to bedrock of greater than 24 inches represents an area smaller than that required for a conventional onsite system.

4.2. GIS Analysis Results

The results of the analysis are represented on Figure 3 and summarized on Table 5 in the section titled Environmental Assessment Results. The factors affecting the analysis results are included in the table. Of the 78 parcels in the study area, there were 42 parcels that can support an onsite wastewater disposal system under the assumptions listed above. These parcels met all the environmental setbacks required in the Area Analysis Criteria table in section 4.1.1 as well as the depth to groundwater and bedrock criteria described in Sections 4.1.4 and 4.1.5.

There were 36 parcels that the GIS analysis estimated could not support an onsite wastewater disposal system. Of these parcels, 5 were constrained by only environmental setbacks, 19 parcels were constrained by only shallow groundwater, and none were constrained by only shallow bedrock. The remaining 11 parcels had a combination of setback and groundwater constraints.

A total of 16 parcels, mostly located around the Town Common, were constrained by the area restriction of proximity to water supplies. If a property is constrained by an area restriction but has suitable soils for wastewater treatment, it can often be more cost-effective to maintain individual wastewater systems while installing a community water supply system. Eleven of these parcels were also constrained by shallow groundwater, however, so using the community water supply approach would not necessarily allow increased development or redevelopment that required increases in wastewater disposal capacity.

A total of 13 parcels were constrained by the area restriction of proximity to surface waters. Nine of these parcels were also constrained by shallow groundwater. The remaining four parcels, while not constrained by shallow groundwater, were all constrained both by proximity to water supplies and to surface waters. In all four cases, the parcels are relatively small (less than 1 acre) and have significant land within the floodway fringe areas of the Browns River or Morgan Brook. Three of these parcels, however, have wastewater permits that were issued by the Vermont DEC (see Figure 3 and Section 4.3).

4.3. Lot-by-Lot Review and Recommended Solutions

Once the results of the GIS analyses were produced, a lot-by-lot review was conducted. This review included using all of the additional information known about the properties, confirming the results of the GIS analyses, and developing recommended solutions for each parcel. Onsite solutions are recommended for most properties that did not have any constraints identified in the GIS analyses. However, approximately a quarter of the properties identified as constrained in the GIS analysis have a state wastewater permit, usually for a mound or an advanced treatment system. These properties are noted on Figure 3.

This is a planning level study and no onsite inspections or soils testing were conducted. If more detailed results are desired, additional onsite evaluations will be necessary.

The results of the needs assessment for the Town Center (Figure 3; Table 5) indicate that slightly less than half (46%) of the properties could benefit from an offsite wastewater treatment solution. Parcels with both groundwater and available area limitations are clustered primarily in the immediate vicinity of the Town Common, indicating that some form of small community system may be needed in the future to meet the needs of these properties. However, comparing the results of the GIS assessment to wastewater permits issued in the study area indicates that property owners are already taking steps to responsibly disperse wastewater on their own properties.

5. WASTEWATER TREATMENT DESIGN CRITERIA AND CLUSTER SYSTEM OPTIONS

Onsite and offsite wastewater treatment systems currently come under a number of different state regulations. Design considerations for individual onsite and small and large community cluster wastewater collection, treatment, and disposal systems are discussed. Changes in the rules and regulations are described, including key information about system designs and site conditions.

Design criteria for onsite wastewater systems are contained in two sets of regulations: The Environmental Protection Rules (EPRs), and the Indirect Discharge Rules (IDRs). Following is a summary of important rule requirements. The latest versions of the EPRs and the IDRs were used to estimate wastewater flows from the study area based on available information and the results of the needs analysis discussed in Section 4.

5.1. Environmental Protection Rules

The latest revisions to the EPRs became effective on September 29, 2007. These rules apply to decentralized wastewater disposal systems with design flows of less than 6,500 gallons per day (gpd) and to sewer connections for any design flow. Important changes were made in many areas of the EPRs, including the implementation of universal jurisdiction and the 'clean slate', an overall re-organization of the EPRs to improve readability, and the addition of several alternative technologies.

With the latest revision to the EPRs, wastewater systems and potable water supplies that were previously exempt from state regulation may be required to obtain a permit for activities such as:

- new construction (including single family residences that need sewage disposal and/or water);
- construction or modification of a wastewater system and/or potable water supply;
- new connections to an existing wastewater system and/or potable water supply;
- subdivision of land; and
- repair or replacement of a failed wastewater system and/or potable water supply.

Vermont is the last state in the nation to implement this kind of permit requirement for all properties statewide. This is often referred to as the state having "universal jurisdiction" over sewage and water.

The legislation includes a "clean slate" exemption that basically grandfathers all buildings, campgrounds, lots, wastewater systems, and potable water supplies that were in existence before January 1, 2007. A permit is now required when any action is taken on or after January 1, 2007 that needs a permit. If the wastewater system or potable water supply fails, a variance from the rules is available if no fully complying replacement can be found. (This is often referred to as a "best fix" situation, see Section 3.1.) This provides relief for a number of properties that currently are unmarketable due to non-compliance with the rules.

New, clearer definitions are provided for "failed" water supplies and wastewater systems. This is important because anyone with a failed system now needs a repair permit and also has a defect in their property title.

The EPRs now include general approvals for the use of constructed wetlands and subsurface drip distribution systems for the disposal of wastewater in addition to the different types of alternative systems allowed through product-specific approval. The general use approvals enable these innovative/alternative components to be used when designing wastewater systems.

Other changes to design requirements that may be useful to landowners in the study area include:

- Reduction in minimum design flow for a single family residence to 2 bedrooms (from 3 bedrooms). This will allow smaller wastewater systems to be built.
- If a primary disposal system is designed and constructed with pressure distribution that can handle 150% of the design flow, no replacement area is required. This change will enable some lots that were not developable (because they lacked the space and soils needed to site the required identical replacement system) to be developed.
- If a mound system is designed and constructed for 100% of the design flow, no replacement area is required. Designers and engineers have advised that, in nearly every case, failed mounds can be replaced or restored to full function on the original footprint. This also means that properties with mound systems and replacement areas that were permitted before the 2007 rule revision may be able to subdivide or redevelop property that was previously at its maximum wastewater treatment capacity.
- Composting toilets are now specifically allowed in the EPRs, and there is no longer a requirement that a project have enough area to build a septic system even though a composting toilet is proposed. The new rules also allow a smaller leachfield to be used for graywater only when a composting toilet is proposed.
- Language has been added to make clear that water and wastewater systems may not be constructed within a floodway and that construction requirements apply when constructing within the flood plain. This brings the EPRs closer in line to what the Town already requires for land within the Flood Hazard Overlay zoning district.

5.1.1. Disposal System Options

Many options are available for the dispersal of treated wastewater from decentralized systems under the EPRs. Leach trenches or seepage beds are commonly utilized under favorable site conditions (those having percolation rates of between 1 and 60 minutes per inch and at least 5-6 feet to seasonal high groundwater levels and bedrock). At-grade and mound dispersal systems are generally used where minimum site conditions are met, but the site conditions are not favorable enough for the design of subsurface systems. Finally, filtrate effluent disposal systems may be used when secondary treatment is a component of the wastewater system. Any of the previously discussed soil-based dispersal systems are permissible as filtrate systems; further, loading rates may be increased and vertical separation distances from bedrock and seasonal high water tables may be reduced if the treated effluent meets certain standards (see Section 3.1 for more detail on wastewater dispersal options).

Spray dispersal (disposing of treated wastewater into native soil by surface application, using sprinklers) may also be used under the EPRs for systems with design flows of up to 6,499 gpd. A continuous impeding layer beneath more permeable soils must underlie a spray dispersal site, and the treated wastewater must be chlorinated before dispersal. While these site conditions are likely to be found in and near the study area, there are also significant requirements for winter storage of wastewater that may be difficult to meet.

5.2. Indirect Discharge Rules

Since January 1990, wastewater treatment systems with design flows of 6,500 gpd or greater are regulated under Chapter 14 of the EPRs, commonly known as the Indirect Discharge Rules or IDRs. The IDRs are used to permit septic tanks and leach fields, and also treatment plants and spray disposal systems, which use soil as part of the wastewater treatment process. Following primary and/or secondary treatment, the soil provides final effluent polishing and renovation before it reaches groundwater and, eventually, surface water. This is in contrast to direct discharge systems, which may discharge through a pipe directly to surface waters.

Any flows directed to a cluster wastewater treatment system with design flows of greater than 6,500 gpd that is constructed to support development which was already complete as of May 17, 1986 will likely be considered an “Existing Indirect Discharge” under the IDRs. The DEC is required by statute to issue a permit for existing indirect discharges unless they find that the discharge is causing a violation of the Vermont Water Quality Standards. This application category, however, is limited to indirect discharges already occurring in 1986 and thus may not be suitable if significant new development is desired within the study area.

Any community wastewater treatment system constructed in the study area to support both existing and new development will be considered a “System with New Indirect Discharge”.

If wastewater dispersal sites with design flows of greater than 6,500 gpd are located near the Browns River, they may be considered "Systems with New Indirect Discharges to Class B Waters" under the IDRs. These systems are required to obtain an indirect discharge permit before construction begins. In order for a permit to be issued, the Town of Westford must demonstrate that the new discharge:

- will not significantly alter the aquatic biota of the receiving waters;
- will not pose more than a negligible risk to public health;
- will be consistent with existing and potential beneficial uses of the waters; and
- will not violate Water Quality Standards.

The Town must also document compliance with the Aquatic Permitting Criteria, the Reliability Permitting Criteria, and the Public Health Protection Criteria as stated in the IDRs before a permit will be issued. The larger a proposed cluster system is, the more likely it is to trigger additional hydrogeological and biological testing and monitoring requirements. Permits issued under the IDRs typically include effluent monitoring and downgradient groundwater monitoring requirements.

The latest IDRs, which became effective in April 2003, represent the first significant revision to the rules since their inception in 1990. These revisions were based on a review of the data collected on indirect discharge systems and were also meant to streamline the permitting process and to increase latitude to permittees in the operation of their systems. Following is a brief description of some key changes.

A General Permit is allowed for systems with design flows of 15,000 gpd or less and that do not require a certified operator to manage the system. This change streamlines the permitting process without any loss of oversight, because the General Permit still requires annual inspections and reporting of system failures.

Significant changes were made to the Aquatic Permitting Criteria. Sampling for nutrient parameters (total dissolved phosphorus and nitrate-nitrite nitrogen) will still be required, but sampling for other parameters that did not often appear in groundwater near permitted systems (such as total chlorine, biological oxygen demand, and total kjeldahl nitrogen) is no longer required. Changes were also made to the methods by which an applicant may demonstrate compliance with the Aquatic Permitting Criteria. A new method (the Dilution Method) was added, and the applicability of the Treatment Index and Modified Site Specific Methods has been expanded to include more potential projects. These alternatives to the more complex and costly Site Specific Method provide a range of options for projects with smaller design flows that do not appear to have the potential for significant environmental impact.

5.3. Wastewater Flow Projections and Land Required for a Community System

An estimated wastewater flow projection was developed for the properties surrounding the Town Common, in order to better understand the costs involved to provide for both current property uses and up to 10% future growth. Flow values were developed using the design flow tables in the current (2007) version of the EPRs. The design flow estimate was made for 40 housing units (at 245 gpd/unit), or a total of 9,800 gpd. With 10% growth, the total design flow was 10,780 gpd. Since this estimated flow is greater than 6,500 gpd, the system would be permitted under the Indirect Discharge Rules, and alternating disposal fields would probably be required. Thus, the disposal system would need to be designed for two times the design flow, or about 20,000 gpd. This design flow would translate to an estimated required in-ground leachfield area of about 80,000 square feet (roughly 2 acres). A community wastewater dispersal system using a mound would require a larger land area, but the exact area needed is dependent on the slope of the individual site and a number of other factors. Thus, the land area needed for a community mound system was not estimated.

5.4. Potential Suitable Areas for Offsite Cluster Wastewater Disposal Systems

Several areas of land within and near the Town Center study area were considered as potential cluster system sites (Figure 4). All of these areas were at least two acres in size. Some of the criteria used in evaluating sites for cluster systems included:

- Well suited soils over an area large enough to support a community leachfield
- Relatively flat or moderate slopes
- Proximity to properties recommended for offsite solutions
- Environmental issues such as downgradient water supplies, surface water crossings, floodways and floodplains
- Physical issues such as access, bedrock depths for collection system, and bridge or river crossings
- Local knowledge of properties
- Other permit issues

No on-site evaluation of any of the potential suitable areas discussed below was conducted during this study. The permission of the individual landowners would be needed before any site-specific evaluations could occur.

Two areas with soils that are potentially suitable for offsite community wastewater disposal systems were identified north of Brookside Road. Area 1 consists of Colton and Stetson soils and Stetson gravelly fine sandy loam, suited for conventional in-ground systems, and is located on two parcels (Figure 4). Portions of the Colton and Stetson soils may be limited by steep slopes (up to 60% slope). There is a small unnamed stream located immediately to the east of Area 1. If a wastewater disposal system with design flows of greater than 6,500 gallons per day were sited here, the unnamed stream would be the 'receiving water' under the IDRs, and it may be difficult to meet the Aquatic Permitting Criteria with such a small receiving water. There are also a number of water supplies, both springs and drilled wells, located to the east of Area 1. While the unnamed stream should act as a hydrologic divide, protecting these water supplies from potential impact by a community wastewater treatment system, further hydrogeologic investigation would be required to confirm this finding. Since this area is located at a higher elevation than most of the properties that would be served by a community wastewater solution, it would be necessary to pump the wastewater up to the disposal field. Additionally, a stream crossing would be necessary in order for the sewer line to cross the unnamed stream.

The second potential area along Brookside Road, Area 2, has similar soils to those underlying Area 1, but with gentler slopes (Figure 4). There is a mapped wetland overlying part of the soils in this area, suggesting that the wastewater treatment capacity of at least some of the soils here may be more limited than what is shown in the soil survey data. The water supply serving the house down-slope from Area 2 is unknown, so it is difficult to determine whether it would be impacted if a community wastewater disposal system were to be constructed at this site. Area 2 is located at a higher elevation than most of the properties which would be served by a community wastewater treatment system at this site, so it would again be necessary to pump the wastewater up to the disposal field. While a stream crossing would not be necessary, Area 2 is almost half a mile from the Town Common, so the costs for installing pressurized force-main to transport the wastewater to the disposal site would be high. There are also several areas of bedrock outcrops along Brookside Road between the Town Common and Area 2, indicating that significant ledge removal may be necessary in order to accommodate the line.

Area 3 is located on open land immediately south of the Town Common. Although this area has the advantage of being located very near the area likely to be served by a community wastewater disposal system, and is at a similar elevation to much of the potential service area, it is underlain by Munson and Belgrade silt loam soils with shallow groundwater limitations, meaning that a mound system (and possibly advanced pre-treatment) would be necessary to construct a community system on this site. A portion of Area 3 is also located in the Flood Hazard Overlay zoning district, so any wastewater system constructed in that portion of Area 3 would need to be modified to be above the base flood elevation. If the community wastewater treatment system had a design flow of greater than 6,500 gpd, the Browns River would be the 'receiving water' under the IDRs, so the Town would need to prove that any system constructed here could meet the Aquatic Permitting Criteria before the system was constructed.

The Town Common (Area 4) initially seemed a good site for a community wastewater dispersal system, since it was centrally located and undeveloped. However, the soils underlying the Common are extremely limited, and an underdrain system was recently installed beneath the entire area to improve drainage. Since the entire area has underdrains installed, the construction of wastewater treatment systems would not be allowed.

An area of open land located southeast of the Town Common (Area 5) was also initially considered as a potential community wastewater dispersal site. The site consists of gently sloping Agawam fine sandy loam soils suitable for conventional in-ground wastewater dispersal, and has an elevation lower than much of the likely service area, so much of the wastewater could be transported to the site by gravity. However, Area 5 is bordered on three sides by the Browns River, so it is located almost entirely within the Flood Hazard Overlay zoning district and significant portions of the site are within the 100-foot Water Resource Overlay zoning district. Both these districts limit the area available to locate a wastewater treatment system on this site. The landowner advises that a portion of the site is already being used to treat wastewater from the home on this property.

An area of open field located southeast of the Town Garage (Area 6) also holds potential as a community wastewater treatment site. This land is underlain by Stetson gravelly fine sandy loam soils, which are likely suited for conventional in-ground wastewater disposal. In order to use this site, wastewater would need to be collected from around the Town Common area, probably by gravity, and then transported across the Browns River and up to the site through a force main. The soils along the probable route of the force main do not appear to be constrained by shallow bedrock, but without a more detailed assessment it is difficult to say how much ledge removal might be needed for this option.

Of the six sites which were initially considered, the three areas closest to the Town Common (Areas 3, 4, and 5) are not suitable for a community wastewater system. The remaining three areas have soils and site conditions that are potentially suitable, but have other attributes that make their use difficult. Areas 1 and 6 would require a stream crossing as part of the construction project, which is not allowable under the current zoning bylaws. (If the Town wishes to move forward with a project in the future, it may be prudent to revisit this provision in the zoning bylaws, since directional drilling and other less invasive technologies can now be implemented to reduce or eliminate disturbance to streams during installations that require stream crossings.) Area 2 would not require a stream crossing, but its distance from the Town Common and the presence of shallow bedrock along the Brookside Road force main route both would significantly increase construction costs.

5.5. Investigating Constructing a Community Wastewater Treatment Solution

An alternative to sharing solutions between property owners or encouraging changes in property use (see Section 6) is to encourage new homes and businesses in the Town Center zoning district by constructing a community wastewater collection and treatment system to serve properties around the Town Common. In order to understand what the costs of such a solution might be, we estimated that the collection and treatment system would serve approximately 40 existing residences and businesses in the Town Center, and allow 10% capacity for future growth (the basis for flows was described in Section 5.3). For costing purposes, we assumed that the system would include approximately 3,600 linear feet (l.f.) of gravity sewer collection, a pump station and river crossing, approximately 1,600 l.f. of sewer force main to a nearby (+/- ¼ mile) mound disposal system. A total project cost for a system of this nature may be on the order of $ 2.2 million, including construction costs, land costs, design and construction phase engineering, and legal and administrative costs.

A more detailed feasibility study, including site-specific testing of the potential wastewater dispersal sites discussed in Section 5.4, would be needed in order to further refine this cost estimate. The final project costs could be lower if, for example, a suitable site very close to the Town Common was found, or it was learned that the wastewater flows could be split between several smaller disposal sites. However, costs could also shift higher if, for example, site-specific monitoring were needed to comply with the Indirect Discharge Rules or if extensive pre-treatment was needed in order to utilize a particular disposal site.

Deciding to move forward with a community wastewater treatment solution is a major decision that should be made by the entire interested community, after careful consideration of all possible options. A needs assessment, like the one provided by this study, is a good first step and provides important facts for the community decision making process.

6. COMMUNITY WASTEWATER MANAGEMENT ALTERNATIVES, RECOMMENDATIONS, AND RESOURCES

Given the limitations of the range of potential community wastewater disposal sites, the Committee decided not to move forward with a traditional engineering alternatives analysis. Instead, they asked the consultant team for information on a range of alternatives to the construction of larger community systems that would still support development or redevelopment in the Town Center study area, and that might also be transferable to other areas of the Town.

Information about several different alternatives for community wastewater management in the Town Center study area are provided in this section, as well as some recommendations for next steps that the Town could take if a decision is made to pursue the construction of a community wastewater treatment solution. Even without a "construction solution", there are still several ways that the Town can encourage growth and creative development in the Town Center.

6.1. Encourage Proper Maintenance of Existing Systems

The answers provided to the survey conducted for this study (Section 3.3) showed that respondents were generally knowledgeable about how to operate and maintain their wastewater treatment systems. However, not all owners responded to the survey, so it is hard to know whether all property owners in the study area understand how to care for their wastewater treatment investment. Several brochures (prepared by National Small Flows Clearinghouse) are included in Appendix C detailing the components, operation, and maintenance of on-site wastewater systems. While the operation and maintenance of conventional sewage disposal systems is simple, it is crucial that property owners are aware of necessary maintenance procedures to maximize the useful-life of the system and avoid costly repairs. We recommend that property owners be supplied with these three brochures, as they prove to be valuable resources. At a minimum, the brochures can be made available for interested parties in the Town Offices.

6.2. Encourage Creative Solutions for Area-Related Restrictions

It is sometimes possible to work with neighboring landowners to overcome area-related wastewater treatment restrictions, such as separation distances from property lines or water supplies. The Westford Planning Commission has in the past required applicants to replace or relocate water supply wells already installed on neighboring properties, so that an applicant could build a wastewater disposal system that would otherwise be located within the isolation distance of the pre-existing well. The result is that a previously restricted parcel can be developed, and the neighbor gets a new well. Similarly, it may be possible to locate a septic system less than 25 feet from a property line if an easement on a neighboring property is acquired.

6.3. Investigate Sharing Existing Wastewater Treatment Capacity

The wastewater needs analysis conducted for this project indicated that up to 46% of the properties in the Town Center study area may not be able to meet current regulatory requirements if, in the future, property owners need to repair their systems or want to do something with their property that requires additional wastewater treatment capacity. Therefore, it may be beneficial for the Town to investigate the option of shared treatment systems between neighboring property owners. For example, the consultant team understands that the Brick Meeting House has additional wastewater treatment capacity that is currently not being utilized. Review of the approved Wastewater permit indicates that as much as 420 gpd may be available for use by adjacent property owners. This un-committed capacity would be suitable for a three bedroom single family residence.

Alternately, the un-committed wastewater treatment capacity in the Brick Meeting House's system would also be sufficient to accept the wastewater currently being generated from the Town Offices and the library. The wastewater treatment system serving these two structures appears to be operating properly, but the in-ground disposal system is located beneath the parking lot to the east of the Town Offices. While the system does appear to be operating properly now, driving cars or heavy equipment over in-ground wastewater disposal systems is discouraged, as this can cause crushed pipes, compaction, and premature failure of the disposal system. Additionally, if the parking lot is re-graded or paved in the future, the disposal system could easily be destroyed, necessitating expensive repairs.

Although a wastewater disposal permit was not located for the Westford United Church, the parcel contains some soils that are suitable for conventional wastewater disposal (Figure 2). There may be some opportunity for sharing of wastewater capacity on this property similar to that discussed for the Brick Meeting House.

7. OTHER CONSIDERATIONS FOR INCREASING DEVELOPMENT DENSITY IN THE TOWN CENTER

One way to create a more diverse range of property uses within the Town Center area without constructing new wastewater treatment infrastructure is to change the use of existing buildings. Property owners can apply to the Vermont DEC for a change in use for systems that have existing "grandfathered" flows. Part of a house could be converted into a business that used a bedroom's worth of wastewater treatment capacity without any need to expand the wastewater system. By the same token, an entire single family home could be converted to a business that used a home's worth of wastewater treatment capacity without needing to expand the system. Table 6 shows several examples of the kinds of businesses that could be feasible using one bedroom's worth of wastewater treatment capacity (which is 140 gpd), and the same examples if a three-bedroom home (with 420 gpd worth of capacity) were converted to that business.

TABLE 6: Examples of Possible Home Business Ventures With Existing Wastewater Capacity

Business type	Use possible with 1-bedroom conversion	Use possible with 3-bedroom conversion
Office	9 employees	28 employees
Day care facility (no meals)	2 care providers, 7 children	4 care providers, 24 children
Day care facility (1 meal)	1 care provider, 6 children	3 care providers, 18 children
Doctor's office	2 staff, 7 patients	4 staff, 28 patients
Post office	9 employees	28 employees
Retail store	9 employees	28 employees
Tavern or café	4 seats	12 seats

Property owners within the Town Center zoning district, and in other areas of Town, may also be able to leverage recent changes in the State's septic system rules (EPRs) to increase development density on their properties. Some of the changes in the latest version of the EPRs may have the effect of encouraging subdivision and changes of use to a small extent within the Town Center study area. In the 2007 EPRs, both the per-bedroom and required minimum design flows have been reduced from what was required in the 1996 version of these rules. Recently permitted systems may be able to slightly increase their capacity so long as the systems comply with the other current requirements of the EPRs. For example, the design flow for a 3-bedroom house under the 1996 EPRs was 450 gpd; under the 2007 EPRs the same house would be permitted for 420 gpd. The resulting increase in wastewater capacity (30 gpd) would be enough to support an additional two employees in a 1-bedroom office conversion.

With the 2007 rule revision, properties with mound systems that were permitted with fully complying replacement areas may in some cases be able to subdivide their properties without conducting additional test pits to find more wastewater treatment capacity. Replacement areas are no longer required for mound systems. Any new subdivision of land would, however, still need a permit from the Vermont DEC.

8. REFERENCES

Town of Westford. 2004. Westford Town Plan (adopted October 26, 2004).

Town of Westford, Planning Commission. 2006. Zoning Regulations (adopted November 1972; last revised January 2006).

Town of Westford, Planning Commission. 2006. Subdivision Regulations (adopted November 1972; last revised January 2006).

Vermont Department of Environmental Conservation. 1996. Environmental Protection Rules, Chapter 1: Wastewater System and Potable Water Supply Rules. Effective August 8, 1996.

Vermont Department of Environmental Conservation. 2003. Environmental Protection Rules, Chapter 14: Indirect Discharge Rules. Effective April 30, 2003. Accessed online at http://www.anr.state.vt.us/dec/ww/Rules/IDR/Adopted-IDR-4-30-03.pdf on January 16, 2008.

Vermont Department of Environmental Conservation. 2007. Environmental Protection Rules, Chapter 1: Wastewater System and Potable Water Supply Rules. Effective September 29, 2007. Accessed online at http://www.anr.state.vt.us/dec/ww/Rules/OS/2007/FinalWSPWSRuleEffective20070929.pdf on January 16, 2008.

TABLES AND FIGURES

Study of Community Wastewater Disposal Alternatives for the Town Center
Town of Westford, Vermont
TABLE 1: Summary of Survey Responses Regarding Wastewater Needs
Surveys Mailed: 61, Surveys Returned: 32, Response Rate: 52%

Survey Question	Response	Number of Responses	% of Responses
1.	How many people live or work in the building served by your wastewater treatment system?		
	0 (vacant land)	3	10%
	1-2	11	35%
	3-4	12	39%
	5-6	4	13%
	7-8	1	3%
	more than 8	1	3%
2.	If the building served by your wastewater treatment system is a residence, how many bedrooms does it have?		
	1-2	4	13%
	3-4	20	65%
	5-6	2	6%
3.	Is there more than one septic system on your property?		
	No	28	90%
	Yes	1	3%
4.	Please indicate when your septic system was originally installed.		
	1970-1981	4	13%
	1982-1989	3	10%
	1990-1995	3	10%
	1996-2001	4	13%
	2002-present	5	16%
	Before 1970	4	13%
	Unsure	6	19%
5.	Please indicate any upgrades or repairs that have been performed on your septic system within the last ten years.		
	None or blank	23	74%
	Other repair	5	16%
	Replaced the leachfield	1	3%

Study of Community Wastewater Disposal Alternatives for the Town Center
Town of Westford, Vermont
TABLE 1 (cont.): Summary of Survey Responses Regarding Wastewater Needs
Surveys Mailed: 61, Surveys Returned: 32, Response Rate: 52%

Survey Question	Response	Number of Responses	% of Responses
6.	Please indicate the components of your septic system.		
	Advanced treatment unit	2	6%
	Concrete septic tank	28	90%
	Distribution box (d-box)	7	23%
	Dry well	1	3%
	Leachfield	21	68%
	Mound	5	16%
	Other	1	3%
	Other septic tank	1	3%
	Pump station	6	19%
	Unknown	2	6%
7.	How often is the septic tank pumped?		
	1-2 years	1	3%
	3-4 years	14	45%
	5-7 years	8	26%
	More than 7 years	4	13%
7a.	Year that septic tank was last pumped?		
	2000	2	6%
	2001	1	3%
	2002	2	6%
	2003	1	3%
	2004	2	6%
	2005	4	13%
	2006	7	23%
	2007	4	13%
	Before 2000	4	13%
7b.	What company pumps your septic tank?		
	Envirotech	3	10%
	Other	10	32%
	P & P Septic	10	32%
	Senesac	3	10%

Study of Community Wastewater Disposal Alternatives for the Town Center
Town of Westford, Vermont
TABLE 1 (cont.): Summary of Survey Responses Regarding Wastewater Needs
Surveys Mailed: 61, Surveys Returned: 32, Response Rate: 52%

Survey Question	Response	Number of Responses	% of Responses
8.	How deep below the surface is your septic tank?		
	0-1 foot	3	10%
	1-2 feet	7	23%
	2-3 feet	10	32%
	More than 3 feet	6	19%
	Unsure	3	10%
9.	Have you ever experienced any of the following conditions in or around your leach field or drywell?		
	None	26	84%
	Surfacing sewage or effluent	3	10%
10.	Have you ever experienced sewage back up into a building?		
	No	28	90%
	Yes	1	3%
10a.	If Yes, has the situation been corrected?		
	Yes	1	3%
10b.	If Yes, please briefly describe how the situation was corrected.		
	Describe in comment	1	3%
11.	Do you have a copy of any sketches, plans or permits of your septic system available for reference?		
	No	18	58%
	Yes	11	35%
12.	Do you have any plans to change the way your property is used?		
	No	26	84%
	Yes	3	10%
13.	If sewage capacity was not an issue, is there anything you would want to do with your property that you can't do now?		
	No	23	74%
	Yes, describe in comment	6	19%
14.	Do you have more than one water system on your property?		
	No	26	84%
	Yes	3	10%

Study of Community Wastewater Disposal Alternatives for the Town Center
Town of Westford, Vermont
TABLE 1 (cont.): Summary of Survey Responses Regarding Wastewater Needs
Surveys Mailed: 61, Surveys Returned: 32, Response Rate: 52%

Survey Question		Response	Number of Responses	% of Responses
15.	Does the second water system on your property serve you or another landowner?			
		Another landowner	2	6%
		Me	1	3%
16.	Please indicate which type of water system you have.			
		Individual drilled well	23	74%
		Individual dug well	3	10%
		Individual spring	4	13%
		Shared drilled well	1	3%
17.	Have you ever had contamination problems with the water supply system(s) on your property?			
		No	26	84%
		Yes (describe in comment)	3	10%
18.	Have you ever run out of water?			
		Every few years	1	3%
		Never	28	90%
19.	If you have ever run out of water with your current system please briefly describe the circumstances.			
		Describe in comment	2	6%
20.	Do you have any comments regarding wastewater management in Westford?			
		No or blank	23	74%
		Yes (describe in comment)	6	19%
21.	Sketch of property included, with locations of septic system and well?			
		No sketch	2	6%
		Sketch completed	27	87%
22.	Contact information provided?			
		No	6	19%
		Yes (add in comment)	23	74%

TABLE 2: Study Area Description

Parcel ID	Property Location	Owner or Contact Name	Acres	Property Description
05CU004.	21 BROOKSIDE RD	UNITED CHURCH OF WESTFORD	2.5	Church
05BS001.	22 BROOKSIDE RD	MATTHEW COBB & ROSEMARY SHEA	2	Single Family
05BS002.	29 BROOKSIDE RD	JASON & PAMELA HOOVER	1.34	Single Family
05BS004.	33 BROOKSIDE RD	FRANCIS & CAROL BARKYOUMB	1.27	Single Family
05BS003.	36 BROOKSIDE RD	RICHARD & JANET GOLDEN	3.55	Single Family
05BS004.A	37 BROOKSIDE RD	FRANCIS & CAROL BARKYOUMB	1.27	Single Family
05BS006.	41 BROOKSIDE RD	PAUL ROBERGE	1.3	Single Family
05BS005.	42 BROOKSIDE RD	EDWARD & JULIETTE HORTON	8.1	Single Family
05BS007._1	62 BROOKSIDE RD	PATRICK & AMBER HALLER	7.2	Vacant Land
05BS007._2	62 BROOKSIDE RD	PATRICK & AMBER HALLER	7.2	Single Family
05BS010._1	123 BROOKSIDE RD	ROBERT JACKSON	201.3	Single Family
05BS010._2	123 BROOKSIDE RD	ROBERT JACKSON	201.3	Vacant Land
05BS009.	146 BROOKSIDE RD	TOWN OF WESTFORD	77.6	Town-Owned: Elementary School
05BS009.A	146 BROOKSIDE RD	TOWN OF WESTFORD	20.3	Town-Owned: Vacant Land
05BS012.	167 BROOKSIDE RD	DAVID & SANDRA ASHLEY	77	Single Family
05BS018.	201 BROOKSIDE RD	JAY LEONARD & BARBARA THURSTON	0.9	Single Family
05CM003.	2 CAMBRIDGE RD	CHARLOTTE VINCENT & KATHLEEN SAWYER	1.7	Single Family
06CM005._1	18 CAMBRIDGE RD	ARMANDO & LINELL VILASECA	3	Single Family
06CM005._2	18 CAMBRIDGE RD	ARMANDO & LINELL VILASECA	3	Vacant Land
06CM004.	35 CAMBRIDGE RD	TOWN OF WESTFORD	14	Town-Owned: Town Garage and Fire Dept.

Source: Town of Westford Grand List, 2006.
Notes: Parcel acreage is from the Assessor's list. If data was unavailable, the value was left blank.
Path: O:\Proj-06\1854-W-Westford\Data\Westford_Project_Data.mdb [rptTable02_StudyAreaProperties]
Date/init: 10/18/07 anm

TABLE 2 (continued): Study Area Description

Parcel ID	Property Location	Owner or Contact Name	Acres	Property Description
06CM007.	42 CAMBRIDGE RD	LAURENT & DORIS LAVALEE	77.9	Single Family
05CC001.	16 CHACE LANE	STUART & CHRISTINA ASHLEY	10	Single Family
05VL014.	4 COMMON RD	DAVID & SUSAN ADAMS	0.3	Single Family
05VL012.	10 COMMON RD	KEVIN & SUZANNE KEARNS	0.5	Vacant Land
05VL010.	16 COMMON RD	BETH ALLEN	1	Single Family
05VL008.	20 COMMON RD	BERNARD & SHERYL FLEURY	13.8	Single Family
05VL006.	26 COMMON RD	NORMAN SPILLER	1.7	Single Family
06HU001.	4 HUNTLEY RD	HUGH & PHOEBE CLARK	1.1	Single Family
06HU003.	12 HUNTLEY RD	HUGH & PHOEBE CLARK	11.5	Camp
06CM006._1	2 OLD #11 RD	KENNETH & CHRISTINE O'DONNELL	7	Single Family
06CM006._2	2 OLD #11 RD	KENNETH & CHRISTINE O'DONNELL	7	Vacant Land
06EL004.	39 OLD #11 RD	RICHARD LAVALLEE	2.45	Single Family
06OS006.	1246 OSGOOD HILL RD	ALEXANDER & ALLISON WEINHAGEN	0.7	Single Family
06OS004.	1248 OSGOOD HILL RD	THOMAS WOLFE & JANET JAFFE	0.65	Single Family
05PO001.	2 POST RD	CHERYL , EMIL & JEAN AHOKAS	1	Single Family
05PO002.	5 POST RD	EDWARD & FRANCIS VONTURKOVICH	10.06	Apartment and Post Office
05PO004.	6 POST RD	DAVID & PATRICIA KUHFAHL	31.2	Single Family
05PD001.	1760 VT Route 128	Paul Birnholz	5.4	Vacant Land
05PD003.	1760 VT Route 128	Paul Birnholz	6.2	Vacant Land
05TW056._1	1478 VT RT 128	DONALD & DALE POULIOT	265.5	Vacant Land
06OS001.	1601 VT RT 128	THEODORE LAVALLEE	3.49	Single Family
05TW054._1	1602 VT RT 128	ELAINE LAVALLEE REVOCABLE TRUST	102.7	Single Family

Source: Town of Westford Grand List, 2006.
Notes: Parcel acreage is from the Assessor's list. If data was unavailable, the value was left blank.
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Date/init: 10/18/07 anm

TABLE 2 (continued): Study Area Description

Parcel ID	Property Location	Owner or Contact Name	Acres	Property Description
05TW054._2	1602 VT RT 128	ELAINE LAVALLEE REVOCABLE TRUST	102.7	Vacant Land
06TW065.	1613 VT RT 128	PHILIP GUARE & SUSAN HOULE	3.9	Single Family
05TW063.	1621 VT RT 128	SHIRLEY & MADELINE MINOR	1.7	Single Family, 1 apartment
05TW054.B	1630 VT RT 128	DAVID MARK LAVALLEE	4.7	Vacant Land
05TW052.A	1640 VT RT 128	CHRISTOPHER & JESSICA SIMAYS		Single Family
05TW061.	1641 VT RT 128	BARTLETT & LINDA WILLEY	0.62	Single Family
05TW052.	1650 VT RT 128	CHRISTOPHER HOWARD & JOY ATWOOD-HOWARD	2	Single Family (rental)
06EL002.	1650 VT RT 128	ROGER LAVALLEE REVOCABLE TRUST	85	Vacant Land
05TW057.	1659 VT RT 128	RAYMOND BELAIR	0.79	Single Family
05TW050._1	1670 VT RT 128	TOWN OF WESTFORD	1.3	Town-owned: Vacant Land
05TW050._2	1670 VT RT 128	TOWN OF WESTFORD	1.3	Town-owned: Vacant Land
05TW055.	1671 VT RT 128	GREGORY & LESLEY LARSON	0.7	Single Family
05TW053.	1677 VT RT 128	PATRICIA INDOE	7.4	Single Family
05TW048.	1678 VT RT 128	SHIRLEY & MADELINE MINOR	1.2	Apartments: 3 units
05TW051.	1681 VT RT 128	IRA & LIVONA ALLEN	0.9	Single Family
05TW049.	1685 VT RT 128	BRICK MEETING HOUSE	0.056	Brick Meeting House
05TW047.	1689 VT RT 128	RICHARD & CHERYL SWANSON	0.9	Single Family
05TW045.	1691 VT RT 128	KEVIN & SUZANNE KEARNS	0.06	Store and Apartment
06CM002.	1693 VT RT 128	DOUGLAS FRINK & NORA SABO	0.5	Single Family
05CM001.	1695 VT RT 128	THOMAS & CHERYL DUNKLEY/ CHRISTOPHER & ANDREA MCBRIDE	0.32	Apartments: 4 units

Source: Town of Westford Grand List, 2006.
Notes: Parcel acreage is from the Assessor's list. If data was unavailable, the value was left blank.
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Date/init: 10/18/07 anm

TABLE 2 (continued): Study Area Description

Parcel ID	Property Location	Owner or Contact Name	Acres	Property Description
05TW043.	1705 VT RT 128	ROLAND & NETTIE PIGEON	3.3	Single Family
05VL001._1	1713 VT RT 128	TOWN OF WESTFORD	3.6	Town-owned: Office and Library
05VL001._2	1713 VT RT 128	TOWN OF WESTFORD	3.6	Town-owned: Town Common
05VL001._3	1713 VT RT 128	TOWN OF WESTFORD	3.6	Town-owned: West of Town Common
05TW041.X	1715 VT RT 128	MARY CAVANAUGH	0.6	Single Family
05TW039.	1723 VT RT 128	ROBERT VAUGHAN & DENISE BRICKELL	1.69	Single Family
05TW039.AX_1	1729 VT RT 128	JOEL & MARY FAY	11.41	Vacant Land
05TW039.AX_2	1729 VT RT 128	JOEL & MARY FAY	11.41	Single Family
05TW037.	1737 VT RT 128	ARTHUR VIGIL	0.6	Single Family
05TW046.	1738 VT RT 128	SUSAN SCHMIDT & THOMAS ORFEO	1.15	Single Family
05PO006.	1750 VT RT 128	MICHELLE & BRIAN MARTIN & CHRISTOPHER & ROSEMARY PERRY	15.62	Vacant Land
05TW035.	1760 VT RT 128	PAUL BIRNHOLZ	51.7	Vacant Land
05TW035.A	1797 VT RT 128	ELIZABETH WINTERS	10.63	Single Family
05WC002.A	20 WHITE CHURCH LANE	THOMAS & CHERYL DUNKLEY	1.25	Vacant Land
05WC002.B	20 WHITE CHURCH LANE	THOMAS & CHERYL DUNKLEY	0.75	Vacant Land
05CU002.	24 WHITE CHURCH LANE	THOMAS & CHERYL DUNKLEY	2.7	Single Family

Source: Town of Westford Grand List, 2006.
Notes: Parcel acreage is from the Assessor's list. If data was unavailable, the value was left blank.
Path: O:\Proj-06\1854-W-Westford\Data\Westford_Project_Data.mdb [rptTable02_StudyAreaProperties]
Date/init: 10/18/07 anm

Study of Community Wastewater Disposal Alternatives for the Town Center

Town of Westford, Vermont

TABLE 3

Summary of Soil Characteristics Regarding Onsite Wastewater Disposal Within Study Area

Series Name	Mapping Unit	Slope (Percent)		Water Table (Feet)		Hydric Soil	Depth to Bedrock (Inches)		Potential On-Site System Suitability	% Study Area
		Low	High	Low	High		Low	High		
Adams and Windsor loamy sands	AdA	0	5	6	6	N	60	60	Conventional Subsurface	0.0
Agawam fine sandy loam	AgA	0	5	6	6	N	60	60	Conventional Subsurface	0.4
Alluvial land	An	999	999	99.9	99.9	U	999	999	Not Ranked	0.7
Cabot extremely stony silt loam	CbD	3	25	0	2	Y	60	60	Filtrate + Mound w/Curtain Drain	1.7
Cabot stony silt loam	CaA	0	3	0	2	Y	60	60	Not Suited or 2 Year Time of Travel and/or Store + Dose	0.5
Colton and Stetson soils	CsD	20	30	6	6	N	60	60	Conventional Subsurface	1.8
Colton and Stetson soils	CsE	30	60	6	6	N	60	60	Conventional w/Excessive Slope or Permeability	0.2
Duane and Deerfield soils	DdA	0	5	1.5	3	N	60	60	Mound or Filtrate + At-grade	0.2
Duane and Deerfield soils	DdB	5	12	1.5	3	N	60	60	Mound or Filtrate + At-grade	0.1
Enosburg and Whately soils	EwA	0	3	0	1.5	Y	60	60	Not Suited or 2 Year Time of Travel and/or Store + Dose	0.2
Hadley very fine sandy loam	Hf	0	3	4	6	N	60	60	At-grade or Filtrate + Conventional	0.4
Hartland very fine sandy loam	HlE	25	60	6	6	N	60	60	Conventional w/Excessive Slope or Permeability	0.5
Hinesburg fine sandy loam	HnA	0	3	2	4	N	60	60	Mound or Filtrate + At-grade	0.3
Lyman-Marlow rocky loams	LmB	5	12	2	6	N	10	60	Filtrate + Mound w/Curtain Drain	0.0
Lyman-Marlow rocky loams	LmC	12	20	2	6	N	10	60	Filtrate + Mound w/Curtain Drain	1.8

Source: National Resource Conservation Service (NRCS), SEI Field Notes

STONE ENVIRONMENTAL, INC.

Notes: % Area was calculated using data from NRCS and Geographic Information Systems (GIS) by dividing the total area (acres) of each Series in the Service Area by the total area (acres) of the Service Area.

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Date/Initials: 10/16/07 anm

Study of Community Wastewater Disposal Alternatives for the Town Center
Town of Westford, Vermont
TABLE 3 (continued)
Summary of Soil Characteristics Regarding Onsite Wastewater Disposal Within Study Area

Series Name	Mapping Unit	Slope (Percent)		Water Table (Feet)		Hydric Soil	Depth to Bedrock (Inches)		Potential On-Site System Suitability	% Study Area
		Low	High	Low	High		Low	High		
Lyman-Marlow very rocky loams	LyD	5	30	2	6	N	10	60	Filtrate + Mound w/Curtain Drain	28.9
Lyman-Marlow very rocky loams	LyE	30	60	2	6	N	10	60	Not Suited	4.2
Marlow extremely stony loam	MeC	5	20	2	3.5	N	60	60	Mound or Filtrate + At-grade	0.1
Munson and Belgrade silt loams	MuD	12	25	0.5	3.5	N	60	60	Filtrate + Mound w/Curtain Drain	14.0
Munson and Raynham silt loams	MyB	2	6	0	2	Y	60	60	Not Suited or 2 Year Time of Travel and/or Store + Dose	16.7
Munson and Raynham silt loams	MyC	6	12	0	2	Y	60	60	Not Suited or 2 Year Time of Travel and/or Store + Dose	11.1
Peru extremely stony loam	PsC	0	20	1	2	N	60	60	Filtrate + Mound w/Curtain Drain	0.7
Peru stony loam	PeD	20	30	1	2	N	60	60	Filtrate + Mound w/Curtain Drain	0.2
Scantic silt loam	ScA	0	2	0	1	Y	60	60	Not Suited or 2 Year Time of Travel and/or Store + Dose	2.3
Scantic silt loam	ScB	2	6	0	1	Y	60	60	Not Suited or 2 Year Time of Travel and/or Store + Dose	3.0
Stetson gravelly fine sandy loam	StB	5	12	6	6	N	60	60	Conventional Subsurface	1.1
Stetson gravelly fine sandy loam	StC	12	20	6	6	N	60	60	Conventional Subsurface	2.9
Terrace escarpments, silty and clayey	TeE	999	999	99.9	99.9	U	999	999	Not Ranked	0.6
Winooski very fine sandy loam	Wo	0	3	1.5	3	N	60	60	Mound w/Curtain Drain or Filtrate + Mound	1.8

Source: National Resource Conservation Service (NRCS), SEI Field Notes

Notes: % Area was calculated using data from NRCS and Geographic Information Systems (GIS) by dividing the total area (acres) of each Series in the Service Area by the total area (acres) of the Service Area.

Path: O:\Proj-06\1854-W-Westford\Data\GISData\Spatial_Analysis\WW_Analysis.mdb[rptTableXX_SoilsSummary]

Date/Initials: 10/16/07 anm

Study of Community Wastewater Disposal Alternatives for Westford Town Center
Town of Westford, Vermont
Table 4: Permit Information Summary

Parcel ID	Permittee Name	Permit	Permit Date	Reason for Permit
05PO004.	Edward Von Turkovich	D-4-1341	2/21/1990	Retain Lot 6B, 2.05 acres, not improved. Part of EC-4-1411
05PO004.	Edward Von Turkovich	DE-4-1400	2/21/1990	Retain Lot 6C, 0.97 acres, not improved. Part of EC-4-1411
05PO002.	Edward Von Turkovich	EC-4-1411	2/21/1990	Four-lot subdivision, on-site water and septic. Retain 14.6 acres.
05PO002.	E.B. & F.J. Von Turkovich	PB-4-1303	2/21/1990	Construction of new post office
06CM007.	Clyde C. Drinkwine	EC-4-0035	1/17/1975	DENIAL-one lot subdivision denied for type and depth of soils not meeting the regulations
06CM006._1	Norman Spiller	EC-4-0250	9/10/1976	One-lot subdivision
06EL004.	Norman Spiller	EC-4-0301	8/10/1977	One-lot subdivision
06EL001.	Norman Spiller	DE-4-1666	10/22/1991	Convey 3 acre parcel with no acreage remaining
06EL001.	Clifford & June Ross	EC-4-2155	5/13/1998	Remove deferral DE-4-1666 for proposed 3 bdrm s.f.r.on 2.69 acres, on-site water and sewer
05BS003.	David M. Driscoll	HE-4-0076	7/6/1995	1 lot being 3+/- acres on-site water; privy to be replaced with septic system
06OS004.	Linda Rivers	HE-4-0083	9/13/1995	Single family dwelling on .65 acre parcel with onsite water & sewage disposal
06OS006.	Francis & Karen Benoit	HE-4-0084	9/13/1995	Single family dwelling on .56 acre parcel with onsite water & sewage disposal
06OS006.	Gretchen C. Perez	HE-4-0084-1	10/25/2001	Amend Homestead to 0.70 acre parcel with single family dwelling onsite water & sewage disposal
05BS001.	Steven Levinson	HE-4-0148	10/24/1996	Single family residence on 2 acres with on-site water and sewer.
05BS005.	Lisa Gail Friedman	HE-4-0164	5/1/1997	Single family dwelling on 9.7 acres with onsite water & septic
05CU002.	Tom & Cheryl Dunkley	HE-4-0364	8/7/2002	Single family dwelling with onsite water & sewage disposal on Lot 2 1.09 acre parcel.
06CM004.	Town of Westford	PB-4-0270		Construction of Town Highway Garage and office area
05BS009.	Westford Elementary School	PB-4-0324	5/23/1978	8 classroom addition, 2 bathrooms, 2 storage rooms, and subsurface disposal system
05BS009.	Westford School District	WW-4-0630	1/22/2001	Addition to school for gym and classroom space, on-site water & sewer; 5320 gpd
05BS009.	Westford School District	WW-4-0630-1	1/22/2001	Relocate water storage and water lines, add new floor drains, no increase in flows
05BS009.	Westford School District	WW-4-0630-2	12/18/2001	Relocate 5,000 gallon water storage tank outside of building, no changes to water or septic
05VL001._1	Town of Westford	WW-4-0877	7/20/1995	Drill new well for existing Town offices & Library, onsite sewage disposal
05TW049.	United Church of Westford	WW-4-1173	6/16/1998	Construct new onsite sewage disposal for Brick Meeting House
05TW049.	Brick Meeting House Soc. of VT	WW-4-1173-R	6/16/1998	Amended permit to correct wrong date noted on the plans
05TW039.	Joel, Mary, William & Jeanne Fay	WW-4-1965	10/1/2003	Boundary line adjustment for Lot #1, existing single family dwelling, onsite water and sewer
05TW039.	William & Vanessa Smith	WW-4-1965-1	7/8/2005	Construct replacement system using Septitech instead of Advantex for a failed system on Lot #1
05CU002.	Thomas & Cheryl Dunkley	WW-4-2409	8/22/2005	Two-lot subdivision (one existing 3-BR home, one proposed 4-BR home) onsite water and sewer
05TW035.	Paul Birnholz	WW-4-2419	7/21/2005	3 lot subdivision, all with onsite water and sewer

Source: Review of Vermont Dept. of Environmental Conservation permits, September 2007.

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Notes: D or DE = Deferral of permit; EC = Subdivision permit; HE = Homestead Exemption; PB = Public Building Permit; WW = Wastewater System and Potable Water Supply Permit

Path: O:\Proj-06\1854-W Westford WW Feasibility Study\Data\Permits\Westford-WWPermitsSummary.xls

Date: 9/11/2007, anm

Study of Community Wastewater Disposal Alternatives for the Town Center

Town of Westford, Vermont

TABLE 5: Summary of Needs Assessment Results

Description:

47 Single Family Residences
1 Camp
5 Apartments
10 Public Properties
16 Vacant Properties

79 Properties Total

Water Supplies:

40 Individual Drilled Wells
7 Individual Dug (Shallow) Wells
1 Property Using a Shared Drilled Well
1 Property Using a Public Drilled Well
13 Unknown Water Supplies

Factors Affecting Recommended Solutions:

Factor	Number of Properties Affected	% of Tota
Limited Available Area Only	5	6%
Proximity to Water Supply Wells	5	6%
Proximity to Surface Water	4	5%
Proximity to Steep Slopes	0	0%
Shallow Seasonal Groundwater Only	19	24%
Shallow Seasonal Groundwater and		
Limited Available Area	12	15%
Proximity to Water Supply Wells	11	14%
Proximity to Surface Water	9	12%
Proximity to Steep Slopes	0	0%
Shallow Bedrock Only	0	0%
No Restrictions	42	54%

Recommended Solutions:

42 Properties Recommended for an Onsite Solution
36 Properties May Need Offsite Solutions

Source: Stone field notes; Survey results; Town Grand List data table; parcel GIS database
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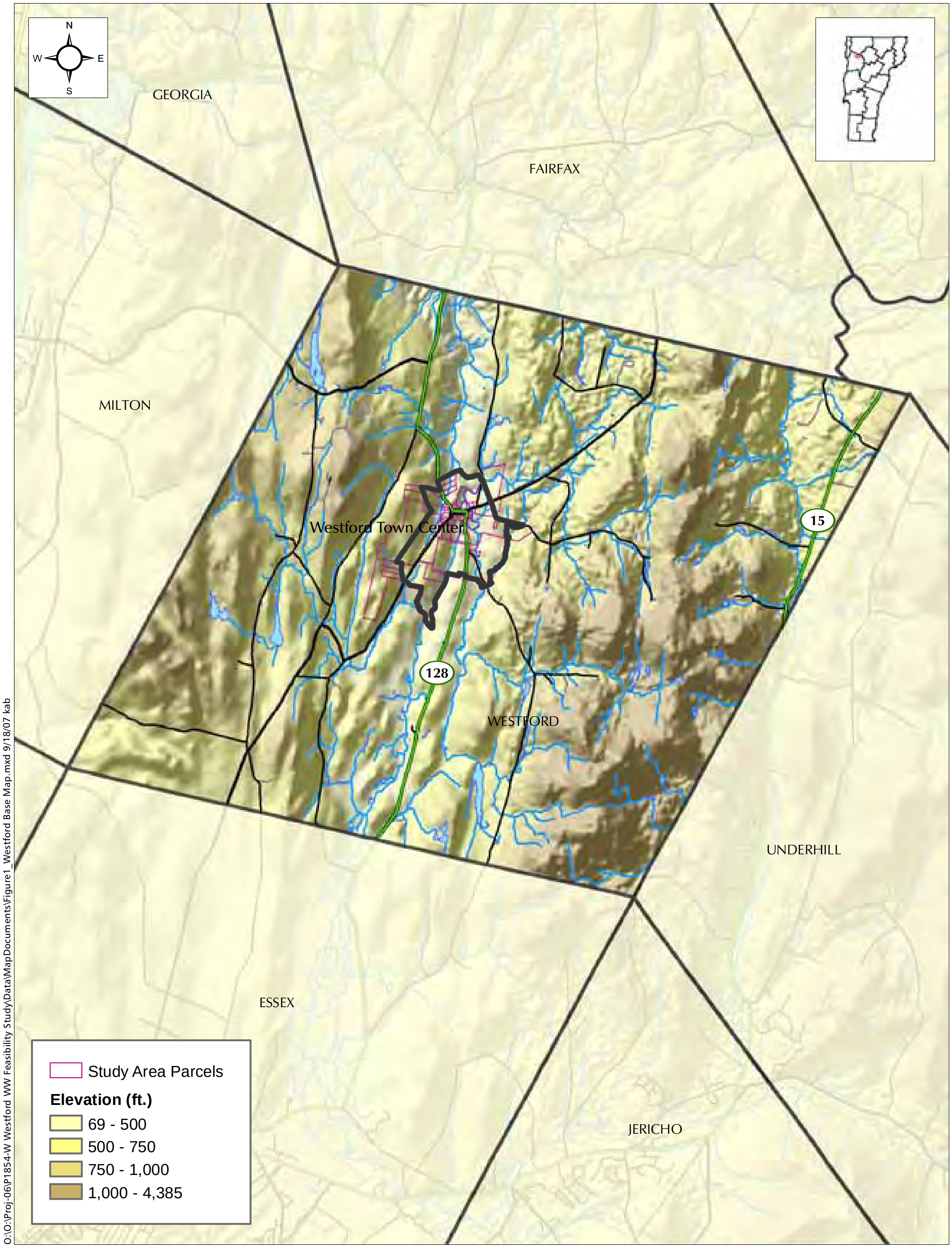

O:\O:\Proj-06\P1854-W Westford WW Feasibility Study\Data\MapDocuments\Figure1_Westford Base Map.mxd 9/18/07 kab

FIGURE 1: STUDY AREA

Study of Community Wastewater Disposal Alternatives for Westford Town Center, Vermont

Sources: Hydrography, VCGI, 2003; Roads, VCGI, 2003; Digital Elevation Model, VCGI, 2001; Town Boundaries, VCGI, 2001; Parcel Boundaries, Informational & Visualization Services, 2002; Watershed Boundaries, VGIS, 2004.

0 1 2 Miles

Scale

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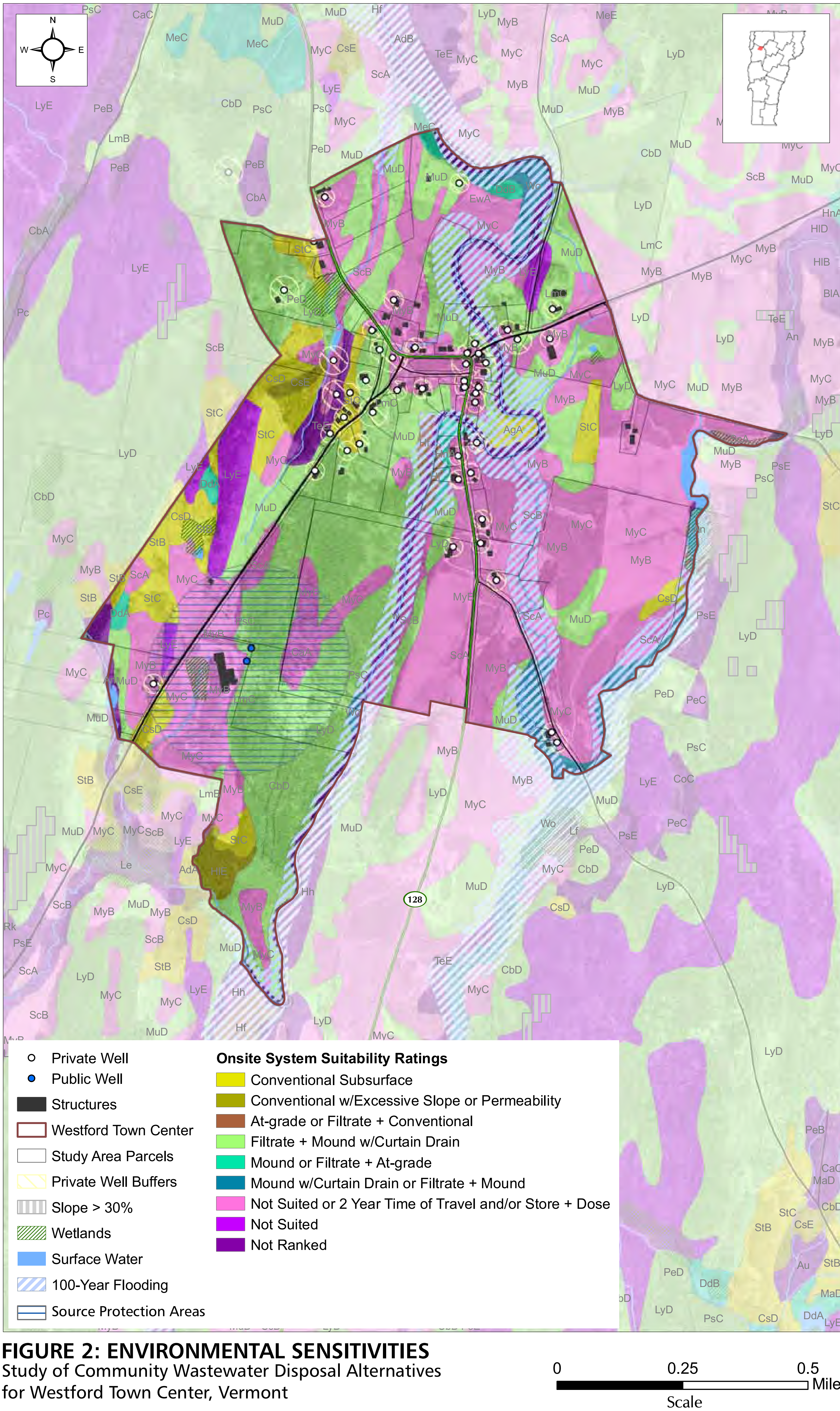

O:\O:\Proj-06\P1854-W Westford WW Feasibility Study\Data\MapDocuments\Figure2_Westford Enviro Sensitivity Map.mxd 10/16/07 kab

FIGURE 2: ENVIRONMENTAL SENSITIVITIES

Study of Community Wastewater Disposal Alternatives for Westford Town Center, Vermont

Sources: Hydrography, VCGI, 2003; Roads, VCGI, 2003; Digital Elevation Model, VCGI, 2001; Parcel Boundaries, IVS, 2002; Onsite System Suitibility, SEI, 2007; Map Unit Symbols, NRCS, 2004.

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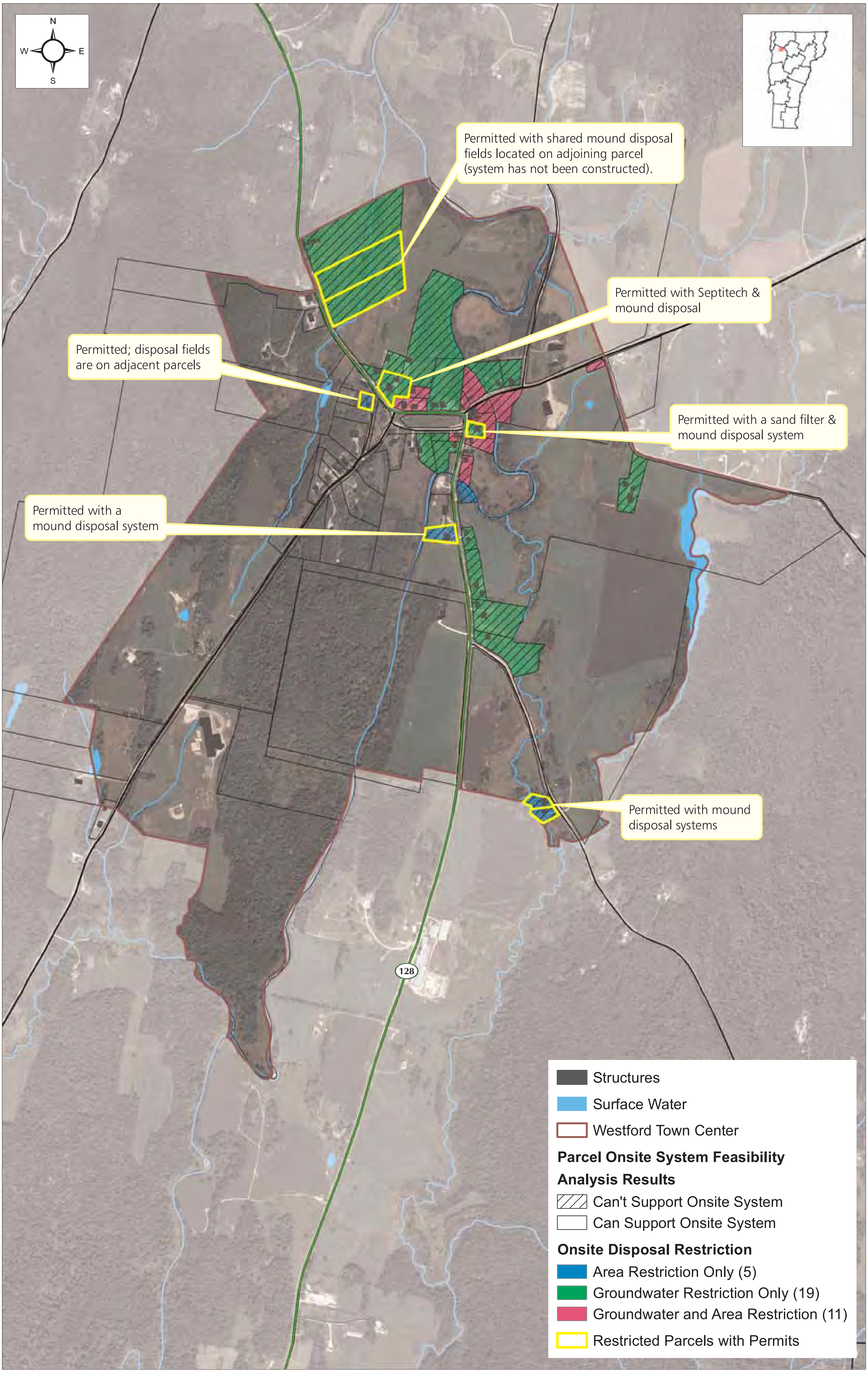

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FIGURE 3: ONSITE DISPOSAL SYSTEM SUITABILITY RESTRICTIONS

Study of Community Wastewater Disposal Alternatives for Westford Town Center, Vermont

0 0.25 0.5 Miles

Scale

Sources: Hydrography, VCGI, 2003; Roads, VCGI, 2003;
Parcel Boundaries, IVS, 2002; Onsite System Suitibility, SEI, 2007; Map Unit Symbols, NRCS, 2004.

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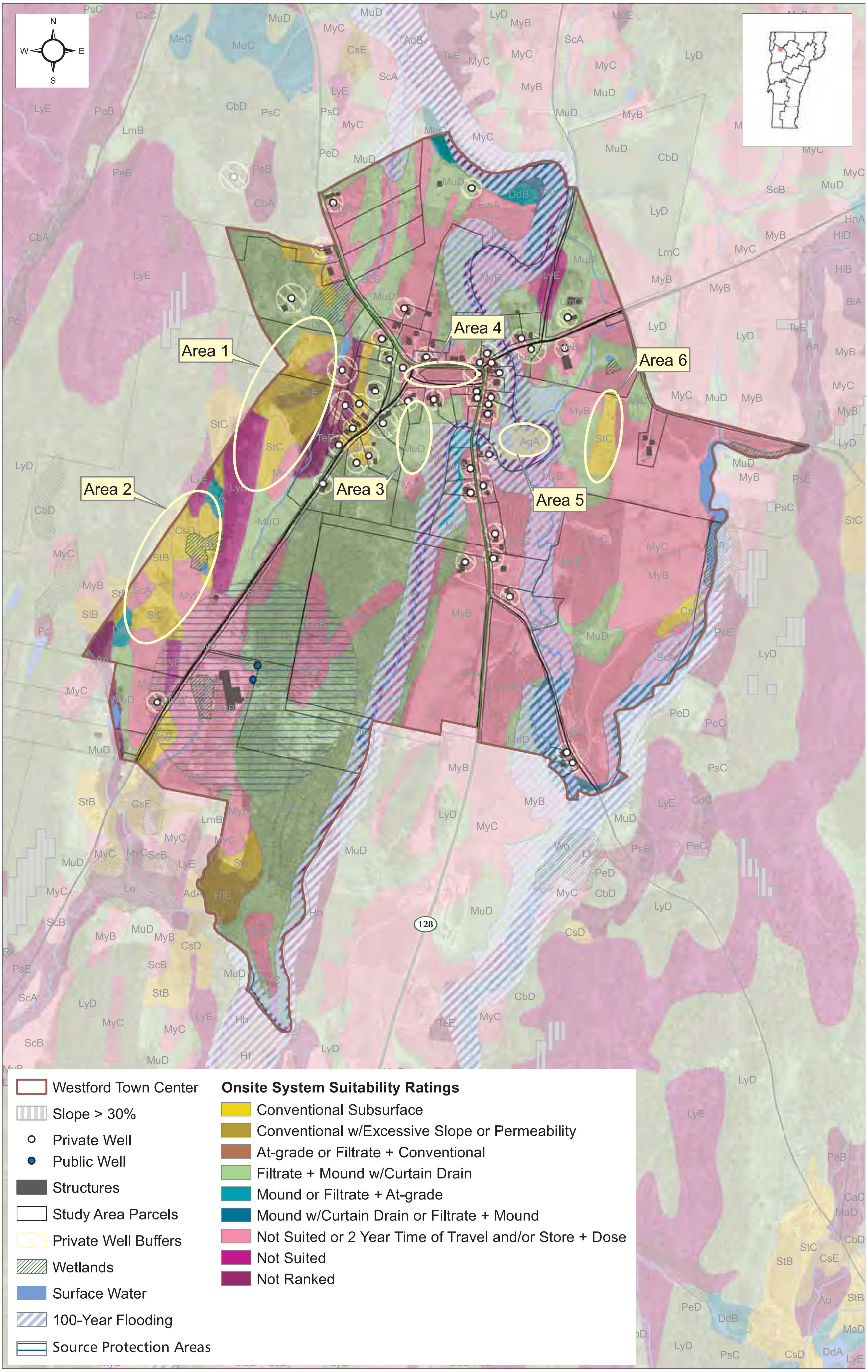

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FIGURE 4: POTENTIAL COMMUNITY WASTEWATER DISPOSAL SITES

Study of Community Wastewater Disposal Alternatives
for Westford Town Center, Vermont

0 0.25 0.5 Miles
Scale

Sources: Hydrography, VCGI, 2003; Roads, VCGI, 2003; Digital Elevation Model, VCGI, 2001; Parcel Boundaries, IVS, 2002; Onsite System Suitibility, SEI, 2007; Map Unit Symbols, NRCS, 2004.

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APPENDIX A WESTFORD WASTEWATER COMMITTEE MEMBERS

Seth Jensen
Tom Orfeo
Dave Tilton
Paul Birnholz
Ben Ware
Douglas Frink

APPENDIX B HANDOUTS FROM PUBLIC MEETINGS

Study of Community Wastewater Disposal Alternatives for the Westford Town Center

Presented by: Amy Macrellis, Stone Environmental Inc.

September 20, 2007

Objectives of presentation

- What are septic systems
- How do they affect public health and the environment
- What are the soils and site requirements
- What are the local and state regulations
- Current results and next steps in study

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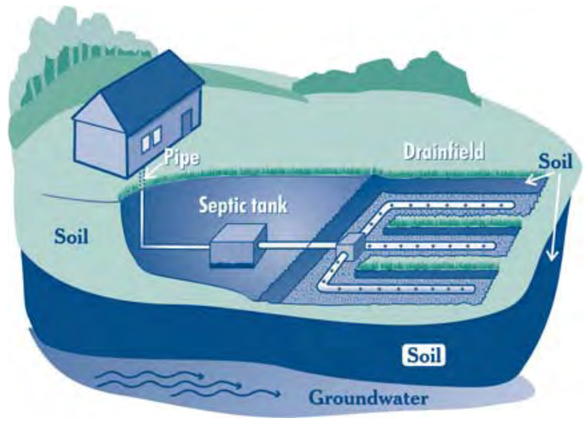
Traditional onsite system



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Benefits of soil absorption systems

- Treatment and dispersal close to source
- Resilient to variable flows and wastewater content
- Minimize costs
  - Use existing investment in functioning systems
  - Avoid costs of new sewer lines
- Safe and effective when properly designed and managed
- Recharge local groundwater

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Potential public health & environmental impacts

- Exposures to surfacing sewage, discharging of poorly treated sewage
- Pathogens, risk of disease
- Beach closures, swimming exposures
- Drinking water supplies (drilled and shallow wells)

Health risks from exposure to untreated wastewater

- Infectious Organisms (Disease)
  - Bacteria
    - Fecal coliform, *E. coli* (gastroenteritis)
    - Others (e.g., cholera)
  - Viruses
    - Hepatitis A (infectious hepatitis)
    - Others
  - Protozoa
    - Cryptosporidium
    - Giardia (giardiasis)
    - Others

System constraints based on current regulations

- Setbacks
  - Surface waters and wetlands
  - Drinking water wells
  - Water lines
- Soils
  - Depth to seasonal high groundwater table
  - Depth to impervious soils
  - Depth to bedrock

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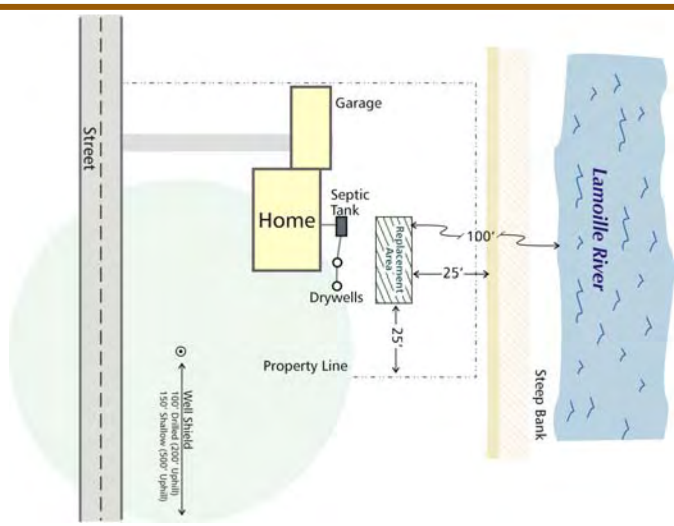
Typical lot layout with well



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Types of decentralized wastewater systems

- Seepage Beds and Leach Trenches
- Drywells
- At-grade and Mound Systems
- Sand Filters and Other Alternative Systems
- Shared or Cluster Systems

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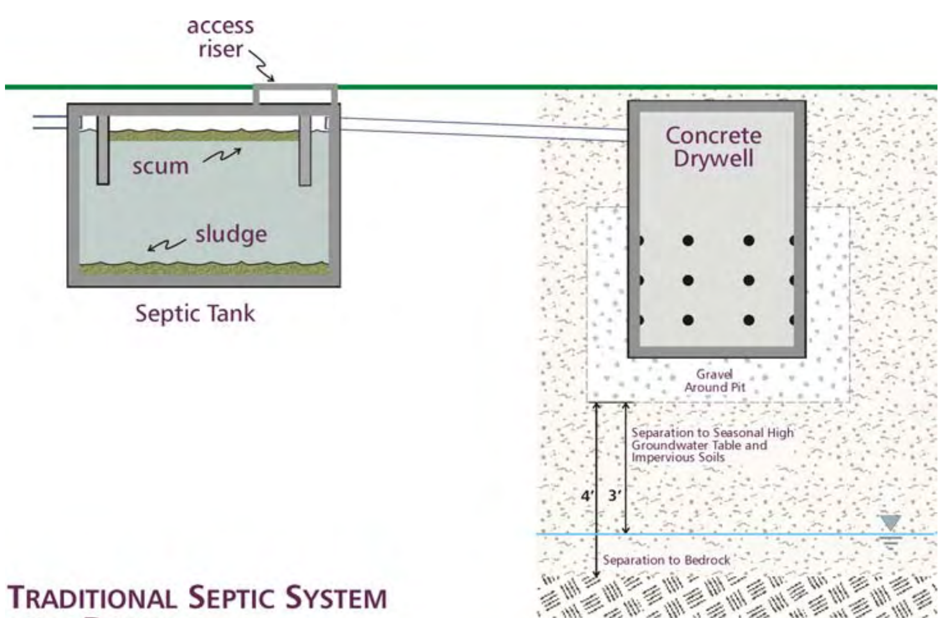

TRADITIONAL SEPTIC SYSTEM WITH DRYWELL

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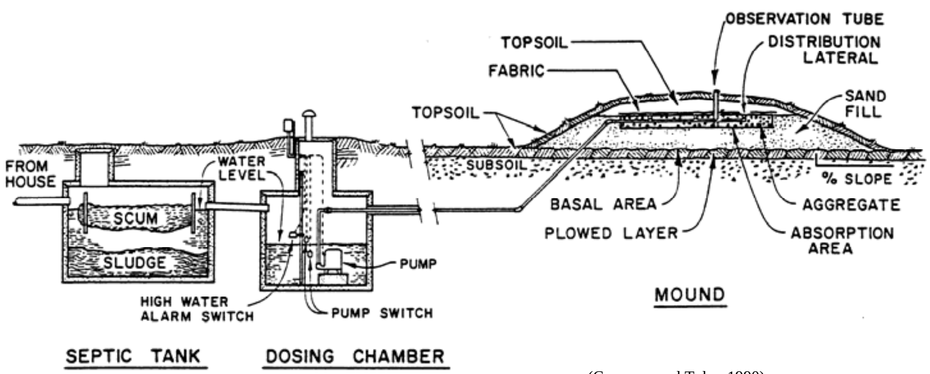
Mound system



(Converse and Tyler, 1990)

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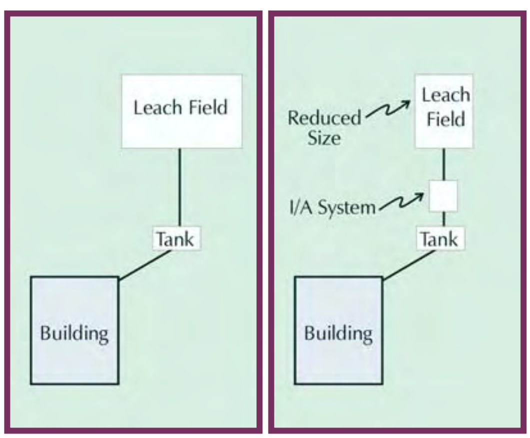
Beyond the Mound

- Traditional septic system
- Alternative system
  - when to use?
  - allowable alternative systems
  - part of management plan



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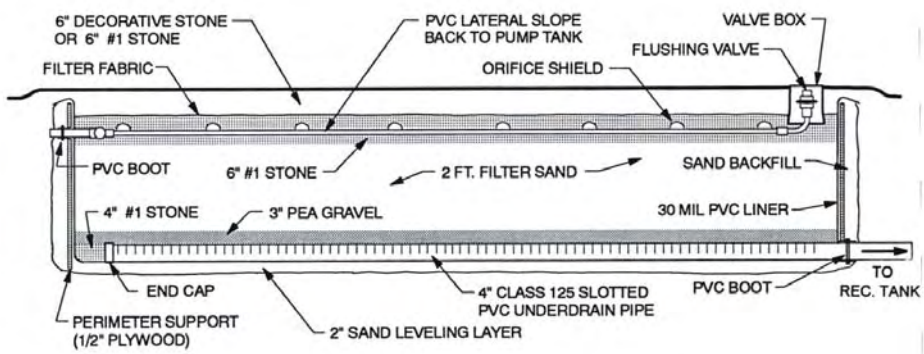
Sand filter



(Converse 1999, adapted from Orenco)

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Approved alternative systems

- Sand filters
- Constructed wetlands
- Avantex geotextile filter
- Ecoflo and Puraflo peat biofilters
- Several aerobic treatment units
- Enviro-Septic and Infiltrator leaching systems

- Disposal field can be ½ the size of conventional septic tank system
- Separation distance to groundwater can be reduced
- Systems don't work if they are not maintained

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Town regulations

- Westford Zoning Ordinance
- Construction or change of use requires a zoning permit
- State permits must be approved before zoning permit is issued
- Water Resources Overlay District establishes stricter protection than State wastewater disposal rules

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Vermont Department of Environmental Conservation

- Regional Office in Essex
  - Environmental Protection Rules (EPRs) are for systems smaller than 6,500 gallons per day
- Water Supply Division in Waterbury
- Indirect Discharge Section in Waterbury for larger systems

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EPR new rule changes

- New rules effective September 29, 2007
- “Universal permitting”—no more exemptions
- “Clean Slate”—grandfathers working wells and systems built before January 1, 2007
- Site and Design Changes
  - Constructed wetlands and drip irrigation allowed
  - Minimum design flow = 2 bedrooms (was 3)
  - No replacement area required for mounds

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Want to replace your system?

- Determine what permits are needed at town & state levels
- Hire a licensed site designer or professional engineer
- Coordinate field work with town/state
- Submit plans & application
- Construct/inspect system

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Elements of this study

- Collect and review available information
- Property owner survey questionnaire
- GIS analysis and lot-by-lot review
- Identify properties that may benefit from an offsite system connection
- Identify potential cluster system sites
- Preliminary engineering layouts and cost estimates

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Some possible outcomes of study

- Do nothing
- Encourage owners to maintain systems
- Find off-site solutions for properties with limited or no onsite capacity

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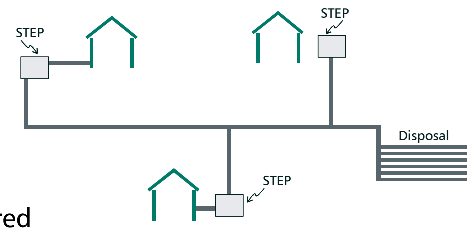
A few off-site replacement options

- Collection Systems
  - STEP systems
  - Grinder pumps
- Treatment Systems
  - Depending on size if required
  - Sand filter, other alternative systems
- Disposal Systems
  - <6,500 gpd (Environmental Protection Rules)
  - >6,500 gpd (Indirect Discharge Rules)



Questions and Answers

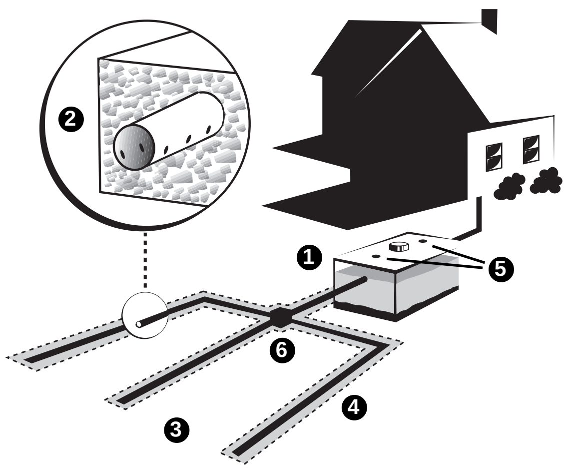
APPENDIX C BROCHURES FOR PROPERTY OWNERS ABOUT MAINTAINING WASTEWATER SYSTEMS

So . . . now you own a septic system

More than 25 million homes, encompassing almost 25 percent of the U.S. population, dispose of domestic wastewater through onsite (unsewered) systems. According to the American Housing Survey for the United States, in 1993 1.5 (million) out of every 4 (million) new owner-occupied home starts relied upon a form of onsite sewage disposal.

One of the major differences between owning an unsewered versus a sewered home is that unsewered wastewater treatment and disposal systems must be maintained by the homeowner. Treatment and disposal of wastewater should be one of the primary concerns of any homeowner in an unsewered area.

The most common way to treat and dispose of wastewater in rural homes is through the use of an onsite disposal system. The majority of onsite disposal systems in the United States are septic systems.



1. septic tank
2. 4” perforated pipe
3. absorption field
4. crushed rock or gravel lined trench
5. inspection ports
6. distribution box

Typical Septic System Fig. 1

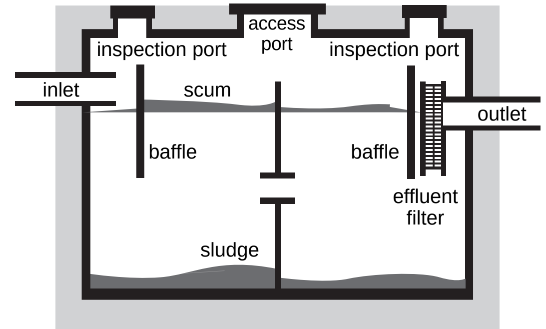
HOW IT WORKS

A typical septic system contains two major components: a septic tank and the absorption field (see Figure 1). Often, a distribution box is included as part of the system to separate the septic tank effluent evenly into a network of distribution lines that make up the absorption field. The septic tank is usually made of concrete, fiberglass, or plastic, is typically buried and should be watertight. All septic tanks have baffles (or tees) at the inlet and outlet to insure proper flow patterns (see Figure 2). Most septic tanks are single compartment; however, a number of states require two-compartment tanks or two single compartment tanks in series.

While typically designed to hold a minimum of 750–1000 gallons of sewage, the size of the tank may vary depending upon the number of bedrooms in the home and state and local regulatory requirements. The primary purpose of the septic tank is to separate the solids from the liquids and to promote partial breakdown of contaminants by microorganisms naturally present in the wastewater. The solids, known as sludge, collect on the bottom of the tank, while the scum floats on the top of the liquid. The sludge and scum remain in the tank and should be pumped out periodically (see Figure 2).

Solids that are allowed to pass from the septic tank may clog the absorption field. Keeping solids out of the absorption field not only prevents clogging, but also reduces potentially expensive repair or replacement costs and helps ensure the ability of the soil to effectively treat the septic tank effluent. Therefore, an additional safeguard in keeping solids out of the absorption field is the use of effluent filters on the outlet of the septic tank (see Figure 2).

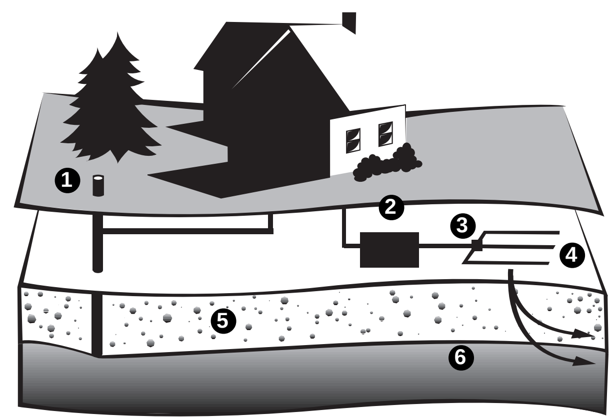
The wastewater (effluent) coming out of the septic tank may contain many potentially disease-causing microorganisms and pollutants (i.e., nitrates, phosphates, chlorides). The effluent is passed on to the absorption field through a connecting pipe or distribution box. The absorption field is also known as the soil drainfield, the disposal field, or the leachfield. The absorption field contains a series of underground perforated pipes, as indicated in Figure 1, that are



Cross-section of a two-compartment septic tank
Fig. 2

sometimes connected in a closed loop system, as illustrated on the front cover, or some other proprietary distribution system

The effluent is distributed through the perforated pipes, exits through the holes in the pipes, and trickles through the rock or gravel where it is stored until absorbed by the soil. The absorption field, which is located in the unsaturated zone of the soil, treats the wastewater through physical, chemical, and biological processes. The soil also acts as a natural buffer to filter out many of the harmful bacteria, viruses, and excessive nutrients, effectively treating the wastewater as it passes through the unsaturated zone before it reaches the groundwater (see Figure 3).



1. drinking water well
2. septic tank
3. distribution box
4. absorption field
5. soil absorption (unsaturated zone)
6. groundwater (saturated zone)

Wastewater treatment and disposal in soil Fig. 3

Wastewater contains nutrients, such as nitrates and phosphates, that in excessive amounts may pollute nearby waterways and groundwater supplies. Excessive nutrients in drinking water supplies can be harmful to human health and can degrade lakes and streams by enhancing weed growth and algal blooms. However, the soil can retain many of these nutrients, which are eventually taken up by nearby vegetation.

What to Put In, What to Keep Out

- Direct all wastewater from your home into the septic tank. This includes all sink, bath, shower, toilet, washing machine and dishwasher wastewaters. Any of these waters can contain disease-causing microorganisms or environmental pollutants.
- Keep roof drains, basement sump pump drains, and other rainwater or surface water drainage systems away from the absorption field. Flooding of the absorption field with excessive water will keep the soil from naturally cleansing the wastewater, which can lead to groundwater and/or nearby surface water pollution.
- Conserve water to avoid overloading the septic system. Be sure to repair any leaky faucets or toilets. Use low-flow fixtures.
- Do not use caustic drain openers for a clogged drain. Instead, use boiling water or a drain snake to open clogs.
- Do not use septic tank additives, commercial septic tank cleansers, yeast, sugar, etc. These products are not necessary and some may be harmful to your system.
- Use commercial bathroom cleaners and laundry detergents in moderation. Many people prefer to clean their toilets, sinks, showers, and tubs with a mild detergent or baking soda.

continued . . .

- Check with your local regulatory agency if you have a garbage disposal unit to make sure that your septic system can accommodate this additional waste.

- Check with your local regulatory agency before allowing water softener backwash to enter your septic tank.

- Your septic system is not a trash can. Do not put grease, disposable diapers, sanitary napkins, tampons, condoms, paper towels, plastics, cat litter, latex paint, pesticides, or other hazardous chemicals into your system.

- Keep records of repairs, pumpings, inspections, permits issued, and other system maintenance activities.

- Learn the location of your septic system. Keep a sketch of it handy with your maintenance record for service visits.

- Have your septic system inspected every 1–2 years and pumped periodically (usually every 3–5 years) by a licensed inspector/contractor.

- Plant only grass over and near your septic system. Roots from nearby trees or shrubs may clog and damage the absorption field.

- Do not drive or park over any part of your septic system. This can compact the soil and crush your system.

In summary, understanding how your septic system works and adhering to these few simple rules will ensure that your septic system is a safe and economical method for treating and disposing of your wastewater onsite.

For more information regarding the care of your septic system, contact your local health department.

More information about septic systems is available from the National Small Flows Clearinghouse (NSFC) through other brochures in this series:

Groundwater protection and your septic system, Item #**WWBRPE21**

The care and feeding of your septic system, Item #**WWBRPE18**

For more information about this or other NSFC products, please contact us by writing to:
National Small Flows Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
or phone:
(800) 624-8301, (304) 293-4191
or fax: (304) 293-3161

www.nsfc.wvu.edu

Helping America's small communities meet their wastewater needs

So . . . now you own a septic system

One in a series of three brochures designed to aid you in caring for your septic system.

Helping America's small communities meet their wastewater needs

The care and feeding of your septic system

Septic systems are very much like automobiles. They need periodic inspections and proper maintenance to continue working properly. Also, like automobiles, they must be operated properly and cannot be overtaxed without the owner suffering consequences such as repair or replacement bills.

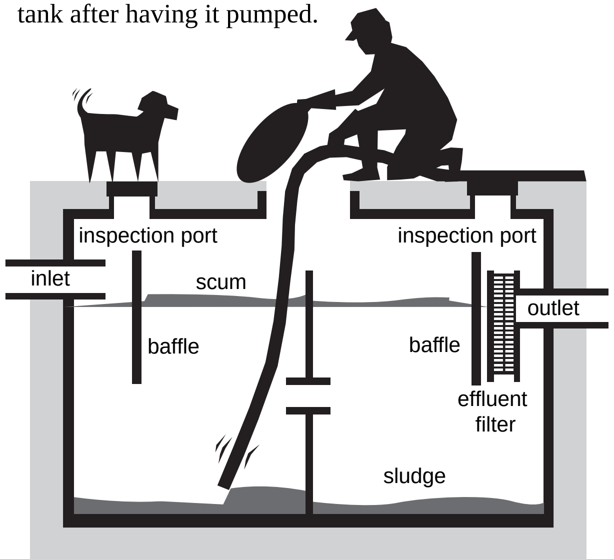
Often overlooked or neglected is the fact that a septic system should have a regular check-up to prevent problems. You should have your septic system inspected every 1-2 years by a professional and your tank pumped when necessary. The septic tank traps the solids in the wastewater and should be checked to determine whether or not it is time for it to be pumped out. The inspection port should be opened and the baffles (internal slabs or tees) should be checked to ensure that they are in good condition since the last check-up (see Figure 1). If you have a septic tank effluent filter, it should also be inspected. Effluent filters require periodic cleaning. Some filters are now equipped with alarm systems to alert the homeowner when the filter has become dirty and needs to be cleaned. Failure to keep the filter clean may result in a backup of wastewater in the home from a clogged filter. Septic systems that have mechanical parts such as a pump should be inspected at least once a year or more frequently as recommended by the manufacturer. The absorption field should be checked for sogginess or ponding, which indicates improper drainage, a clogged system, or excessive water use. The presence of damp or soggy areas or odors may indicate a leak in the system.

SEPTIC TANK

A properly designed septic system will have a septic tank with sufficient volume to accumulate solids for several years. As the level of solids rises in the tank, the wastewater has less time to settle properly and suspended solid particles flow into the absorption field. If the tank is not periodically pumped out, these solids will eventually clog the absorption field to the point where a new field will be needed.

When the tank is pumped, the contractor should pump the contents through the manhole, which is usually located in the center of the tank, rather than through the inspection ports. Pumping through one of the inspection ports could damage the baffles inside the tank (see Figure 1). Damage to the baffles could result in the wastewater flowing directly into the absorption field without the opportunity for the solids to settle.

Remember, commercial septic tank additives do not eliminate the need for periodic pumping and may be harmful to the absorption field. You should check your local health department regulations before using additives. Be sure when the septic tank is pumped that it is completely emptied. It is not necessary to retain any of the solids to restart the digestive process. You do not need biological or chemical additives for successful restart or continuous operation of your septic system, nor should you wash or disinfect the tank after having it pumped.



Cross-section of a two-compartment septic tank being pumped **Fig. 1**

When to Have Your Septic Tank Pumped

A specific determination of when it's time to pump out the solids can be made by having the depth of solids and level of scum buildup on top of the wastewater in the septic tank checked periodically. Two factors affect how often you should have your septic tank pumped. Whether you need to have your tank pumped every year, once every five years, or some other time interval is affected by these factors. The first factor is the size or capacity of the tank itself. If more people are living in the home than when the system was installed, or if new high water use appliances or technologies such as a hot tub or whirlpool bath are now in use, then the capacity may be too small. The more people using a system, the faster the solids will accumulate in the tank, and the more frequently the tank will need to be pumped. Also, the additional surge of water from hot tubs and whirlpool baths may wash solids out of the tank and into the absorption field. An inspection can determine whether the system is of adequate capacity to handle the volume of solids and flow from the number of people in the household and types of appliances used. A larger capacity system provides better treatment and requires less pumping.

The second factor is the volume of solids in the wastewater. If you have a garbage disposal, for example, you will have to pump out your system more frequently than persons disposing of their food wastes through other means. The use of a garbage disposal may increase the amount of solids in the septic tank by as much as 50 percent. Excessively soiled clothes may add solids to your septic tank. Sometimes, geographical location may also contribute to extra solids ending up in the septic tank. For example, systems in coastal areas may have an accumulation of sand in the septic tank from washing beach clothes.

Reducing the Flow of Wastewater

Generally, the more people, the more water will flow through the system. However, the use of water conservation devices such as low-flow toilets or shower fixtures greatly reduces the amount of wastewater thus prolonging the life of your septic system. For example, up to 53 gallons of water are discharged into your system with each load of laundry. If several loads are done in one day, it can put considerable stress on your system. A better practice would be to space your laundry washing throughout the week.

The new ultra low-flush toilets use between 1 and 1.6 gallons of water per flush and will provide as much as a 30 percent water savings. Low-flow faucet aerators on sink faucets and low-flow showerheads will save additional water. There are also low-flow washing machines which use much less water than standard washing machines.

ABSORPTION FIELD

An absorption field generally does not require any maintenance. However, to protect and prolong the life of the absorption field, follow these simple rules:

- Plant only grass over and near your septic system. Roots from nearby trees or shrubs may clog and damage the absorption field.
- Do not drive or park over any part of your septic system. This can compact the soil and crush your system.
- Direct all wastewater from your home into the septic tank. This includes all sink, bath, shower, toilet, washing machine and dishwasher wastewaters. Any of these wastewaters can contain disease-causing microorganisms or environmental pollutants.
- Keep roof drains, basement sump pump drains, and other rainwater or surface water drainage systems away from the absorption field. Flooding of the absorption field with excessive water will keep the soil from naturally cleansing the wastewater, which can lead to groundwater and/or nearby surface water pollution.

continued . . .

Septic System Health Tips

What you put into your septic system will have a direct effect on whether or not you have a healthy, long-lasting and trouble-free system. Your septic system is not a dispose-all.

- Conserve water to avoid overloading the septic system. Be sure to repair any leaky faucets or toilets. Use low-flow fixtures.
- Do not use caustic drain openers for a clogged drain. Instead, use boiling water or a drain snake to open clogs.
- Do not use septic tank additives, commercial septic tank cleansers, yeast, sugar, etc. These products are not necessary and some may be harmful to your system.
- Use commercial bathroom cleaners and laundry detergents in moderation. Many people prefer to clean their toilets, sinks, showers, and tubs with a mild detergent or baking soda.
- Check with your local regulatory agency if you have a garbage disposal to make sure that your septic system can accommodate this additional waste.
- Check with your local regulatory agency before allowing water softener backwash to enter your septic tank.
- Your septic system is not a trash can. Do not put disposable diapers, sanitary napkins, tampons, condoms, paper towels, facial tissues, plastics, cat litter, or cigarettes into your septic system. These items quickly fill your septic tank with solids, decrease the efficiency, and will require that you pump out the septic tank more frequently. They may also clog the sewer line to the septic system causing wastewater to back up into your home.
- Avoid dumping grease or fats down your kitchen drain. They solidify and the accumulation may contribute to blockages in your system.
- Keep latex paint, varnishes, thinners, waste oil, photographic solutions, pesticides, or other hazardous chemicals out of your system. Even in small amounts, these items can destroy the biological digestion taking place within your septic system.

Septic systems are a very simple way to treat household wastewater and are easy to operate and maintain. Although homeowners must take a more active role in maintaining septic systems, once they learn how their systems work, it is easy for them to appreciate the importance of a few sound operation and maintenance practices.

For more information regarding the care of your septic system, contact your local health department.

More information about septic systems is available from the National Small Flows Clearinghouse (NSFC) through other brochures in this series:

Groundwater protection and your septic system,
Item #**WWBRPE21**

So . . . now you own a septic system,
Item #**WWBRPE20**

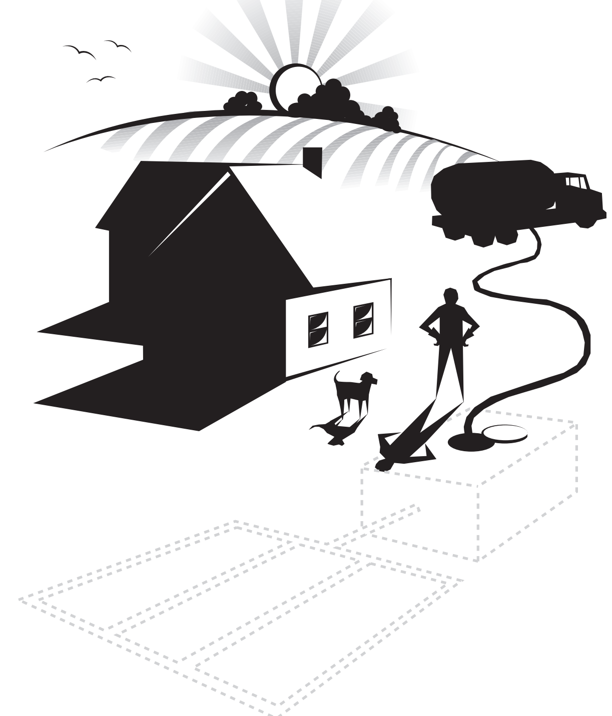
For more information about this or other NSFC products, please contact us by writing to:
National Small Flows Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
or phone:
(800) 624-8301, (304) 293-4191
or fax (304) 293-3161

www.nsfc.wvu.edu

Helping America's small communities meet their wastewater needs

The care and feeding of your septic system

One in a series of three brochures designed to aid you in caring for your septic system.

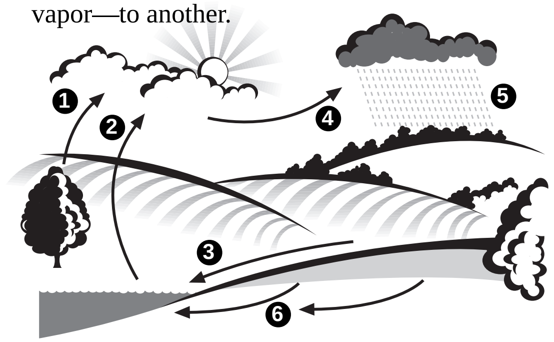


Helping America's small communities meet their wastewater needs

Groundwater protection and your septic system

WHAT IS GROUNDWATER?

Water in the saturated zone beneath the soil surface is commonly referred to as *groundwater*. Groundwater is but one stage, or form, through which water passes in the earth's *hydrologic cycle* (see Figure 1). The hydrologic cycle is the continual movement of water over, in, and through the earth and its atmosphere as it changes from one form—solid, liquid, or vapor—to another.



1 evapotranspiration
2 evaporation
3 runoff
4 water-vapor transport
5 precipitation
6 groundwater flow

Hydrologic cycle **Fig. 1**

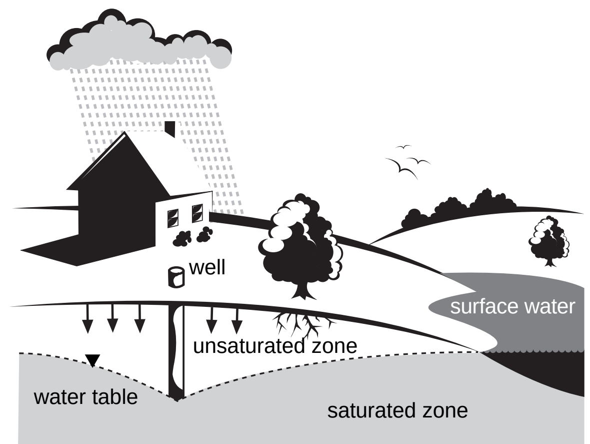
The water you use today may have evaporated from an ocean, traveled through the atmosphere, fallen back to the earth's surface, gone underground, and flowed through streams leading back to the oceans. Water is readily visible in many forms, including clouds, rain, snow, fog, lakes, streams, oceans, and polar ice caps. However, groundwater located beneath the soil surface is a vital resource for the success and survival of the entire ecosystem.

Groundwater has been tapped for thousands of years, but only recently have we started to understand its importance and how to manage this precious resource. Much remains to be discovered about groundwater, and wider public awareness of its nature and properties is an important first step.

Recharge

The process by which water—from rainfall, snowmelt, and other sources—flows into a water-bearing geologic formation (aquifer) is known as *recharge*. Water first passes through the *unsaturated zone*, where soil pores are filled partly with air and partly with water. The water then flows downward through the unsaturated zone into the *saturated zone*, where the soil pores are completely filled with water.

The boundary between these two zones is called the *water table* (see Figure 2). The water table rises when water enters the saturated zone and falls when water is discharged from the saturated zone either naturally (e.g., springs, lakes, or rivers) or by pumping (e.g., wells).



Water table **Fig. 2**

The unsaturated zone is important to the groundwater underlying it. As incoming water seeps down through the unsaturated zone, impurities are removed, helping to cleanse the water. Both the quantity and quality of groundwater is affected by the condition of the unsaturated zone in a recharge area.

SEPTIC SYSTEMS

A properly designed, installed, and maintained septic system poses no threat to groundwater. However, inadequately functioning and/or failing septic systems can contribute to the contamination of groundwater. Wastewater from septic systems may include many types of contaminants, such as nitrates, harmful bacteria, and viruses.

Trace amounts of metals may be contributed to the system from persons using some medications. Also, commonly used chemical substances, such as pesticides, paints, varnishes, and thinners, can contaminate the groundwater if they are not disposed of properly. Some chemicals, even in small amounts, can be dangerous to both the environment and public health.

Through physical, chemical, and biological processes, the soil acts as a natural buffer to remove bacteria and viruses in the unsaturated zone. However, various geologic conditions, such as fractured bedrock and shallow groundwater tables, may allow these bacteria and viruses to be transported very rapidly and could contaminate nearby drinking water supplies.

Therefore, it is critical that your drinking water well is properly sited, has a sealed casing, and the required distances from nearby septic systems are maintained. This will help prevent contaminants from seeping into and mixing with your drinking water (see Figure 3).

Separation Distances

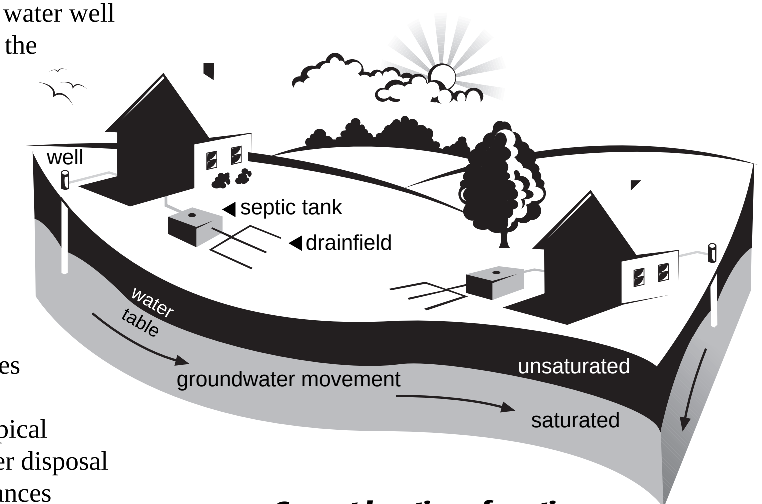
A septic system must be located a certain distance away from drinking water wells, streams, lakes, and houses. These distances are referred to as *horizontal separation distances*. Figure 4 (see back) shows a typical layout of a conventional onsite wastewater disposal system. Actual horizontal separation distances have been established and are specified in local regulations.

In order to maintain aerobic digestion processes and remove contaminants effectively, the absorption field must be adequately separated from the groundwater or other limiting layer. This is known as the *vertical separation distance* and is also specified by local regulations.

Determining System Size and Water Usage

Water use in rural households can be predicted from the house plan, depending on the number of bedrooms, water-using appliances, and potential additions. Although the actual number of residents determines water use in a house, the house plan determines the potential number of residents (e.g., number of bedrooms), water usage, and subsequent wastewater flow.

Typical wastewater flow rates range from 60–120 gallons per person per day. Typical minimum septic tank sizes range from 750–1000 gallons. The flow estimate, plus the soil permeability estimate (i.e., how easily water moves through the soil), is used to determine the area of the absorption field needed for the system. Installing a drainfield of sufficient size is critical to the proper functioning of your septic system. Local regulations should always be reviewed before installing a septic system.



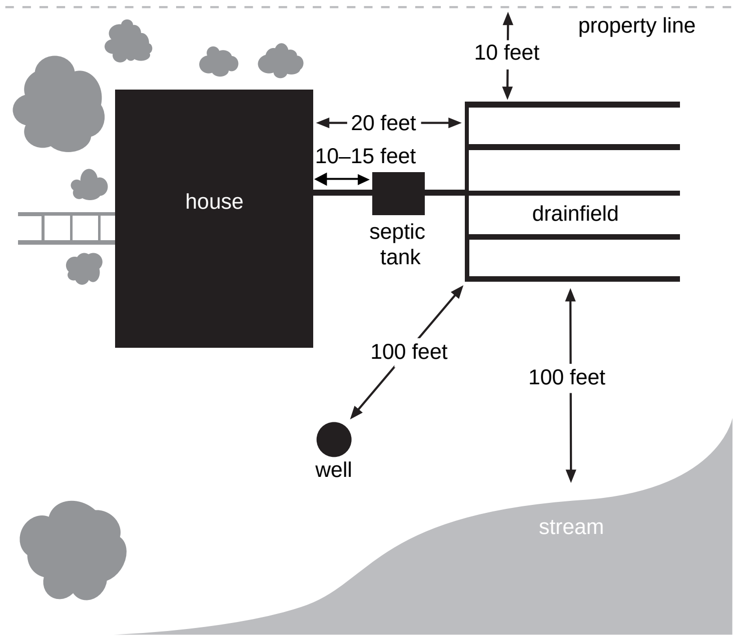
Correct location of septic systems and drinking water wells **Fig. 3**

Are Contaminants Reaching the Water?

Signs that wastewater from your septic system could be reaching water sources include:

- **Unpleasant odors (e.g., persistent rotten egg smell), soggy soil, liquid waste flow, or excessive grass growth over the soil absorption area.** These symptoms often indicate failure of the system and the need for repairing, expanding, or replacing the absorption area.

continued . . .



Typical layout of a septic system **Fig. 4**

- **Excessive weed or algae growth in the water near shorelines.** Nutrients leaking from septic systems could be a cause of this type of growth.
- **Health department test results of well water indicate the presence of contamination.** These tests may show the presence of indicator bacteria (e.g., total coliform, fecal coliform) in the water. Nitrate testing is not commonly performed and may need to be requested. Although wastes from septic systems are not the only source of these contaminants, they can be likely suspects.
- **Indicator dye put into your septic system reaches nearby ditches, streams, lakes, or drinking water supplies.** Special dyes are available from your local health department that may help find problems that otherwise are difficult to detect. This method can also help verify the other symptoms listed above.

How to Prevent Problems

- Before installation is complete, have the septic tank tested for watertightness.
- Maintain your septic system by having it inspected and pumped regularly.
- Conserve water in your home by using low-flow fixtures and by implementing water conservation practices to avoid hydraulic overload of your septic system.
- Redirect surface water flow away from your soil absorption field.
- Do not drive vehicles or heavy equipment over the absorption field. This will compact the soil and reduce its ability to absorb water.
- Plant a greenbelt (grassy strip or small, short-rooted vegetation) between your soil absorption field and the shoreline of any nearby surface water body.
- Keep chemicals and other hazardous wastes out of the septic system.
- If you have a drinking water well, have it tested yearly for contaminants. If you suspect a contamination problem, have it tested more often.

For more information regarding the care of your septic system, contact your local health department.

More information about septic systems is available from the National Small Flows Clearinghouse (NSFC) through other brochures in this series:

So . . . now you own a septic system,
Item #**WWBRPE20**

The care and feeding of your septic system,
Item #**WWBRPE18**

For more information about this or other NSFC products, please contact us by writing to:
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or phone:
(800) 624-8301, (304) 293-4191
or fax: (304) 293-3161

www.nsfc.wvu.edu

Helping America's small communities meet their wastewater needs

Groundwater protection and your septic system

One in a series of three brochures designed to aid you in caring for your septic system.

Helping America's small communities meet their wastewater needs

C-2. Table of Wastewater Permits in Project Area, October 2020

Westford Community Wastewater Disposal System, Preliminary Engineering Report
Town of Westford, Vermont
Appendix C-2. Wastewater Permit Information Summary

Parcel ID	Permittee Name	Permit Number	Permit Date	Reason for Permit
05PO004.	Edward Von Turkovich	D-4-1341	2/21/1990	Retain Lot 6B, 2.05 acres, not improved. Part of EC-4-1411
05PO004.	Edward Von Turkovich	DE-4-1400	2/21/1990	Retain Lot 6C, 0.97 acres, not improved. Part of EC-4-1411
06CM007.	Clyde C. Drinkwine	EC-4-0035	1/17/1975	DENIAL-one lot subdivision denied for type and depth of soils not meeting the regulations
05PO002.	Edward Von Turkovich	EC-4-1411	2/21/1990	Four-lot subdivision, on-site water and septic. Retain 14.6 acres.
05BS003.	David M. Driscoll	HE-4-0076	7/6/1995	1 lot being 3+/- acres on-site water; privy to be replaced with septic system
06OS004.	Linda Rivers	HE-4-0083	9/13/1995	Single family dwelling on .65 acre parcel with onsite water & sewage disposal
06OS006.	Francis & Karen Benoit	HE-4-0084	9/13/1995	Single family dwelling on .56 acre parcel with onsite water & sewage disposal
06OS006.	Gretchen C. Perez	HE-4-0084-1	10/25/2001	Amend Homestead to 0.70 acre parcel with single family dwelling onsite water & sewage disposal
05BS001.	Steven Levinson	HE-4-0148	10/24/1996	Single family residence on 2 acres with on-site water and sewer.
05BS005.	Lisa Gail Friedman	HE-4-0164	5/1/1997	Single family dwelling on 9.7 acres with onsite water & septic
05CU002.	Tom & Cheryl Dunkley	HE-4-0364	8/7/2002	Single family dwelling with onsite water & sewage disposal on Lot 2 1.09 acre parcel.
05BS009.	Westford Elementary School	PB-4-0324	5/23/1978	8 classroom addition, 2 bathrooms, 2 storage rooms, and subsurface disposal system
05PO002.	E.B. & F.J. Von Turkovich	PB-4-1303	2/21/1990	Construction of new post office
05BS009.	Westford School District	WW-4-0630	1/22/2001	Addition to school for gym and classroom space, on-site water & sewer; 5320 gpd
05BS009.	Westford School District	WW-4-0630-1	1/22/2001	Relocate water storage and water lines, add new floor drains, no increase in flows
05BS009.	Westford School District	WW-4-0630-2	12/18/2001	Relocate 5,000 gallon water storage tank outside of building, no changes to water or septic
05VL001._1	Town of Westford	WW-4-0877	7/20/1995	Drill new well for existing Town offices & Library, onsite sewage disposal
05VL001._1	Town of Westford	WW-4-0877-1	8/16/2016	Replace existing steel 500 gallon septic tank with a new 1,000 gallon precast concrete septic tank.
05VL001._1	Town of Westford	WW-4-0877-1R	8/29/2016	Correct permit to reference Library Septic Tank not Town Office.
05TW049.	United Church of Westford	WW-4-1173	6/16/1998	Construct new onsite sewage disposal for Brick Meeting House
05TW049.	Brick Meeting House Soc. of VT	WW-4-1173-R	6/16/1998	Amended permit to correct wrong date noted on the plans
05TW039.	Joel, Mary, William & Jeanne Fay	WW-4-1965	10/1/2003	Boundary line adjustment for Lot #1, existing single family dwelling, onsite water and sewer
05TW039.	William & Vanessa Smith	WW-4-1965-1	7/8/2005	Construct replacement system using Septitech instead of Advantex for a failed system on Lot #1
05CU002.	Thomas & Cheryl Dunkley	WW-4-2409	8/22/2005	Two-lot subdivision (one existing 3-BR home, one proposed 4-BR home) onsite water and sewer
05TW035.	Paul Birnholz	WW-4-2419	7/21/2005	3 lot subdivision, all with onsite water and sewer
05TW041.x	Mary Cavanaugh	WW-4-3163	9/19/2008	Replace failed septic system for a 1BR house, Cromaglass pre-treatment and bottomless sand filter system. Design variances.
05TW054.B	David Lavallee	WW-4-3335	7/23/2009	Construct 3-BR bedroom single family residence on an existing 4.7 acre parcel with on site water supply and wastewater disposal system - performance based mound system
05TW057.	Raymond Belair	WW-4-3460	4/1/2009	Best fix replacement system for a failed wastewater system on an existing three bedroom single family residence with on site drilled well
05TW055.	Gregory Larson	WW-4-3738	9/14/2011	best fix replacement system for a three bedroom single family residence
05BS005.	Edward & Juliette Horton	WW-4-3832	4/12/2012	create Lot 1 (4.6 +/- acres) with an existing three bedroom single family residence, Lot 2 (1.27 +/- acres) for a proposed four bedroom single family residence and Lot 3 (2.57 +/- acres) for a proposed three bedroom single family residence
05TW054.	Elaine Lavallee Revocable Trust	WW-4-4058	6/24/2013	Lot #1 to become 6.4 acres with an existing one bedroom single family residence with a designated replacement area
05TW054.C	Travis Lavallee	WW-4-4058-1	9/14/2015	proposed four bedroom single family residence on existing 25.9 acre parcel being Lot #2
05BS008.	Christopher & Tatiana Friesen	WW-4-4390	2/12/2015	proposed three bedroom single family residence on existing 5.58 acres
05TW063.	Minor Family Trust	WW-4-4497	8/17/2015	replace failed wastewater system for existing 3-BR SFR with a one bedroom apartment
05BS010.	David Gauthier, Lynn Gauthier	WW-4-4711	10/11/2016	Subdividing existing 178.64 acre parcel to create three lots. Proposed Lot 1 will be 3.99 acres and is to serve the existing farm house and barn. New wastewater and future potable water systems are proposed for Lot 1. The existing shallow well on Proposed Lot 3 will continue to be used, the drilled well will be installed in the future. Proposed Lot 2 will be 1.17 acres for a new four bedroom dwelling and new wastewater and potable water systems. Proposed Lot 3 will be the remaining undeveloped1
05BS002.	Jason and Pamela Hoover	WW-4-4884	8/28/2017	Replace existing failed system for a single family house on a 1.34 acre parcel with a drilled well.
05VL006.	Town of Westford	WW-4-5160	1/31/2019	Demolish an existing 3 bedroom residence and construct a convenience store with deli, 3 employees and 9 seats (serving 2 meals/day).

Source: Review of Vermont Dept. of Environmental Conservation permits, October 2020.

Notes: D or DE = Deferral of permit; EC = Subdivision permit; HE = Homestead Exemption; PB = Public Building Permit; WW = Wastewater System and Potable Water Supply Permit

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Date: 10/22/2020, anm

C-3. Evaluation of Community Wastewater Disposal System Options

Six areas of land within and near the Town Center were considered as potential cluster system sites during the 2007-8 alternatives study (Appendix C-1, Figure 4). All of these areas were at least two acres in size. Of the six sites initially considered, the three closest to the Town Common (Areas 3, 4, and 5) are not suitable for a community wastewater system. Area 3 is underlain by Munson and Belgrade silt loam soils with shallow groundwater limitations and is partially located in the Flood Hazard Overlay zoning district. The Town Common (Area 4) is centrally located and undeveloped, but the soils underlying the Common are extremely limited, and an underdrain system was installed beneath the entire area in the early 2000s to improve drainage. Since the entire area has underdrains installed, the construction of wastewater treatment systems would not be allowed. Area 5 consists of gently sloping Agawam fine sandy loam soils suitable for conventional in-ground wastewater dispersal and has an elevation lower than much of the likely service area. However, it is bordered on three sides by the Browns River, so it is located almost entirely within the Flood Hazard Overlay zoning district and significant portions of the site are within the 100-foot Water Resource Overlay zoning district. Both these districts limit the area available to locate a wastewater treatment system on this site.

Of the remaining sites identified during the alternatives study, Area 6 had potentially suitable soils and site conditions but would require a stream crossing as part of the construction project, which is not allowable under the current zoning bylaws. Area 2 also had potentially suitable soils and would not require a stream crossing, but its distance from the Town Common and the presence of shallow bedrock along the Brookside Road force main route both would significantly increase construction costs. Area 1, north of Brookside Road and closer to the Town Common, was considered to require a stream crossing during the alternatives study, but site visits completed in 2016-2018 determined that the stream's source is north of the potential disposal site (Figure 2).

Area 1 consists of Colton and Stetson soils and Stetson gravelly fine sandy loam, suited for conventional in-ground systems, and is located on two parcels (Appendix C-1, Figure 4). Two zones in the southern portion of Area 1 were evaluated for potential community wastewater treatment system capacity in 2014-15, and preliminary system layouts and project cost estimates to construct a community system were completed for one of the identified land areas[16]. The soils underlying the up-slope area were generally not suitable, while a second area of suitable soils was further evaluated and confirmed in the northern portion of the hay field. A preliminary community wastewater system capacity of 16-17,000 gallons per day was calculated, but additional testing was needed to confirm the extent of suitable soils. Additional testing and analysis completed in 2016-17 further limited the identified preliminary wastewater system capacity to 12,600 gpd[17].

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[16] Stone Environmental, Inc. and Green Mountain Engineering. 2015. *Site Investigation, Capacity, and Preliminary Cost Estimates for a Shared Wastewater System at the Jackson Farm Property, Westford, Vermont.* Letter to the Westford Planning Commission dated October 5, 2015. https://westfordvt.us/wp-content/uploads/2014/09/Westford_JacksonFarm_capacity_ltr_2015-10-05-final.pdf

[17] Stone Environmental Inc. and Green Mountain Engineering. 2017. *Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site, Westford, Vermont*. Letter to the Westford Planning Commission dated May 30, 2017.https://westfordvt.us/wp-content/uploads/2014/09/Westford_Jackson-Farm-Capacity-and-Financing-Update_ltr_2017.05.31-FINAL-REPORT.pdf

Area 1, and particularly the 1.5-acre portion of this area located in the upper field of the Maple Shade Town Forest property, is the only viable disposal option for Westford's project.

Several other sites were identified and evaluated following the alternatives study. Three properties located near Westford's Town Common were evaluated as part of the 2013-14 *Town Center Revitalization Project and Visual Preference Survey*: the Westford Common Hall property; the portion of the Town Common located between Brookside Road and White Church Lane; and the Brick Meeting House[18]. While the soils underlying the Brick Meeting House property and the Town-owned land were generally not suitable for the construction of new onsite wastewater treatment systems, a small area of suitable soils was located on the Common Hall of Westford property. This area may support a new onsite wastewater system with a capacity of at least 1,220 gallons per day, if further testing confirms the results of the preliminary field investigation. The Town also evaluated the Spiller property when it was Town-owned[19] and went through an ANR process to preserve the existing system on-site. The Spiller property is now the site of the Westford Country Store and Café.

[18] Stone Environmental Inc. 2014. Site Specific Community Wastewater Capacity Soil Study . Tests in the Town Common Area. Letter to the Westford Planning Commission dated April 30, 2014. https://westfordvt.us/wp-content/uploads/2014/09/13-224-Westford-Town-Common-Capacity_compiled_final.pdf
[19] https://westfordvt.us/wp-content/uploads/2014/09/Spiller-Wastewater-Report.pdf

C-4. Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

May 30, 2017

Westford Planning Commission
Attn: Melissa Manka, Planning Coordinator
Westford Town Office
1713 VT Route 128
Westford, Vermont 05494

Stone Project No. 16-130
Subject: Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site, Westford, Vermont

Dear Melissa,

Stone and Green Mountain Engineering are pleased to provide the results of field and desktop analysis of the soil-based wastewater treatment capacity of the area identified as "Zone 3" in the Hamlin Engineers report cited below on the Jackson Farm at 123 Brookside Road, near Westford's Town Common. We also present updated system layout, project cost estimates, and financing options to construct and operate a community system at this location. This work was completed with Municipal Planning Grant funding administered by the Vermont Department of Housing and Community Development, to support the Westford Planning Commission's continued exploration of ways to build capacity to accommodate focused and appropriate development in the Town Center. The extent of suitable soils, while substantial, is smaller than was estimated during earlier evaluations, and revised capacity calculations and system layouts indicate the area is likely to support a new soil-based community wastewater system with a capacity of approximately 12,600 gallons per day. The lowest cost wastewater collection, treatment and disposal system was anticipated to be a Septic Tank Effluent Pump (STEP) system, followed by a conventional trench disposal system (Drawings No. 1 and No. 2). Construction costs were estimated $1,590,000 in 2018 dollars, total project costs were estimated to be $2,230,000, and the first-year operation and maintenance costs were estimated to be $24,000. These preliminary opinions of probable cost were used to evaluate a series of possible user fee breakdown and financing options, understanding that there are still many unknowns in how any community wastewater project in the Town Center and at the Jackson Farm property would ultimately be developed and financed.

Sources of information consulted to complete the analyses included:

- *Site Investigation, Capacity, and Preliminary Cost Estimates for a Shared Wastewater System at the Jackson Farm Property, Westford, Vermont:* Letter report, maps, test pit logs, capacity calculations, collection and disposal system layout drawings, and calculations for Opinions of Probable Cost and User Fee Estimates, from Stone Environmental, Inc. and Green Mountain Engineering, dated October 5, 2015 (and sources therein)
- Backhoe test pit logs completed by Amy Macrellis of Stone Environmental, Inc. on November 16, 2016.

- Limited topographic survey, including locations of backhoe test pits, completed by Kevin Camara, P.E. of Green Mountain Engineering on November 16, 2016.
- *Drawing No. 1: Proposed Wastewater Collection System Map*, preliminary collection system layout for existing connections completed by Green Mountain Engineering, dated October 1, 2015.
- *Drawing No. 2: Wastewater Disposal System Site Plan*, preliminary leachfield layout completed by Green Mountain Engineering, dated May 15, 2017.

Project Background

The property, located at 123 Brookside Road, is approximately 201 acres in size with an existing single family home and associated barns and outbuildings. A soils investigation completed by Hamlin Engineering in December 2014-January 2015 identified three areas on the property that were potentially suitable for wastewater disposal. The area identified in that report as Zone 3, located in the "northern lobe" of the hay field, was further evaluated by Stone and GME in August 2015, with the excavation of nine test pits (TP-109 through TP 116) and completion of a limited topographic survey, followed by completion of preliminary capacity calculations and disposal system layouts, along with development of planning-level opinions of probable cost and project financing.

This work, presented to the Planning Commission in October 2015, indicated that a new in-ground wastewater disposal system to accommodate existing or new development with design flows of up to 16,920 gpd may be feasible in the Zone 3 area on the Jackson Farm property. This design flow would be adequate to serve the current needs of the areas identified as "high priority" for community wastewater service by the Planning Commission (combined design flow of approximately 9,435 gallons per day), with up to 7,485 gallons/day of capacity remaining available to serve other current or future needs. The preliminary disposal system layout was created to represent a maximum likely footprint, and thus extended onto previously un-tested portions of the field. Completion of limited additional soil characterization to confirm system capacity, primarily in the southern portion of Zone 3, was a recommended next step.

Field Soil Characterization Results

Eight new text pits (TP-117 through TP-124) were located using survey-quality GPS prior to excavation, in order to precisely locate the new test pits relative to work completed previously on this property. The soils investigation was conducted by Amy Macrellis of Stone on November 17, 2016 using a backhoe supplied by John Roberts of Roberts Excavation Inc. Others present during some or all of the investigation included David Gauthier (property owner), Melissa Manka (Town of Westford Planning Coordinator), Kevin Camara (Green Mountain Engineering), Mary Clark (Vermont DEC, Indirect Discharge Permitting Program), and Jessanne Wyman (Vermont DEC, Regional Engineer). Appendix A contains test pit logs and hydraulic capacity calculations. Test pit locations are shown on the site plan (Drawing No. 2).

Test pits TP-117 and TP-118, located at the southern extent of the initial disposal field layout, generally consisted of surface horizons of gravelly very fine sandy loam to gravelly fine sand underlain by clay loam with firm consistence that corresponded with indications of seasonal high groundwater at 25 to 29 inches below ground surface. These locations could be used for mound wastewater treatment systems, but are generally not suitable for larger-scale community wastewater treatment.

Test pit TP-119 was excavated in the field north-northwest of TP-024, to confirm and attempt to extend the area of suitable soils north from that location. This test pit consisted of gravelly loamy fine to very coarse sands throughout the soil profile, with no indications of limiting features to a depth of 120 inches (10.0 feet).

Test pits TP-120 and TP-121 were excavated just north of TP-119, to further define the northern extent of the well-suited soils present at that location. Both of these locations, however, generally consisted of gravelly silt loam to clay loam, with firm horizons at 24-31 inches below ground surface. In both test pits, indications of seasonal high groundwater were identified slightly above the firm soil horizons (20-24 inches below ground surface). These locations could be used for mound wastewater treatment systems, but are generally not suitable for larger-scale community wastewater treatment.

Test pit TP-122 was excavated along the western treeline between TP-019 and TP-022, in order to more closely define the larger area of deep and sandy soils previously identified at the northern end of Zone 3. This test pit consisted of gravelly fine to very coarse sands throughout the soil profile, with no indications of limiting features to a depth of 120 inches (10.0 feet).

Test pit TP-123 was excavated towards the northern end of Zone 3 and down-slope from TP-020, in order to more closely define the eastern edge of this larger area of deep and sandy soils. At this location, gravelly sand to coarse sand extends to nearly 5 feet (58 inches) below ground surface, where it is underlain by firm, silty clay with indications of seasonal high groundwater. This location is suitable for in-ground leachfield construction, but the silty clay horizon represents a limiting condition for infiltrating large volumes of water.

Test pit TP-124 was excavated in the western tree-line to understand whether indications of shallow bedrock encountered farther north in this forested area (TP-109) were consistent along the entire field boundary. This test pit consisted of gravelly fine to coarse sands throughout the soil profile, with no indications of limiting features to a depth of 84 inches (7.0 feet). The lower four feet of this profile, however, was firm and extremely dry. If, ultimately, a decision is made to try to move the proposed disposal fields closer to or within the current tree-line in order to further expand capacity, additional testing to include infiltration testing is warranted in this vicinity.

The best possible option for wastewater disposal remains in the northern portion of the Zone 3 area identified in the Hamlin Engineering report in the vicinity of test pits TP-017, TP-018, TP-019, TP-020, TP-021, and TP-024, and expanded to include TP-110. After adjusting the previously identified area to account for the results described above and separations from areas of unsuitable soils, two areas totaling approximately 1.93 acres are available for wastewater disposal. The larger of the two areas remains additionally limited by the presence of slopes in excess of 20% in portions of the best-suited soils and associated setbacks (roughly 0.4

acres), leaving roughly 1.5 acres. The revised area identified here represents the likely maximum area available for wastewater treatment. In contrast to the prior preliminary investigation, no additional substantial constraints stemming from as-yet unidentified areas of finely textured soils with firm subsoils and shallow seasonal high groundwater are anticipated.

Zone 3 Geology and Groundwater, Conceptual Site Model

The results of the subsurface investigation described above and in previous reports, as well as the historical information collected during the course of the project, were used to develop two east-west geologic cross sections A-A' (Figure 1) and B-B' (Figure 2), and a north-south geologic cross section C-C' (Figure 3). The following sections describe the site's geology and groundwater flow regime.

The test pits completed during this investigation showed that the soils within and near the proposed disposal fields are gravelly loamy sands near the ground surface (Appendix A and Figures 1, 2, and 3). Beneath the surficial soils, gravelly fine to coarse sands were observed to depths of five to 10 feet below the ground surface (Appendix A and Figures 1 and 2). While more finely textured materials (silt to clay) are prevalent in the eastern and southern areas of Zone 3, these were not encountered beneath lenses or areas of coarser, sandy material (see especially Figure 3, cross section C-C'). The well-drained sands, underlain by poorly drained and firm silts and clays, are consistent with surficial geologic mapping in the vicinity, which shows glaciofluvial kame terrace deposits in the vicinity of Zone 3 and glaciolacustrine deposits of clay and boulders located closer to Brookside Road.

Bedrock encountered during the subsurface investigation in and near Zone 3 was limited to TP-109, at a depth of 22 inches below ground surface. The bedrock surface topography in the vicinity of the proposed leachfield should be considered only a preliminary estimate. The presence of outcrops both west of the tree-line adjoining Zone 3 and east of Brookside Road suggest that bedrock below the site may form a buried valley that slopes from southwest to northeast.

Groundwater was encountered only in a seep at TP-111, at a depth of 41 inches below ground surface (Figure 1). Groundwater flow across the site is assumed to generally follow surface topography from west to east, from the proposed disposal fields towards an un-named stream near the eastern edge of the parcel. The un-named stream flows north from its headwaters northeast of Zone 3, ultimately reaching the Browns River.

Revised Wastewater Capacity Analysis for Zone 3

The best possible option for wastewater disposal on this property remains in northern portion of the Zone 3 area identified in the Hamlin Engineering report in the vicinity of test pits TP-017, TP-018, TP-019, TP-020, TP-021, TP-024, and TP-110, parallel to the tree line running from north to south. In order to estimate the hydraulic capacity of this potential wastewater dispersal site, we revised the Darcy's Law calculations completed for our October 5, 2015 analysis and report.

This formula is represented as Q = KiA where

Q = design flow (gallons/day) (gpd)
K = hydraulic conductivity (ft. /day)
i = hydraulic gradient (slope of water table)
A = transmitting soil cross-sectional area (square feet) = D x L where
D = transmitting soil thickness (depth to impeding layer or water table, minus the required separation depth, minus the system depth) (feet)
L = length of the disposal system in the estimated direction of groundwater flow (feet)

We used this formula to develop two hydraulic capacity estimates—one estimate per each of the cross-sections A-A' and B-B'. The full set of assumptions and calculations for each estimate are included in Appendix A. Key assumptions are that the system's design will be in-ground absorption trenches with the bottom of the trench a maximum of 18 inches (1.5 feet) below the ground surface. In this design, the treatment capacity of the upper soil horizons will be maximized. The top of the gravel in the trenches will be at the pre-existing ground surface, and 6 inches of topsoil will be used to cover the trenches. The required separation distance to seasonal high groundwater is 3.0 feet, leaving a varying transmitting soil thickness between the induced groundwater mound and the bottom of the disposal trenches (at least 6.2 feet in cross-section A-A' and an average of 2.5 feet in cross-section B-B').

Based on our calculations, the hydraulic capacity available for wastewater disposal in the vicinity of cross-section A-A' is on the order of 38,975 gallons per day, while at cross-section B-B' the available hydraulic capacity is on the order of 10,970 gallons per day. These hydraulic capacity values suggest that, at the planning level, the area required for layout of the in-ground trenches will be a greater limitation than the capacity of the underlying soil and surficial materials to accept and transmit renovated effluent.

Jackson Farm Property Treatment and Disposal System

The oblong area of approximately 1.5 acres determined to be available for wastewater disposal is shown on Drawing No. 2. To further refine the capacity estimate for this area, a preliminary layout was designed assuming the disposal area will be designed to treat septic tank effluent using in-ground absorption trenches. Once setbacks from steep slopes and un-suitable soils are accounted for, the equivalent of 16 trenches, each 4 feet wide by 100 feet long, can be located parallel to the ground contours in A-A' and the equivalent of 54 trenches, each 4 feet wide by 100 feet long, can be located parallel to the ground contours in B-B'. Since only half of the trenches can be loaded with renovated effluent at any given time, the leachfield's capacity is calculated based on 8 trenches in A-A' and 27 in B-B', as follows:

For A-A' System capacity (gallons/day) = trench length * trench width * total trenches * loading rate, where
Trench length = 100 feet

Trench width = 4 feet
Total trenches = 8
Loading rate = 0.9 gallons/square foot of trench area/day (for loamy sand to coarse sand, see Indirect Discharge Rules Table 19)

System capacity (gallons/day) = 4 feet * 100 feet * 8 trenches * 0.9 gal/square foot

System capacity = 2,880 gallons/day

Since the septic system capacity of 2,880 gallons per day is less than the available hydraulic capacity of 38,975 gallons per day for A-A', then the calculated flow for septic tank effluent is acceptable.

For B-B' System capacity (gallons/day) = trench length * trench width * total trenches * loading rate, where
Trench length = 100 feet
Trench width = 4 feet
Total trenches = 27
Loading rate = 0.9 gallons/square foot of trench area/day (for loamy sand to coarse sand, see Indirect Discharge Rules Table 19)

System capacity (gallons/day) = 4 feet * 100 feet * 27 trenches * 0.9 gal/square foot

System capacity = 9,720 gallons/day

Since the septic system capacity of 9,720 gallons per day is less than the available hydraulic capacity of 10,970 gallons per day for B-B', then the calculated flow for septic tank effluent is acceptable.

Therefore the total capacity of the site for septic tank effluent is 2,880 gallons per day + 9,720 gallons per day=12,600 gallons per day.

An in-ground system utilizing four-foot-wide trenches, maximizing the available length along contour (~730 ft.) with this capacity would have a linear loading rate of 12,600 gal/day / 730 ft. = 17 gallons/day/linear foot. This linear loading rate is higher than 4.5 gallons per day per linear foot, and so if pre-treatment is desired in order to further increase the system's capacity, the state's Indirect Discharge Rules (Section 14-1010(d)(2)) require that a hydrogeologic analysis be completed to demonstrate:

- An unsaturated soil zone of at least 36 inches is maintained beneath the filtrate disposal system; and
- The mounded water table is at least one foot below grade at the downhill toe of the filtrate disposal system.

Wastewater Flow Projections

Wastewater flow projections were developed using the State of Vermont, Environmental Protection Rules (EPR), Chapter 1, dated September 29, 2007. Wastewater flow projections for residential and apartment units were developed based on the number of living units. A living unit is defined as a single family home, apartment or mobile home. For alternatives connected to a system with a system capacity of 12,600 gpd, a design flow of 245 gpd per living unit is used without regard to the number of bedrooms.

Table 1 on the following page provides a summary of the current and design year flow projections for a 12,600 gpd system at the Jackson Farm.

Table 1. Wastewater Flow Projection Summary

Street	Use & Flow Rate	Initial Year Flow (gpd)	Equivalent Users
Brookside Road	White Church= 150 gpd		
	9 SFR x 245 gpd/SFR=2,205 gpd	2,355	10
Cambridge Road	1 SFR x 245 gpd/SFR=245 gpd	245	1
Common Road	4 SFR x 245 gpd/SFR=980 gpd	980	4
VT Rte. 128	11 SFR x 245 gpd/SFR=2,695 gpd		
	8 Apt. X 245 gpd/Apt.=1,960 gpd		
	1 Store=140 gpd		
	Town Office & Library=90 gpd		
	Brick Meeting House= 480 gpd	5,365	22
White Church Lane	2 SFR x 245gpd/SFR=490 gpd	490	2
Initial Year Total		9,435	39

The number of equivalent users is used later in the report for the user cost analysis. For residential users, one equivalent user is defined as one house, one apartment, or one mobile home, etc. For non-residential users, the equivalent unit is defined as 245 gpd. The non-residential equivalent user amount is calculated by dividing that establishment's flow basis and dividing it by 245 gpd. The minimum equivalent unit for all accounts is 1 equivalent unit.

For a system designed for the maximum capacity of 12,600 gpd, there would be approximately 3,165 gpd in reserve capacity, which equates to approximately 13 additional single family homes.

Wastewater Collection and Disposal System

For this preliminary evaluation, the lowest cost wastewater collection, treatment and disposal system was anticipated to be a Septic Tank Effluent Pump (STEP) system (Drawing No. 1), followed by a conventional trench disposal system (Drawings No. 1 and No. 2). The Indirect Discharge Rules require dual alternating disposal systems, and that the systems are pressurized. A STEP system is a system in which both the septic tank and effluent pumping processes occur in a single tank. Portions of the tank are dedicated to septic tank capacity, effluent pumping, and emergency storage. The STEP tank for a typical single family home is a 1,500 gallon tank.

Located inside the STEP tank is a pump vault that houses a filter and pumping system. Effluent from the clear zone of the septic tank enters the pump vault and is filtered by the effluent filter. Because only effluent is pumped, a small ½ horsepower submersible turbine high head effluent type pump is used to pump the effluent. The ½ horsepower effluent pump saves energy over larger horsepower solids handling pumps. The electrical service is typically connected to the property's electrical system and the electrical costs are typically borne by the property owner.

The STEP system utilizes small diameter pressure sewer and low pumping rates. The STEP tank operates on a "pump on/pump off" scenario based on float positions. The low pressure sewer service is typically minimum of 1" diameter and the main line low pressure sewer is typically 2" diameter. Pumping heads for operation of the system are developed using the combined energy of multiple STEP system pumps working together to convey flow through the collection system.

The STEP system will convey the effluent to a dosing tank at the Jackson Farm site. The dosing tanks will dose the disposal fields at the proper pressure and flow volume. There will also be a valve pit for the dosing tank.

Opinion of Probable Construction Cost

Prior to the development of the opinion of probable construction cost, quantity take-offs were completed to establish quantities of equipment, materials, and labor necessary to construct a fully operational system. Construction costs were generated using *RS Means Building Construction Data*, cost quotations from vendors and contractors, and bid results from recent construction jobs in Vermont. An ENR cost index was used to project the construction cost to February 2018 to account for inflation. Opinions of probable construction costs were developed for both the wastewater collection system (Contract No. 1) at $1,150,000 and the wastewater disposal system (Contract No. 2) $440,000, for a total opinion of probable construction cost of $1,590,000 in 2018 dollars. A 10% contingency is included in the construction cost estimate. Detailed summaries of costs are provided in Appendix B.

Opinion of Total Project Cost

An Opinion of Total Project Cost was developed to include all project costs including construction cost, preliminary engineering, permitting, hydrological, archeological, final design engineering, construction services engineering, land acquisition, legal, fiscal and administrative costs. The Opinion of Total Project Cost is $2,230,000. The Opinion of Total Project Cost is detailed in the table in Appendix B.

Opinion of "First Year" Operation and Maintenance Cost

An Opinion of Operation and Maintenance (O&M) Cost was developed to include all operation and maintenance costs for the proposed system including contract operations, electrical expenses, sludge pumping, groundwater testing, capital replacement, insurance, miscellaneous repairs, and administration/billing. The Opinion of First Year O&M Cost is $24,000. The Opinion of First Year O&M Cost is detailed in the table in Appendix B.

Opinion of User Fee Analysis

An opinion of user fess is the method used in this report to determine if an alternative is affordable or not. Annual user rates from wastewater collection and treatment systems in Vermont vary from community to community and range from a low of $250/year to as high as $1,200/year. The typical average wastewater user rate fee across the State is between $400 - $600/year. Newer systems are typically higher, in the $1,000+/year range. User costs over $1,000 are generally considered unaffordable.

Typically, the users of the system pay for 100% of the O&M costs of a system. Therefore, the user cost for the annual O&M cost of this system would be the $24,000 annual O&M cost divided by the 39 users or $615. If and as additional users or connections are added to the system, it is likely that the per-user O&M costs will decrease.

Different communities handle the debt retirement in different ways. The three most common approaches are the following:

1. The users pay all of the debt retirement.
2. The debt retirement is distributed throughout the Town on a parcel tax basis.
3. The debt retirement is distributed throughout the Town tax based on the grand list.
4. Combinations of the above.

Because the funding package is not known at this time, the debt retirement user fees are also not known. User costs were estimated for the total project cost using method #1 (only the users pay the debt retirement) and using grant scenarios of 0%, 35%, 50%, and 75%. See Appendix B for detailed calculations of the user costs per approach. Table 2 on the following page provides a summary of the user cost using the first three approaches described above.

Table 2. Estimated User Fee Summary

Approach	User Fee			
	No Grants	35% Grants	50% Grants	75% Grants
Users Pay both Debt & O&M Costs				
Non-Connected Property	$0	$0	$0	$0
Connected Property	$4,112	$2,888	$2,364	$1,490
Users Pay O&M and Debt on a Town Wide Parcel Tax Basis				
Non-Connected Property	$146	$95	$73	$36
Connected Property	$761	$710	$688	$652
Users Pay O&M and Debt of a Town Wide Parcel Tax Basis [1.]				
Non-Connected Property	$151	$98	$76	$38
Connected Property	$766	$714	$691	$653

1. Note: The Town wide parcel tax user fee portion is based on a property value of $275,000.

Potential Funding Sources

A summary of the available State and Federal funding programs potentially available for this project are described in the following narratives.

- State of Vermont, Department of Environmental Conservation (VTDEC)
  - Clean Water State Revolving Fund (CWSRF)
  - Pollution Abatement Grant
- USDA Rural Development (RD)
- U.S. Environmental Protection Agency (EPA)
- Vermont Community Development Program (VCDP)

The State of Vermont offers low interest loans for planning, design, and construction of municipal infrastructure improvements. This loan is offered with an annual administrative fee equivalent to 2% of the remaining balance for a 20 year period. The funding schedule depends on the individual project's priority ranking in comparison to other projects.

The State of Vermont offers a Dry Weather Pollution Abatement Grant to municipalities for the planning and construction of facilities which have project sections that abate pollution to waters of the State. The grant is for 35% of eligible items from the point of pollution to the point of discharge. Available funding is currently limited and dependent upon legislative set-asides.

The USDA Rural Development (RD) Program includes both grants and loans, depending on the project and the community's ability to pay, which is based on the Town's user rates and median household income (MHI). The MHI for the Town of Westford is high at $61,000, which makes the Town not eligible for grants under the RD program.

The U.S. Environmental Protection Agency (EPA) offers a State and Tribal Assistance Grant (STAG) program. These grants are based on financial need and environmental protection. The municipality must work closely with Vermont's U.S. congressional delegates in an effort to get their wastewater projects into the U.S. Capital Budget for STAG grants. These grants have become very limited in the current economic and political climate.

The Vermont Community Development Program (VCDP) administers funding from the U.S. Department of Housing and Urban Development (HUD) under the Community Development Block Grant (CDBG) program. The CDBG program celebrated its 40th anniversary this year. Activities that support economic development and affordable housing continue to be VCDP's top priorities for funding. The VCDP assists communities on a competitive basis by providing financial and technical assistance to identify and address local needs in the areas of housing, economic development, public facilities, public services and handicapped accessibility modifications. The program is designed to predominantly benefit persons of low and moderate income.

Conclusions and Next Steps

In summary, our field and desktop analyses indicate that a new in-ground wastewater disposal system to accommodate existing or new development with design flows of up to 12,600 gpd may be feasible in the Zone 3 area on the Jackson Farm property. This design flow would be adequate to serve the current needs of the areas identified as "high priority" for community wastewater service by the Planning Commission (if connected to a community system, the current uses in this area have a combined design flow of approximately 9,435 gallons per day). Thus, up to 3,165 gallons/day of capacity could be available to serve other current or future needs.

For this preliminary evaluation, the lowest cost wastewater collection, treatment and disposal system was anticipated to be a Septic Tank Effluent Pump (STEP) system, followed by a conventional trench disposal system (Drawings No. 1 and No. 2). Construction costs were estimated $1,590,000 in 2018 dollars, total project costs were estimated to be $2,230,000, and the first-year operation and maintenance costs were estimated to be $24,000. These preliminary opinions of probable cost were used to evaluate a series of possible user fee breakdown and financing options, understanding that there are still many unknowns in how any community wastewater project in the Town Center and at the Jackson Farm property would ultimately be developed and financed.

There are several steps to be taken in moving forward with developing a community wastewater project for the Town Center. The items below are by no means an exhaustive or complete list, and we look forward to collaborating with the Town, the Planning Commission, and other stakeholders on this exciting project.

1. Preliminary Design
    a. Determine receiving water for indirect discharge.
    b. Determine whether additional site-specific hydrogeologic analysis (mounding analysis) will be required to demonstrate that required thicknesses of unsaturated soil are maintained and that the mounded water table is at least one foot below grade at the system's downhill toe.
2. Project Financing and Phasing
    a. Work with project stakeholders to refine financing options, including funding for preliminary and final design, system construction, and operation/maintenance—especially to understand how public-private partnerships and/or companion proposals to develop affordable housing could impact per-user costs and potential reserve fund capacity available for other future uses. Further explore design and construction project phasing options, including constructing portions of the system to serve existing community facilities in conjunction with potential proposals for commercial re-development and new development.

Sincerely yours,

Amy Macrellis
Project Water Quality Specialist

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Encl.

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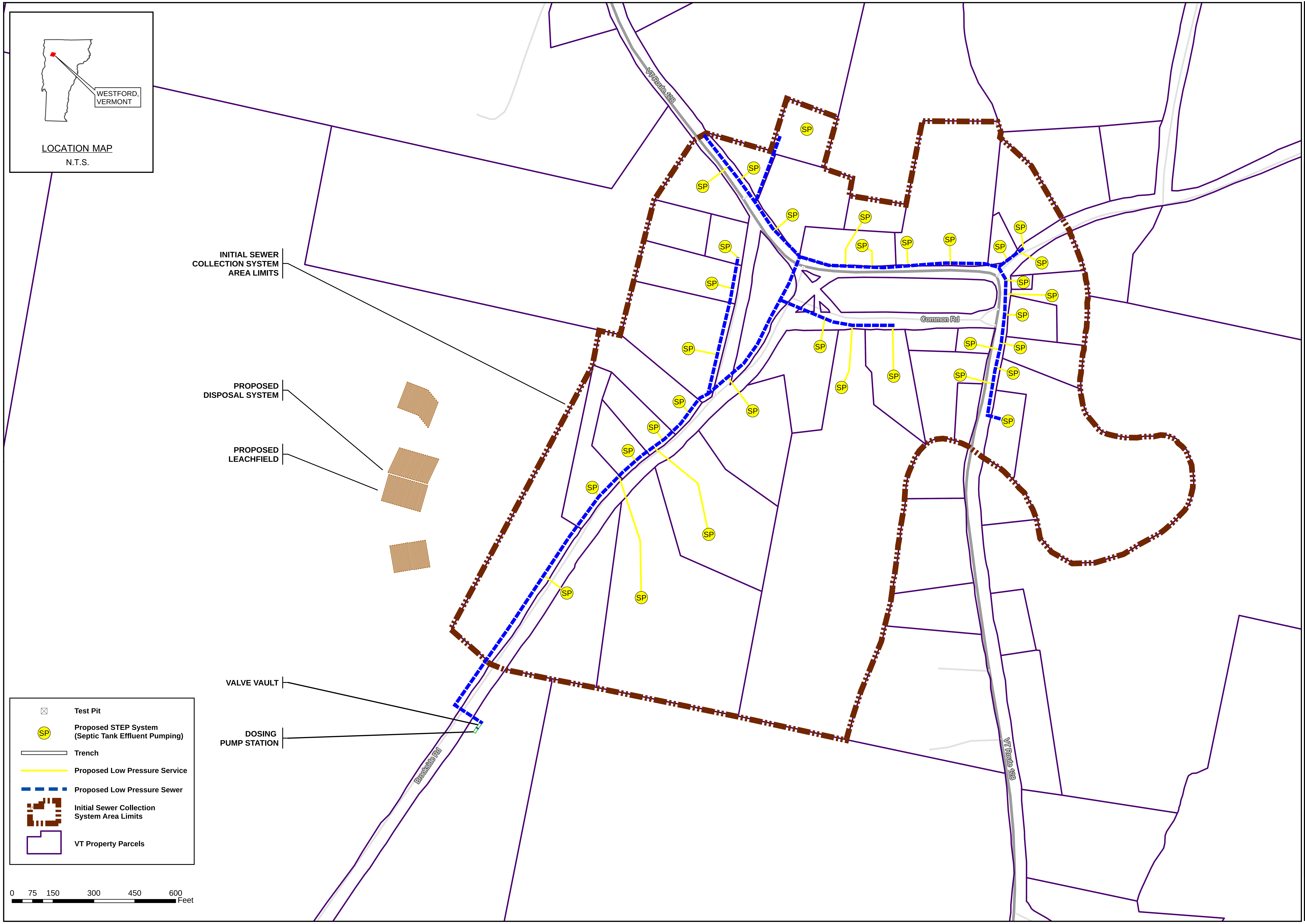


REV.	DATE	DESCRIPTION	BY

GREEN MOUNTAIN ENGINEERING
CIVIL
WATER
WASTEWATER
1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

DRAWING TITLE: PROPOSED WASTEWATER COLLECTION SYSTEM MAP

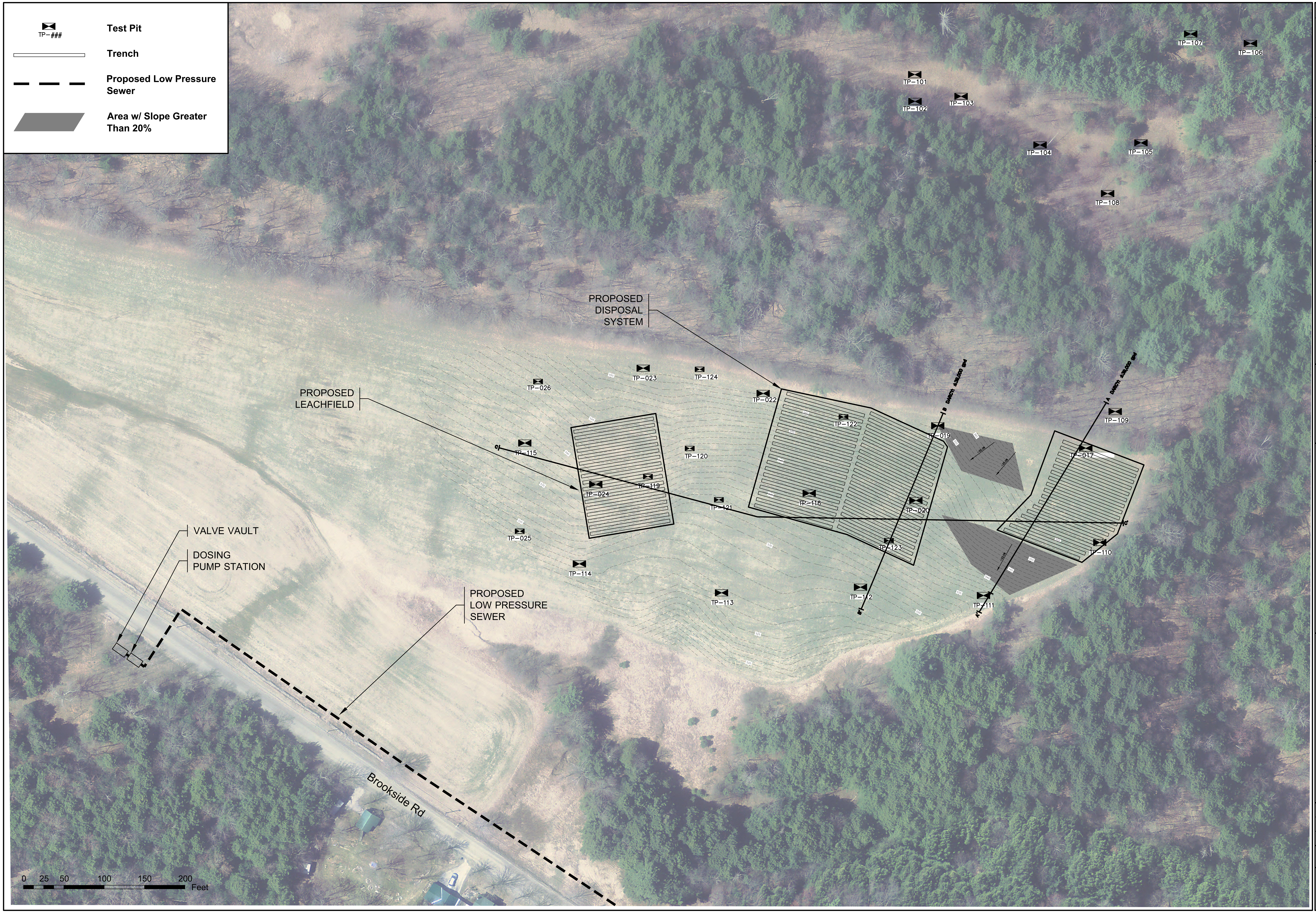
PROJECT: WESTFORD WASTEWATER STUDY

CLIENT: WESTFORD, VERMONT

DESIGNED: KJC	PLOT DATE: 09/30/15
DRAWN: RSO	SCALE: AS SHOWN
CHECKED: KJC	DATE: SEP 2015

PROJECT NO. 25-007

DRAWING NO. 1



REV. | DATE | DESCRIPTION | BY

1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

GREEN MOUNTAIN ENGINEERING
CIVIL
WATER
WASTEWATER

DRAWING TITLE: WASTEWATER DISPOSAL SYSTEM SITE PLAN

PROJECT: WESTFORD WASTEWATER STUDY

CLIENT: WESTFORD, VERMONT

DESIGNED KJC	PLOT DATE 06/01/17
DRAWN RSO	SCALE AS SHOWN
CHECKED KJC	DATE JUNE 2017

PROJECT NO. 25-007

DRAWING NO. 2

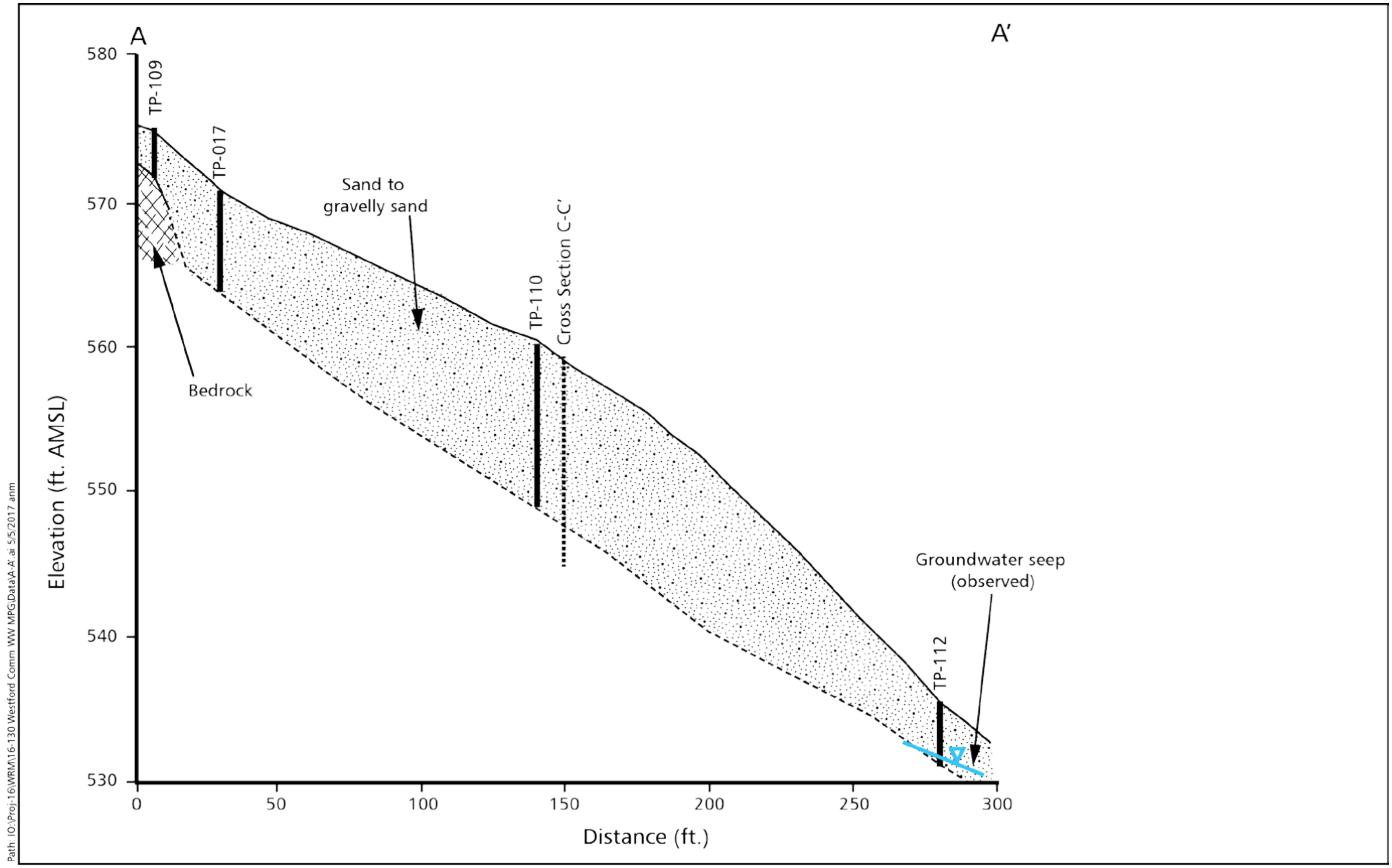


Figure 1: Stratigraphic Cross Section A-A′ (West to East)

Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2016; Green Mountain Engineering topographic survey, 2015-2016.

STONE ENVIRONMENTAL INC

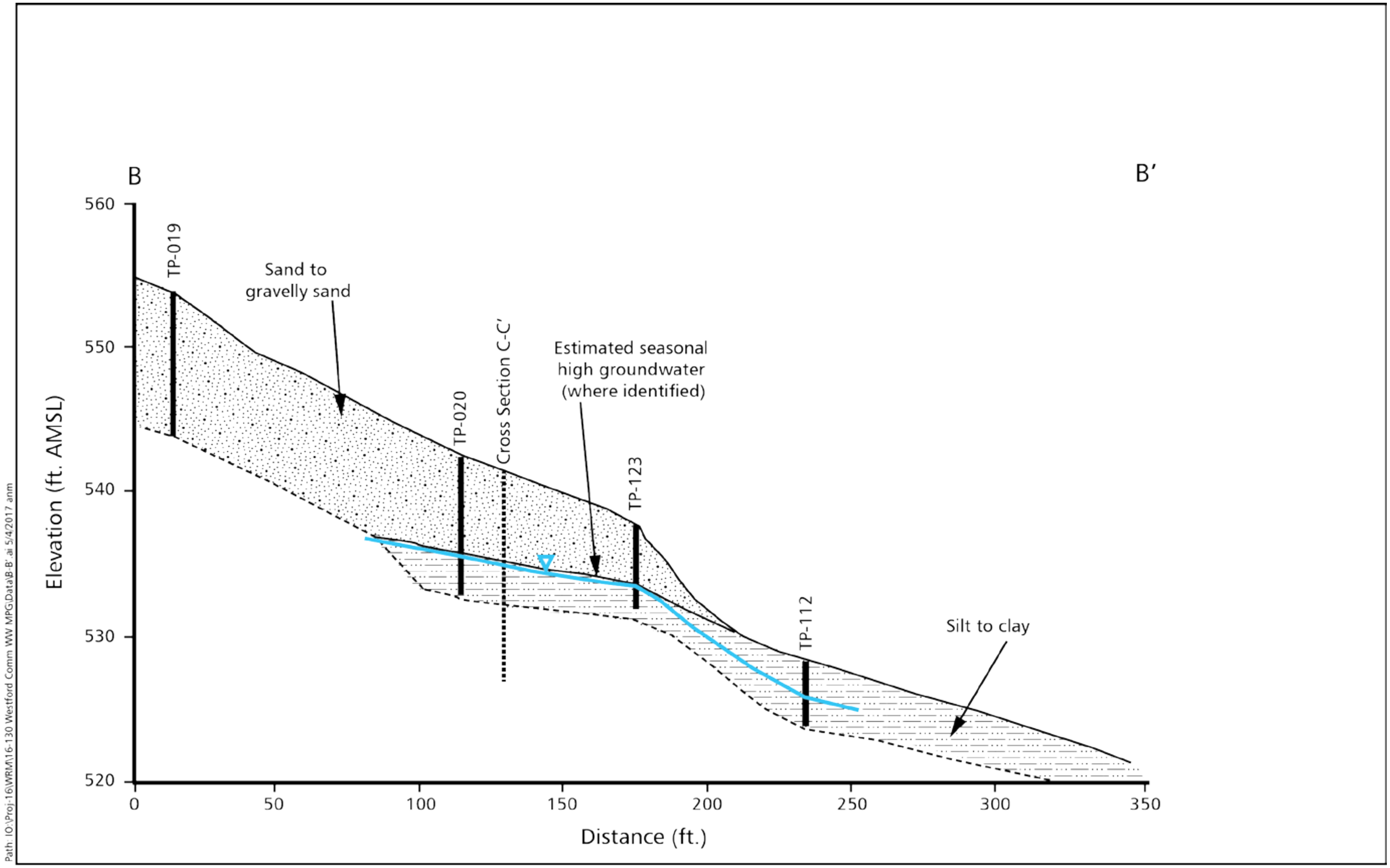


Figure 2: Stratigraphic Cross Section B-B′ (West to East)

Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2016; Green Mountain Engineering topographic survey, 2015-2016.

STONE ENVIRONMENTAL INC

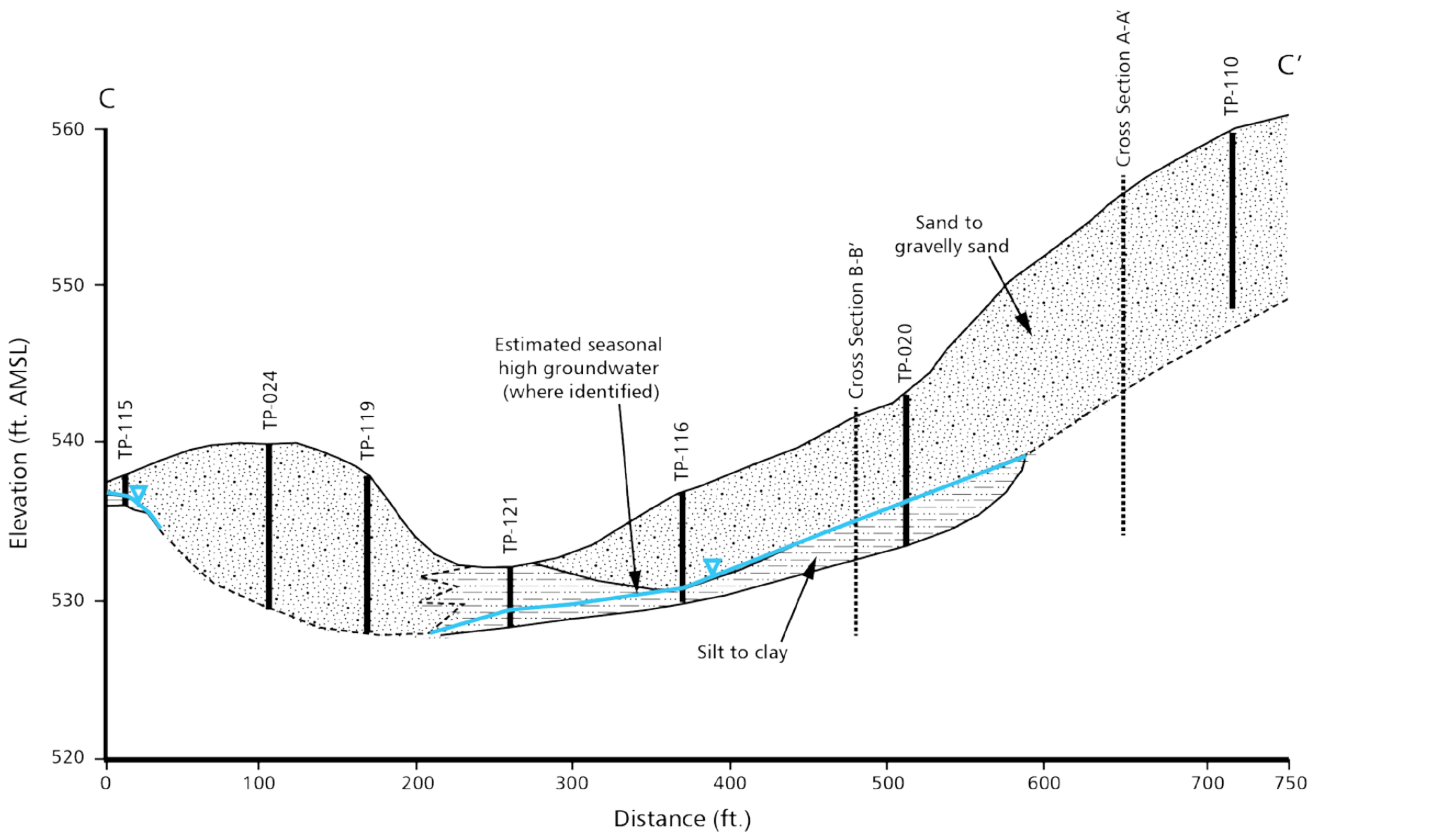


Figure 3: Stratigraphic Cross Section C-C′ (South to North)

Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2016; Green Mountain Engineering topographic survey, 2015-2016.

STONE ENVIRONMENTAL INC

Appendix A: Test Pit Logs and Capacity Calculations

Site Capacity Confirmation and Project Financing Options for Community Wastewater System at the Jackson Farm Property, Westford, Vermont – Backhoe Test Pit Logs

Soils investigation conducted by Amy Macrellis of Stone Environmental, Inc. on November 17, 2016. Backhoe supplied by John Roberts of Roberts Excavation Inc. Others present during some or all of the investigation included David Gauthier (property owner), Melissa Manka (Town of Westford Planning Coordinator), Kevin Camara (Green Mountain Engineering), Mary Clark (Vermont DEC, Indirect Discharge Permitting Program), and Jessanne Wyman (Vermont DEC, Regional Engineer).

Test pits were located using survey-quality GPS prior to excavation, in order to precisely locate the new test pits relative to work completed previously on this property. The preliminary numbering system used on the day of testing included some numbers that duplicated the identification scheme previously used by Donald J. Hamlin Consulting Engineers in their early 2015 investigation of this area. Thus, the descriptions below include both the test pit numbering scheme used during the field investigation, and the final test pit numbering that eliminates duplicate IDs.

"Zone 3" Hay Field

Test Pit TP-117 (TP-025 on day of testing)

0" – 11"	Very dark brown (7.5YR 2.5/3) gravelly fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer. ~5% gravel.
11" – 18"	Strong brown (7.5YR 5/6) gravelly loamy fine sand, weak granular structure, loose consistence, moist.
18" – 27"	Yellowish brown (10YR 5/8) loamy fine sand, weak blocky structure, friable consistence, moist.
27" – 34"	Light olive brown (2.5Y 5/4) clay loam, weak platy structure, friable consistence, moist. Few medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 27" (Stone determination); DEC representatives estimated seasonal high groundwater at 25".

Test Pit TP-118 (TP-026 on day of testing)

0" – 9"	Very dark brown (7.5YR 2.5/2) fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
9" – 14"	Light brown (7.5YR 6/3) gravelly very fine sandy loam, weak granular structure, friable consistence, moist.
14" – 18"	Strong brown (7.5YR 5/6) gravelly fine sand, weak blocky structure, friable consistence, moist. ~10% gravel.
18" – 32"	Yellowish brown (10YR 5/6) fine sand, single grain structure, friable consistence, moist. Gradually becomes stony and with firmer consistence between 26" and 32".
32" – 44"	Olive brown (2.5Y 4/4) clay loam, moderate platy structure, firm consistence, moist. Many medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 32" (Stone determination); DEC representatives estimated seasonal high groundwater at 29" in the northern end of the excavation.

Test Pit TP-119 (TP-027 on day of testing)

0" – 8"	Dark brown (7.5YR 3/3) fine sandy loam to silt loam, weak granular structure, loose consistence, moist. Topsoil.
8" – 16"	Brown (7.5YR 4/4) gravelly loamy fine sand, single grain structure, loose consistence, moist. 15-20% gravel.

16" – 69"	Brown (7.5YR 4/4) gravelly coarse sand to very coarse sand, single grain structure, loose consistence, moist. 15-20% gravel, 5% cobbles.
69" – 120"	Overdug pit, but did not enter. Sand to coarse sand present to depth.

No bedrock or seasonal high groundwater indicators to depth. A lens of light olive brown (2.5Y 5/4) clay loam was present at the north end of the excavation to approximately 18" below ground surface, but no indicators of seasonal high groundwater were present in this material.

Test Pit TP-120 (TP-028 on day of testing)

0" – 12"	Dark brown (7.5YR 3/3) silt loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
12" – 17"	Strong brown (7.5YR 4/6) gravelly very fine sandy loam, weak blocky structure, friable consistence, moist.
17" – 31"	Light olive brown (2.5Y 5/4) silt loam, weak blocky structure, friable consistence, moist. Few fine faint mottles present at 24".
31" – 34"	Light olive brown (2.5Y 5/3) clay loam, moderate platy structure, firm consistence, moist. Few medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 24".

Test Pit TP-121 (TP-029 on day of testing)

0" – 9"	Dark brown (7.5YR 3/3) silt loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
9" – 15"	Strong brown (7.5YR 4/6) gravelly sandy clay loam, weak blocky structure, friable consistence, moist.
15" – 24"	Light olive brown (2.5Y 5/4) silty clay loam, weak blocky structure, friable consistence, moist. Few fine faint mottles present at 20".
24" – 37"	Dark grayish brown (2.5Y 4/2) clay loam, moderate platy structure, firm consistence, moist. Few medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 20".

Test Pit TP-122 (TP-030 on day of testing)

0" – 8"	Dark brown (7.5YR 3/3) loamy fine sand, weak granular structure, loose consistence, moist. Topsoil.
8" – 24"	Brown (7.5YR 4/4) gravelly fine sand to sand, single grain structure, loose consistence, moist. ~5% gravel.
24" – 65"	Brown (2.5Y 5/2) gravelly sand to coarse sand, single grain structure, loose consistence, moist. 5-10% gravel and cobbles.
65" – 120"	Overdug pit, but did not enter. Coarse sand present to depth.

No bedrock or seasonal high groundwater indicators to depth.

Test Pit TP-123 (TP-031 on day of testing)

0" – 7"	Dark brown (7.5YR 3/3) gravelly loamy fine sand, weak granular structure, loose consistence, moist. Topsoil. ~5% gravel.
7" – 36"	Strong brown (7.5YR 4/6) gravelly coarse sand to very coarse sand, single grain structure, loose consistence, moist. ~5% gravel, few cobbles.
36" – 58"	Brown (7/5 YR 4/3) gravelly sand to coarse sand, single grain structure, loose consistence, moist. 5-10% gravel, increasing with depth.

58" – 64"	Olive brown (2.5Y 4/3) silty clay, weak platy structure, firm consistence, moist. Few fine faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 58".

Test Pit TP-124 (TP-032 on day of testing)

0" – 8"	Dark brown (7.5YR 3/3) gravelly loamy sand, weak granular structure, loose consistence, moist. Topsoil with many roots.
8" – 24"	Brown (7.5YR 4/4) gravelly sand to coarse sand, single grain structure, loose consistence, moist. ~10% gravel and cobbles.
24" – 36"	Strong brown (7/5YR 5/6) gravelly fine sand, single grain structure, friable consistence, extremely dry. ~30% gravel.
36" – 84"	Light yellowish brown (2.5Y 6/3) very gravelly fine sand, single grain structure, friable to firm consistence, extremely dry. ~50% gravel.

No bedrock or seasonal high groundwater indicators to depth (96" at uphill/western end of the excavation).

Appendix A, Table 1: Revised Darcy's Law Capacity Analysis, Jackson Farm Site, A-A'

Project Title: Community Wastewater Capacity in the Westford Town Common Area, Jackson Farm site
Stone Project No.: 16-130
Date: December 22, 2016
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA
Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1 Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2 Water table slope (i) is similar to ground surface slope, estimated from site survey, average slope along the A-A' cross section, excluding areas with slope over 20% where leachfields cannot be sited = 23'/200'= 8.7%
3 Depth to limiting feature or bottom of pit (limiting feature unknown in A-A' where leachfields would be sited; use bottom of TP-110, 10.7 feet below ground surface)
4 Design is for in-ground trenches with the bottom of the trenches located 1.5 feet below ground surface
5 Required separation distance to seasonal high groundwater = 3.0 feet for septic tank effluent
6 System length (L) across slope (perpendicular to contours) = 140 feet (along A-A', from treeline west of TP-017 to 25' setback from slope >20%)

Calculations:

K = 69 ft./day
i = 8.7%
L = 140 ft.
D = (10.7 ft. - 1.5 ft. - 3.0 ft.) = 6.2 ft.

Q = 69 ft./day x 0.087 x (140 ft x 6.2 ft) x 7.48 gal/ft^3
Q = 38,975 gallons / day

Appendix A, Table 2: Revised Darcy's Law Capacity Analysis, Jackson Farm Site, B-B'

Project Title: Community Wastewater Capacity in the Westford Town Common Area, Jackson Farm site
Stone Project No.: 16-130
Date: December 22, 2016
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA
Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1. Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2. Water table slope (i) based on elevations of ESHGW at TP-020 and TP-123 along the B-B' cross section as estimated from site survey = 3'/60'= 5%
3. Depth to limiting feature or bottom of pit (ranges from 4.8 ft to >10.0 ft where leachfields would be sited; use average of TP-019, TP-020, and TP-123 = 7.0 feet below ground surface)
4. Design is for in-ground trenches with the bottom of the trenches located 1.5 feet below ground surface
5. Required separation distance to seasonal high groundwater = 3.0 feet for septic tank effluent
6. System length (L) across slope (perpendicular to contours) = 170 feet (along B-B', from treeline west of TP-019 to TP-123)

Calculations:

K = 69 ft./day
i = 5.0%
L = 170 ft.
D = (7.0 ft. - 1.5 ft. - 3.0 ft.) = 2.5 ft.

Q = 69 ft./day x 0.05 x (170 ft x 2.5 ft) x 7.48 gal/ft^3
Q = 10,968 gallons / day

Appendix B: Detailed Calculations for Opinions of Probable Cost and User Fee Estimates

Town of Westford
Jackson Farm Wastewater Capacity Study
Contract No. 1- Septic Tank Effluent Pumping (STEP) Collection System
Opinion of Probable Construction Cost

DESCRIPTION	Unit	Quantity	Unit Price	Total Amount ENR 10,037	Total Amount ENR 11,000
A- Sewers					
A-1 2" HDPE LPS	LF	4,600	$40	$184,000	$201,654
B- Sewerline Appurtenances					
B-1 5' Diameter Air Release/CO Manholes	EA	4	$8,000	$32,000	$35,070
B-2 5' Dia, C.O. Manholes	EA	4	$7,500	$30,000	$32,878
B-3 1 1/4" Low PressureSewer Services	LF	3,300	$34	$112,200	$122,965
B-3 4" Gravity Sewer Services	LF	500	$38	$19,000	$20,823
C- Earthwork					
C-1 Rock Excavation	CY	400	$120	$48,000	$52,605
C-2 Boulder Excavation	CY	50	$100	$5,000	$5,480
C-3 Misc. Extra and Below Grade Excavation	CY	20	$40	$800	$877
C-4 Excavation & Replace Unsuitable	CY	20	$40	$800	$877
D- Roadwork					
D-1 Permanent Bit. Pavement Repair	SY	80	$60	$4,800	$5,261
D-2 Permanent Gravel Road & Drive Repair	SY	800	$50	$40,000	$43,838
E-Incedental Work					
E-1 Class B Concrete	CY	10	$175	$1,750	$1,918
E-2 Calcium Chloride	TON	2	$600	$1,200	$1,315
E-3 Rigid Insulation	LF	300	$8	$2,400	$2,630
E-4 Uniform Traffic Officers	HRS	50	$60	$3,000	$3,288
E-5 Silt Fence	LF	1,000	$4	$4,000	$4,384
E-6 Degradable Erosion Control Blankets	SY	300	$4	$1,200	$1,315
E-7 Temporary Stone Check Dams	EA	12	$120	$1,440	$1,578
E-8 1,500 Gallon STEP Tanks (Includes Electrical and Panels)	EA	31	$10,000	$310,000	$339,743
E-9 2,000 Gallon STEP Tanks (Includes Electrical and Panels)	EA	2	$12,000	$24,000	$26,303
E-10 House Replumbs	EA	10	$1,000	$10,000	$10,959
E-11 Septic Tank Deactivation	EA	33	$1,000	$33,000	$36,166
F- Lump Sum Items					
Preparation of Site and Miscellaneous Work (8%)	LS	1	$69,487	$69,487	$76,154
Bonds (1.5%)	LS	1	$14,071	$14,071	$15,421
Contingency (10%)	LS	1	$95,215	$95,215	$104,350
SUBTOTAL				**$1,047,363**	**$1,147,852**
USE				**$1,050,000**	**$1,150,000**

Notes: The estimate is based on PLANNING phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The quantities and unit prices will likely vary based on the actual design, site conditions. ENR = Engineering News Record- Construction Cost Index. ENR 10,037= July 2015. ENR 11,000= Predicted February 2018 (Bid Date)

Town of Westford
Jackson Farm Wastewater Capacity Study
Contract No. 2- Wastewater Disposal System
Opinion of Probable Construction Cost

DESCRIPTION	Unit	Quantity	Unit Price	Total Amount ENR 10,037	Total Amount ENR 11,000
Mobilization/Demobilization	LS	1	$3,000	$3,000	$3,288
Silt Fence	LF	600	$3	$1,800	$1,973
Excavate Leachfield Trenches	CY	2,333	$8	$18,667	$20,458
Leachfield Stone	CY	1,383	$25	$34,568	$37,885
1 1/2" Laterals	LF	7,000	$6	$42,000	$46,030
Filter Fabric	SY	3,111	$2	$6,222	$6,819
Topsoil	CY	86	$25	$2,160	$2,368
3" Forcemains	LF	2,000	$30	$60,000	$65,757
3" Gate Valves	Ea	6	$800	$4,800	$5,261
6' x 12' Precast Valve Structure					
Excavation	CY	80	$8	$640	$701
Precast Structure	LS	1	$8,000	$8,000	$8,768
Hatch	LS	1	$3,000	$3,000	$3,288
Steps	LS	1	$600	$600	$658
Sump Pump	LS	1	$500	$500	$548
3" Gate Valves	EA	6	$400	$2,400	$2,630
3" Check Valves	Ea	3	$400	$1,200	$1,315
3" SCh 80 PVC Pipe	LF	24	$40	$960	$1,052
Vent Pipe	LS	1	$300	$300	$329
Misc. Items	LS	1	$1,500	$1,500	$1,644
Structural Backfill	CY	50	$25	$1,250	$1,370
6' x 12' Precast Dosing Tank					
Excavation	CY	80	$8	$640	$701
Precast Structure	LS	1	$8,000	$8,000	$8,768
Hatches	LS	1	$9,000	$9,000	$9,864
Pumps and Slide Rails	EA	6	$5,000	$30,000	$32,878
3" SCh 80 PVC Pipe	LF	24	$40	$960	$1,052
Vent Pipe	LS	1	$300	$300	$329
Misc. Items	LS	1	$1,500	$1,500	$1,644
Structural Backfill	CY	50	$25	$1,250	$1,370
Electrical (New Service, Panel., Wiring)	LS	1	$30,000	$30,000	$32,878
Temporary Road					
Excavation	CY	444	$8	$3,556	$3,897
Filter Fabric	SY	1,333	$2	$2,667	$2,923
Gravel	CY	444	$25	$11,111	$12,177
Fine Grade, Seed and Mulch	SY	17,778	$2	$35,556	$38,967
Start-Up/Testing	LS	1	$3,000	$3,000	$3,288
Preparation of Site and Miscellaneous Work (8%)	LS	1	$26,488	$26,488	$29,030
Bonds (1.5%)	LS	1	$5,364	$5,364	$5,879
Contingency (10%)	LS	1	$36,296	$36,296	$39,778
SUBTOTAL				**$399,254**	**$437,561**
USE				**$415,000**	**$440,000**

Notes: The estimate is based on PLANNING phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The quantities and unit prices will likely vary based on the actual design, site conditions. ENR = Engineering News Record- Construction Cost Index. ENR 10,037= July 2015. ENR 11,000= Predicted February 2018 (Bid Date)

Town of Westford Jackson Farm Wastewater Capacity Study Opinion of Probable Total Project Cost	
DESCRIPTION	**Total Cost**
Construction	
Contract No. 1- Wastewater Collection System [1.]	$1,150,000
Contract No. 2- Wastewater Disposal System [1.]	$440,000
Construction Subtotal	**$1,590,000**
STEP I- Preliminary Engineering	
Feasibility Study	$10,000
Preliminary Engineering Study [2.]	$54,855
Act 250 Permitting	$5,000
Indirect Discharge Permitting	$25,000
Water Supply/Wastewater Disposal Permits	$2,000
Archeological Phase 1 B	$5,000
Wetlands Review	$2,500
Environmental Assessment Report	$5,000
Bond Vote Technical Assistance	$5,000
Sewer Use Ordinance	$5,000
STEP I- Preliminary Engineering Subtotal	**$119,355**
STEP II- Final Design Engineering	
Final Design Allowance [2.]	$109,710
STEP II- Final Design Subtotal	**$109,710**
STEP III- Construction Engineering Services	
Construction Enginering [2.]	$201,135
STEP III- Construction Engineering Subtotal	**$201,135**
Other Costs	
Administrative	$5,000
Land Acquisition	$150,000
Easement Assistance	$5,000
Legal & Fiscal	$5,000
Short Term Interest	$40,000
Other Costs Subtotal	**$205,000**
BTOTAL	**$2,225,200**
USE	**$2,230,000**

Notes: The estimate is based on PLANNING phase estimates for construction and engineering. The quantities noted in the estimate are based on GIS scaled unit quantities from scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The quantities and unit prices will likely vary based on the actual design, site conditions. ENR = Engineering News Record- Construction Cost Index. ENR 11,000= Predicted February 2018 (Bid Date)

Constuction Cost	1590000

TABLE I	Projects < $713,300		
Engineering Step	Fixed Fee Allowance	Variable Fee Allowance	Total Fee Allowance
Preliminary	N/A	N/A	N/A
Final Design	N/A	N/A	N/A
Construction	N/A	N/A	N/A
Total	N/A	N/A	N/A

TABLE II	Projects > or = $713,300
Engineering Step	Fee Allowance
Preliminary	$54,855
Final Design	$109,710
Construction	$201,135
Total	$365,700

Town of Westford
Jackson Farm Wastewater Capacity Study
Opinion of Probable First Year O&M Cost

Cost Category	O&M Cost
Contract Operations	$13,000
Electrical	$2,500
Septage Pumping	$2,500
Groundwater Monitoring	$3,000
Capital Replacement	$1,000
Insurance	$500
Misc. Repairs	$1,000
Billing	$500
O&M Cost Total	**$24,000**

Notes: The estimate is based on PLANNING phase estimates for O&M Costs. The estimateis based on scenario's developed by Green Mountain Engineering (GME). GME bears no responsibility for prices and quantities noted in the estimate, beyond the planning phase. The costs will likely vary based on the actual design, site conditions. Contract Operations is based on $45/hour x 288 hr/yr. Electrical is based on $0.14/kw-hr. Each homeowner pays for their own STEP system electrical cost. Septage pumping is based on 1/4 systems pumped each year at a cost of $300/pump out.

Town of Westford
Jackson Farm Wastewater Capacity Study
User Fee Estimates- Users Pay 100%

Category	No Grants	35% Grants	50% Grants	75% Grants
Bond Repayment Amount	$2,230,000	$1,449,500	$1,115,000	$557,500
Annual Bond Payment	$136,365	$88,637	$68,182	$34,091
Annual O&M costs	$24,000	$24,000	$24,000	$24,000
Total Annual Cost	$160,365	$112,637	$92,182	$58,091
No. of EU's	39	39	39	39
Annual User Fee	**$4,112**	**$2,888**	**$2,364**	**$1,490**

Notes: Annual Payment 20yr., SFRF 2% loan ($61.16/$1,000 borrowed)

Town of Westford
Jackson Farm Wastewater Capacity Study
User Fee Estimates- Property Assessment Fee

Category	No Grants	35% Grants	50% Grants	75% Grants
Bond Repayment Amount	$2,230,000	$1,449,500	$1,115,000	$557,500
Annual Bond Payment	$136,365	$88,637	$68,182	$34,091
Increase in Tax Rate Needed	$0.055	$0.036	$0.027	$0.014
Propery Value Assessed Fee	**$151**	**$98**	**$76**	**$38**
Annual O&M costs	$24,000	$24,000	$24,000	$24,000
No. of EU's	39	39	39	39
User O&M Fee	$615	$615	$615	$615
Total User Fee	**$766**	**$714**	**$691**	**$653**

Notes: Annual Payment 20yr., SFRF 2% loan ($61.16/$1,000 borrowed); Property value assessed fee is that typical for a property value of $275,000.

Town of Westford
Jackson Farm Wastewater Capacity Study
User Fee Estimates- Parcel Assessment

Category	No Grants	35% Grants	50% Grants	75% Grants
Bond Repayment Amount	$2,230,000	$1,449,500	$1,115,000	$557,500
Annual Bond Payment	$136,365	$88,637	$68,182	$34,091
No. of Parcels	936	936	936	936
Annual Parcel Fee	**$146**	**$95**	**$73**	**$36**
Annual O&M costs	$24,000	$24,000	$24,000	$24,000
No. of EU's	39	39	39	39
User O&M Fee	$615	$615	$615	$615
Total User Fee	**$761**	**$710**	**$688**	**$652**

Notes: Annual Payment 20yr., SFRF 2% loan ($61.16/$1,000 borrowed)

C-5. Preliminary Aquatic Permitting Criteria Compliance Assessment, Jackson Farm Community Wastewater Site

January 10, 2019

Melissa Manka, Planning Coordinator
Town of Westford
1713 Route 128
Westford, VT 05494
Submitted via e-mail to planner@westfordvt.us

Stone Project No. 18-021
Subject: Preliminary Aquatic Permitting Criteria Compliance Assessment, Jackson Farm Community Wastewater Site, Westford, Vermont

Dear Melissa,

Stone Environmental, Inc. (Stone) is pleased to present a preliminary evaluation of the capacity of the Browns River to assimilate renovated effluent from the proposed 12,600 gallon per day (GPD) community wastewater disposal field on the Jackson Farm property while meeting the Aquatic Permitting Criteria (APC) under Vermont's Indirect Discharge Rules. This order-of-magnitude assessment determined that the design flow proposed can be treated and dispersed while meeting the nutrient-based APC for nitrate-nitrogen (nitrate-N) and total dissolved phosphorus (TDP) in the Browns River.

We recommend that the Town and consulting team meet with Indirect Discharge Program staff to review work completed to date and the results of this assessment, with the goal of obtaining concurrence that the work is sufficient to allow preliminary approval of a community alternative wastewater system. This approval is required in order for the Town to apply for Neighborhood Development Area designation with the Agency of Commerce and Community Development. We also recommend that the Town pursue development of a Capacity Application under the Indirect Discharge Rules.

1. Determination of Receiving Stream and Points of Compliance

This task was completed in coordination with Green Mountain Engineering, Vermont Department of Environmental Conservation (DEC) staff, and the Town. A site meeting was held on September 7, 2018 to review background information and walk over the property. The parties attending were:

- Melissa Manka, Town of Westford
- Aaron Moore and Jim Deshler, Vermont DEC
- Kevin Camara, PE, Green Mountain Engineering
- Amy Macrellis, Stone Environmental, Inc.

Topics of discussion during this meeting and site walk included the history and results of monitoring, testing, and preliminary design previously conducted at the site; an overview of the proposed community wastewater system; and determination of whether the drainage channel adjacent to the proposed disposal field would be suitable for biological monitoring or use as a point of compliance for determining compliance with the APC. Following the site meeting, Aaron Moore confirmed that the biological compliance point for the project would be the Browns River. A precise compliance point was not established due to access and timing; the confluence of the drainage running from south to north away from the proposed leachfield and the Browns River is north of VT Route 128 and on private property.

Following determination of the receiving stream and estimated point of compliance, Stone conducted a preliminary assessment of the proposed community leachfield's potential for compliance with the APC for nitrate-N and TDP, using the Modified Site Specific Compliance (§14-908) method for demonstration of compliance. This method was chosen out of an abundance of caution as early in the determination process, the receiving stream, and thus the stream's low median monthly flow, were not known. This method "may be used to demonstrate compliance ...for septic tank/leachfield systems with capacities of 30,000 gpd or less that discharge to streams using default values for concentrations of in-ground effluent parameters" (§14-908(a)).

2. Watershed Delineation and Existing Data Review

Stone delineated the watershed area of the Browns River as related to the likely point of compliance under the Indirect Discharge Rules, based on the best existing topographic data and using Geographic Information Systems (GIS) spatial analysis tools (Figure 1). We collected and reviewed available in-stream water quality monitoring data for the Browns River, particularly as those data relate to the APC for nutrients (nitrate-N and TDP). We attempted to review existing Indirect Discharge wastewater permitting records for properties in the up-stream portions of the watershed, but no permitted properties exist in the area.

In-stream water quality data are available for the Browns River upstream of the proposed compliance point. Under the guidance of Kevin Sherman, an instructor at the Westford Elementary School, 5th and 6th-grade science students have been performing water quality testing and biological monitoring activities just down-stream of the Westford Covered Bridge (near the intersection of Cambridge Rd. and Huntley Rd.) since approximately 1994. Compilation of these records is still in process. Chemical monitoring data collected by the students in the spring of 2018 indicated excellent water quality in the Browns River, with nitrate-N and total phosphorus concentrations typical of Vermont background conditions. Samples collected by the students in the fall of 2018 were taken after several days of rain, and showed slightly elevated turbidity and elevated nutrient concentrations, as might be expected following a series of substantial rain events.

Finally, our review of existing data showed that stream flow in the Browns River is not gaged. Additional literature review and data collection were needed to complete an assessment of the proposed system's potential for compliance with the APCs, as described below.

3. Browns River Low Median Monthly Flow (LMMF) Evaluation

Stone reviewed electronic datasets available from the US Geological Service and others, to select the most appropriate low flow conditions for the Browns River for use in the mass balance calculations.

Our primary data source was daily stream discharge records downloaded from the United States Geologic Survey's (USGS) National Water Information System website at http://waterdata.usgs.gov/nwis/sw. Stream flow records were collected fusing the following screening criteria:

- Only watersheds located in eastern New York, Vermont, New Hampshire, and inland Maine were considered.
- At least five years of daily stream discharge values were available for the watershed (minimum of 1,825 records).
- The watershed had an area of approximately 50 square miles (32,000 acres) (query range 45-55 square miles).
- The average slope of the watershed was within 3% of the Browns River's mean slope (calculated at 3.5%, given a watershed length of 17.9 miles and elevation change of 3,308 feet).

A total of nine watersheds were identified using these initial screening criteria (Table 1), and the full stream flow datasets were downloaded for analysis. For each dataset, all daily stream flow values for each full month were grouped together, and a monthly median was calculated (so, for example, a median monthly flow was calculated for all January values regardless of year). Once median stream flow values were calculated for each month, the minimum or low monthly median flow was selected for each stream and is reported in Table 1. This LMMF value was divided by each watershed's area to calculate a 'unitized' LMMF.

During the calculation process, five of the original nine watersheds were found to be unusable (Table 1). The Peabody River drains the eastern slopes of Mt. Washington and the western slopes of Carter Dome and Wildcat Mountain, and most of the watershed does not contain conditions representative of those in the Browns River watershed. The stream gage on Wilson Stream in East Wilton, Maine is located just below an impoundment. It was not clear how much flow is controlled by the impoundment, so the watershed was removed from consideration. Records for three additional watersheds meeting the initial screening criteria did not contain a full year of observations collected within the last 50 years (1968 or later).

The four remaining watersheds are located in Vermont and eastern New York. These watersheds, with areas ranging from 50 mi^2 to 54 mi^2, have unitized LMMF values ranging between 0.09 cfs/mi^2 and 1.04 cfs/mi^2 (Table 1). We recommend that the average unitized LMMF for the four identified watersheds (0.51 cfs/mi^2), which results in a LMMF of 25.5 cfs for the Browns River at the estimated compliance location north of the Westford Town Center, be used to complete the mass balance compliance calculations.

Table 1. Summary of Watershed Characteristics and Stream Flows.

USGS ID	Stream Name and Location	Period of Record	Watershed Area (mi^2)	Watershed Slope	LMMF (cfs)	Unitized LMMF (cfs/mi^2)
Reference Watershed						
n/a	Browns River north of Westford Town Center	n/a	50	0.035	25.5	0.51
Watersheds with Acceptable Data						
04276842	Putnam Creek East of Crown Point Center, NY	1990-2018	52	0.026	8.6	0.17
04271815	Little Chazy River near Chazy, NY	1990-2018	50	0.013	4.6	0.09
01133000	East Branch Passumpsic River near East Haven, VT	1938-2018	54	0.047	39.5	0.73
04281500	East Creek at Rutland, VT	1940-1977	51	0.064	53	1.04
Watersheds Evaluated With Unusable Data						
01054114	Peabody River at Gorham, New Hampshire[a]	2012-2018	46	0.088	n/c	n/c
01047730	Wilson Stream at East Wilton, Maine[b]	1977-1984	46	n/c	n/c	n/c
04286500	Dog River at Northfield, Vermont[c]	1909-1943	52	n/c	n/c	n/c
04274500	Black Brook at Black Brook, New York[c]	1924-1969	49	n/c	n/c	n/c
04268600	E. Branch St. Regis River Near Meacham Lake, New York[c]	1958-1968	52	n/c	n/c	n/c
Recommended Estimated LMMF for Browns River[d]					**25.5**	**0.51**

Sources: USGS, 2018; Stone Env. analysis, 2018.

Notes: mi^2 = square miles; cfs = cubic feet per second; n/a = not applicable; n/c = not calculated.

[a] Much of the watershed is steeply sloping. Includes Mt. Washington eastern slopes, Carter Dome, Wildcat Mountain. Not representative of Browns River watershed conditions.

[b] Gage is located below an impoundment - not representative of Browns River conditions.

[c] Period of record does not include any data in last 50 years, calculations not completed.

[d] The recommended unitized low median monthly flow (LMMF) was calculated as the average for the four watersheds with acceptable flow data.

init: 11/26/18, anm

The LMMF of 25.5 cfs proposed for the Browns River translates to a daily flow value of 16,473,000 GPD. Given the Browns River's large watershed area and the correspondingly large LMMF, the Dilution method (§14-902 of the IDRs) may also be used to determine compliance with the APCs. It is a simpler method, and is allowed for septic tank/leachfield systems with design capacity of 20,000 gpd or less that indirectly discharge to streams. Under this method, a system is presumed to meet the APCs and the Vermont Water Quality Standards "if the ratio of the low median monthly flow of the receiving stream to the design capacity is 120:1 or greater" (§14-902(b)). The ratio of the Browns River LMMF to the proposed indirect discharge is 1,307:1 – substantially greater than the required 120:1 ratio.

4. In-Stream Water Quality Sampling

Surface water samples were collected at one location in the Browns River, as near as possible to the compliance location identified by Vermont DEC without requiring access to private property. The location was on the east bank of the river off Huntley Road, south of the intersection with Drinkwine Road (Figure 2). Samples were collected in accordance with Section 14-910(2)(A) of the Indirect Discharge Rules with a deviation on the number of samples collected. This late in the season, it was not possible to collect enough samples to fully satisfy the requirements of this section. Meeting these requirements will require collection of at least 10 surface water samples within a year's time, and those samples must be collected according to a Quality Assurance / Quality Control (QA/QC) Plan approved by Indirect Discharge Program staff.

Samples were collected on October 10 and October 26, 2018. Care was taken to avoid sampling surface water within 24 hours of precipitation. All samples were collected in accordance with Stone's Standard Operating Procedures for surface water sampling. Temperature, pH, and conductivity were measured in the field, and each sample was analyzed for chloride, nitrate-nitrogen (nitrate-N), and total dissolved phosphorus (TDP) (collected in duplicate) at the Endyne, Inc. laboratory facility in Williston, Vermont. Results of the surface water sampling are presented in Table 2.

Table 2. Surface Water Sampling Results, Browns River Above Compliance Point

Date	Temperature (deg. C)	pH	Conductivity (uS)	Chloride (mg/L)	Nitrate-N (mg/L)	TDP (mg/L)	Total P (mg/L)
10/10/2018	18.4	7.87	179.90	12	<0.20	0.011	
10/10/2018 - duplicate						0.010	
10/26/2018	4.3	7.62	183.90	8.7	<0.20	0.012	0.014
10/26/2018 - duplicate						0.015	0.016

Source: Stone Environmental assessment and field notes and Endyne Inc. analytical results, 2018

Date/init: 11/29/2018 anm

5. Aquatic Permitting Criteria Preliminary Compliance Assessment

The potential compliance of the proposed indirect discharge system with the Aquatic Permitting Criteria was evaluated per §14-911 and §14-912 of the Indirect Discharge Rules under the proposed 12,600 gpd design flow. The details of each analysis, and the analysis results, are described below for nitrate-N and TDP.

5.1.1 Soil renovated effluent data

Soil renovated effluent results for nitrate-N and TDP in the downgradient groundwater are not available, so default concentrations for each of the in-ground effluent quality parameters listed in Table 5 of the Indirect Discharge Rules were applied, consistent with the Modified Site Specific Compliance Method (§14-908) of the IDRs. The default concentration for nitrate-N is 60 mg/L, while the default concentration for TDP is 0.14 mg/L.

5.1.2 System Discharge Flows

The proposed design flow of 12,600 gpd was utilized in the mass balance compliance calculations.

5.1.3 In-stream water quality data

Given the limited number of in-stream water quality results available at this stage, the data were not evaluated in accordance with §14-911 of the IDRs. Instead, the average of the two available surface water results were utilized as a proxy for the 95% confidence values, which would normally be used as the basis for calculation and determination of compliance with the APCs. The average in-stream values of 0.20 mg/L for nitrate-N and 0.012 mg/L for TDP were utilized as the existing in-stream receiving water concentrations for purposes of the mass balance calculations (Table 1).

In addition to the proposed indirect discharge meeting the Aquatic Permitting Criteria in the IDRs, water quality in the stream must also meet the relevant Vermont Water Quality Standards[1] (WQS). The standard for nitrate-N in Class B(2) waters is "not to exceed 5.0 mg/l as NO_3-N at flows exceeding low median monthly flows". The applicable WQS for total phosphorus is not clear, as the Browns River is a medium-gradient stream and a cold-water fishery. Table 2 in the WQS indicates that for Class B(2) waters, the nutrient criteria for total phosphorus in medium, high-gradient streams is 0.015 mg/L, while in warm-water, medium-gradient streams it is 0.027 mg/L. In all cases, water in the Browns River above the proposed compliance point, as sampled in October 2018, appears to be in compliance with the WQS for nutrients.

5.1.4 Stream Flow Data

As described in Section 2.1, daily stream flow records were collected for nine watersheds with watershed areas and other characteristics reasonably similar to those of the Browns River. An estimated unitized LMMF of 0.51 cubic feet per second per square mile of watershed area (cfs/mi^2), resulting in a LMMF of 25.5 cfs, was applied in the mass balance calculations.

5.1.5 Compliance with Aquatic Permitting Criteria

Compliance with the Aquatic Permitting Criteria (APC) for nitrate-N and TDP was evaluated in accordance with §14-912 of the IDRs.

[1] https://dec.vermont.gov/sites/dec/files/documents/wsmd_water_quality_standards_2016.pdf

The Aquatic Permitting Criteria for nitrate-N is that "indirect discharge will not raise the in-stream concentration of nitrate nitrogen at the point of compliance at the designated stream flow above 2.0 mg/L. The 2.0 mg/L limitation must include the background concentration of nitrate nitrogen and is applicable to all upland waters (§14-701(b)(4))". The mass balance compliance calculations for nitrate-N are shown in Table 2. The calculation completed for the proposed design flow of 12,600 gpd results in a calculated in-stream nitrate-N concentration of 0.25 mg/L, which is 1.75 mg/L below the APC.

Table 3. Aquatic Permitting Criteria Compliance Calculations, Nitrate-Nitrogen.

Mass Balance Equation for Calculating Resulting In-Stream Concentrations (per §14-912):

$$\frac{[E_c \times E_q + D_c \times D_q]}{(E_q + D_q)} = \text{Resulting in-stream concentration, where:}$$

E_c = existing in-stream water concentration (estimated based on October 2018 sampling, mg/L)
E_q = Appropriate stream flow at point of compliance, for annual release rate (gal/day)
D_c = In-ground effluent concentration (estimated per §14-908, Table 5 in the IDRs), mg/L)
D_q = Proposed discharge flow (design capacity, gal/day)

Proposed Permitted Capacity Wastewater Flow Scenario:				
Existing in-stream receiving water concentration (E_c)	0.20	mg/L		
Appropriate stream flow (E_q)	16,473,000	gal/day or	25.5	ft^3/sec
In-ground effluent concentration (D_c)	60	mg/L		
Proposed discharge flow (D_q)	12,600	gal/day or	0.020	ft^3/sec
Resulting In-stream Concentration at 12,600 gal/day =	0.25	mg/L		
APC Standard, <2.0 mg/L downstream, including background =	2.0	mg/L		

Source: Stone Environmental assessment and field notes and Endyne Inc. analytical results, 2018

Date/init: 11/27/2018 anm

The Aquatic Permitting Criteria for TDP is that "the indirect discharge will not increase the in-stream concentration of Total Dissolved Phosphorus at the point of compliance at the designated stream flow by more than 0.001 mg/L above existing background concentration. The applicant shall also demonstrate the indirect discharge will not increase the in-stream Total Phosphorus above any limit established in the Water Quality Standards (§14-701(b)(1))". The mass balance compliance calculations for TDP are shown on Table 3. The calculation completed for the proposed design flow of 12,600 gpd results in a calculated in-stream TDP concentration of 0.011 mg/L—essentially no change from the existing in-stream receiving water concentration, and in compliance with both the APC and the WQS.

Table 4. Aquatic Permitting Criteria Compliance Calculations, Total Dissolved Phosphorus.

Mass Balance Equation for Calculating Resulting In-Stream Concentrations (per **§14-912**):				
$\frac{[E_c \times E_q + D_c \times D_q]}{(E_q + D_q)}$ = Resulting In-stream concentration, where:				
E_c = existing in-stream water concentration (estimated based on October 2018 sampling, mg/L)				
E_q = Appropriate stream flow at point of compliance, for annual release rate (gal/day)				
D_c = In-ground effluent concentration (estimated per §14-908, Table 5 in the IDRs), mg/L)				
D_q = Proposed discharge flow (design capacity, gal/day)				
Proposed Permitted Capacity Wastewater Flow Scenario:				
Existing in-stream receiving water concentration (E_c)	0.012	mg/L		
Appropriate stream flow (E_q)	16,473,000	gal/day or	25.5	ft^3/sec
In-ground effluent concentration, (Table 5, §14-908) (D_c)	0.140	mg/L		
Proposed discharge flow (D_q)	12,600	gal/day or	0.020	ft^3/sec
Resulting In-stream Concentration at 12,600 gal/day =	0.012	mg/L		
APC Standard, <0.001 mg/L increase from upstream =	0.013	mg/L		

Source: Stone Environmental assessment and field notes and Endyne Inc. analytical results, 2018

Date/init: 11/29/2018 anm

Thank you for the opportunity to work with the Town to advance this important project. We stand ready to answer any questions you may have about our work and look forward to meeting with Green Mountain Engineering and the Vermont Indirect Discharge Program staff on your behalf.

Sincerely,

Amy Macrellis

Amy Macrellis
Senior Water Quality Specialist
Direct Phone / 802.229.1884
Mobile / 802.272.8772
E-Mail / amacrellis@stone-env.com

cc: Alan Huizenga, Green Mountain Engineering
Mary Clark and Bryan Harrington, Vermont DEC Indirect Discharge Program

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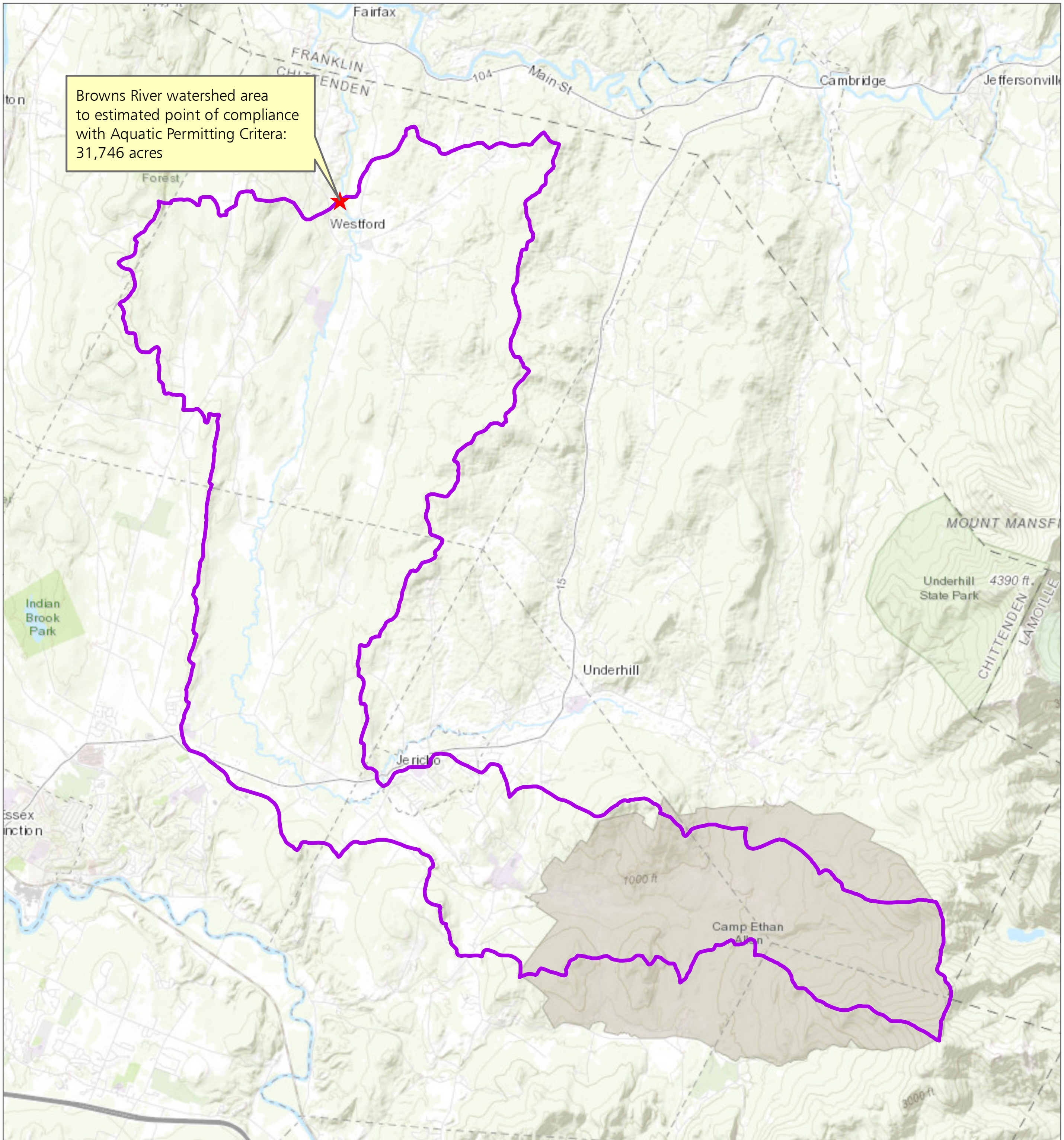


LEGEND

★ Compliance Point (estimated)

Browns River Watershed to Compliance Point

N

0 2,400 4,800

Feet

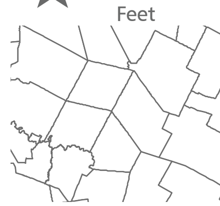


Figure 1, Browns River Watershed to Estimated Compliance Point

Preliminary Aquatic Permitting Criteria Compliance Assessment

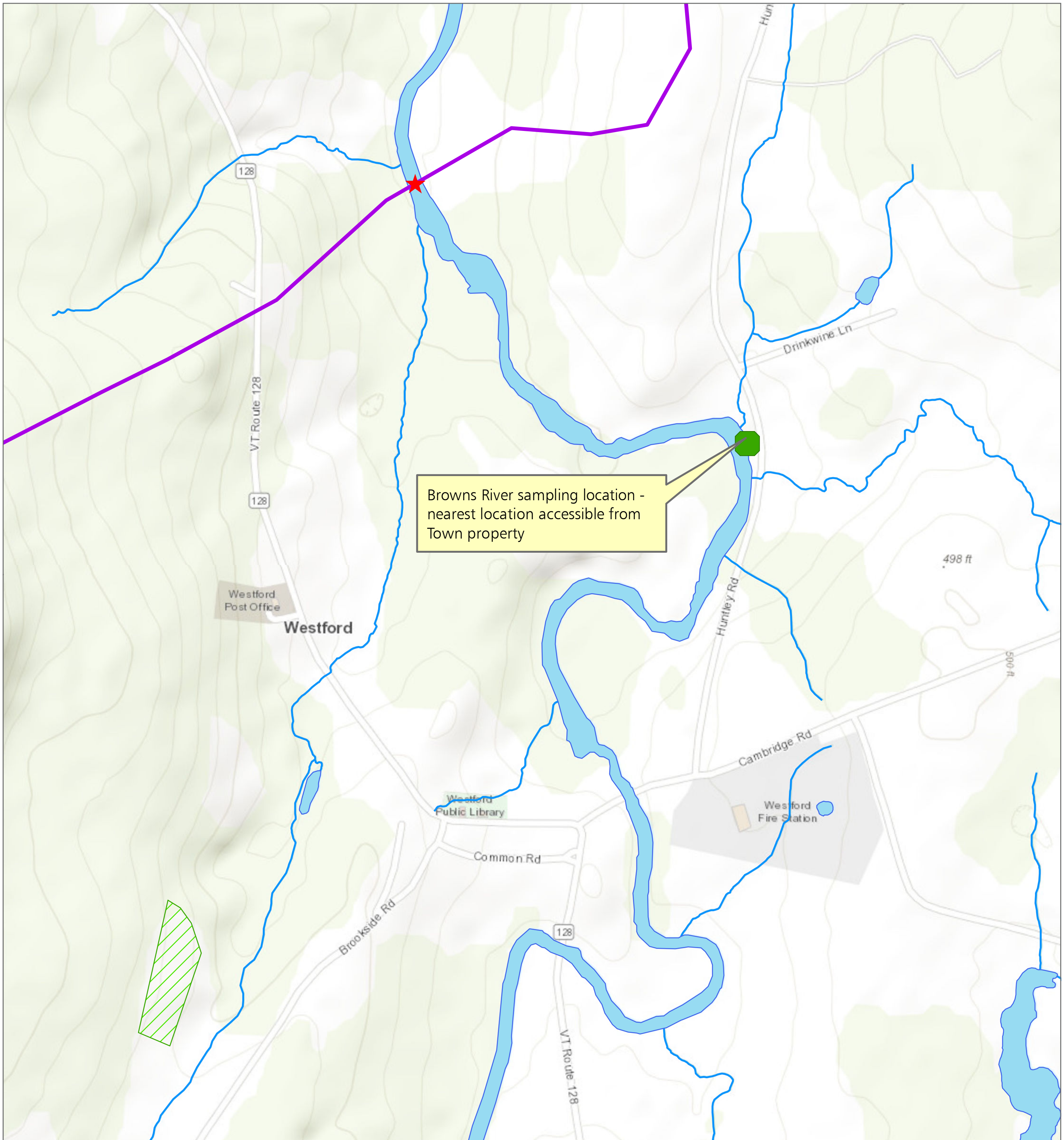
Prepared for the Town of Westford

STONE ENVIRONMENTAL

Sources: Watershed boundary: Vermont Hydrography Dataset (VHD), NHDPlus v2, Stone. Topo graphic base map: Esri World Imagery

Path: O:\PROJ-18\WRM\18-021 Westford WW APC Assessment\GIS\Westford_BrownsRiverCompliancePoint.mxd Saved: 11/16/2018 by AmyM

Notes: Watershed boundary to compliance point delineated from VHD WBD12 boundary for



LEGEND

- Sampling Location
- Compliance Point (estimated)
- Town Center Community WW Disposal Area
- Browns River Watershed to Compliance Point

N

0 190 380

Feet

Figure 2, Browns River, Surface Water Sampling Location

Preliminary Aquatic Permitting Criteria Compliance Assessment

Prepared for the Town of Westford

STONE ENVIRONMENTAL

Sources: Watershed boundary: Vermont Hydrography Dataset (VHD), NHDPlus v2, Stone. Topo graphic base map: Esri World Imagery

Path: O:\PROJ-18\WRM\18-021 Westford WW APC Assessment\GIS\Westford_BrownsRiverSamplingLocation.mxd Saved: 11/29/2018 by AmyM

Notes: Watershed boundary to compliance point delineated from VHD WBD12 boundary for

C-6. Capacity Determination and Aquatic Permitting Criteria Assessment, Jackson Farm Site

VERMONT

Vermont Department of Environmental Conservation
Drinking Water and Groundwater Protection Division
One National Life Drive - Main 2
Montpelier, VT 05620-3521
www.vermontdrinkingwater.org

Agency of Natural Resources

March 25, 2019

Melissa Manka, Planning Coordinator
Town of Westford
1713 VT Route 128
Westford, VT 05494

RE: Capacity Determination and Aquatic Permitting Criteria Assessment
Jackson Farm Site, Westford, Vermont

Dear Melissa,

I am writing in response to the recommendation by Stone Environmental that the Town of Westford obtain a Capacity Determination for a New Indirect Discharge of Sewage in accordance with Subsection 14-402 of the Indirect Discharge Rules for the Jackson Farm site in Westford, Vermont. The Indirect Discharge Program has reviewed the soil investigations performed at the site by Donald Hamlin Consulting Engineers and later by Stone Environmental, the desktop hydraulic capacity analysis and evaluation of aquatic permitting criteria prepared by Stone Environmental, and the proposed wastewater site plan submitted by Green Mountain Engineering. Indirect Discharge Program personnel have also visited the site on a couple of occasions and looked at the soils in numerous test pits.

The Indirect Discharge Program concurs that the proposed wastewater disposal area, referred to as Zone 3, at the Jackson Farm can accommodate up to 12,600 gallons per day of treated sewage at a loading rate of 0.9 gallons per day per square foot of trench area for a 100% dual alternation system. In fact, based on the Green Mountain Engineering March 20, 2019 revised site plan, the disposal capacity may be slightly higher than the 12,600 gallons per day indicated the Stone Environmental reports. However, due to the close proximity of poor soils at test pit TP-120, the final design of the largest leachfield in the disposal system may need to be refined to meet the requirements of the Indirect Discharge Rules for disposal capacity of at least 12,600 gallons per day.

During a September 7, 2018 site visit, the Agency’s aquatic biologists determined that the small unnamed drainage channel downgradient of the proposed disposal site is not suitable for biological monitoring. Therefore, the point of compliance for the proposed discharge will be the Browns River where the small unnamed drainage enters the river.

The Indirect Discharge Program concurs with the preliminary compliance assessment in the January 10, 2019 Stone Environmental report that the proposed discharge will meet the Aquatic Permitting Criteria of the Indirect Discharge Rules in the Browns River. By virtue of the significant dilution provided by the Browns River, demonstration of compliance with the Aquatic Permitting Criteria is also satisfied using the Dilution Method specified in 14-902 of the Indirect Discharge Rules. As such, baseline sampling of the Browns River is not required.

The Indirect Discharge Program intends to start the process of revising the Indirect Discharge Rules in the next few months. The proposed wastewater disposal system will be subject to the Rules that are in effect at the time an application for an indirect discharge permit is submitted.

If you have any questions, please contact me at bryan.harrington@vermont.gov or by phone at (802) 505-0972.

Sincerely,

Bryan Harrington
Indirect Discharge Program

CC: Amy Macrellis, Stone Environmental
Alan Huizenga and Kevin Camera, Green Mountain Engineering
Mary Clark, Indirect Discharge Program

C-7. Preliminary Evaluation Report, Design Criteria for Orenco AX-100 Treatment System

Specialists in Pumping Equipment
Phone: (603) 875-7000
(800) 582-7231
Fax: (603) 875-6999

WATER INDUSTRIES, INC.

PO Box 218
Alton, New Hampshire 03809

Preliminary Evaluation of an AdvanTex® Treatment Facility

Project Name
Westford Vermont WWTP
Westford, VT

Prepared for
Brad Washburn
Green Mountain Engineering

Prepared by
Stephenie Wright
Systems Engineer

Mike Carleton
Water Industries, LLC

Date
January 30, 2020

Orenco® SYSTEMS

Advantex® Treatment System Project Proposal

Project Name: Westford Vermont

Project Location: Westford, VT

Application: Municipal

DESIGN PARAMETERS

The facility addressed in this proposal includes a 20,000 gpd wastewater plant served by effluent sewer. The proposal assumes very few or no commercial connections. Additional treatment processes may be required depending on the type and number of commercial connections. Projected wastewater flow rates were provided, but organic loading was based upon similar systems that Orenco has previously observed.

Wastewater Flow Rates

Wastewater design flows for the service area were provided by Green Mountain Engineering and are outlined in the table below.

Table 1. Hydraulic Design Parameters —Design Maximum Day Flow (DMDF)

Hydraulic Design Parameters for Proposed Facilities		
Service Type	**Flow Assumptions**	**Daily Flow (gpd)**
Municipal	Regulatory Tables	20000

Wastewater Strengths

Wastewater strengths for the service area were estimated based upon similar systems and are outlined in the tables below.

Table 2. Constituent Loading Assumptions

Parameter	**DMDF, gpd**	**Concentration (mg/L)**	**Primary Treated Load (lbs/day)**
Biochemical Oxygen Demand (BOD_5), mg/L:	20,000	180	30.04
Total Suspended Solids (TSS), mg/L:	20,000	100	16.69

Permit Limits and Loading Rates

The following table provides the discharge limitations as provided by Green Mountain Engineering. The scope of this proposal is pertinent only to BOD_5 and TSS.

Table 3. Permit Limits

Permit Constituent or Parameter	Average
Biochemical Oxygen Demand (BOD5), mg/L:	30
Total Suspended Solids (TSS), mg/L:	30

Table 4. Standard AdvanTex Loading Rates

Permit Constituent or Parameter	Design AVERAGE Day	Design MAXIMUM Day
Hydraulic	25 gpd/sq.ft•d	50 gpd/sq.ft•d
BOD_5	0.04 lbs/sq.ft•d	0.08 lbs/sq.ft•d
TN/TKN	0.014 lbs/sq.ft•d	0.028 lbs/sq.ft•d
NH_3-N (or TKN limit)	0.01 lbs/sq.ft•d	0.02 lbs/sq.ft•d

TECHNOLOGY DESCRIPTION & SIZING

Packed bed filters (PBFs) – incorporating treatment media such as sand, gravel, and textile – have been used successfully for decades to treat onsite wastewater flows. These filters reliably produce high quality effluent that is superior to that discharged by the majority of our nation's municipal treatment facilities. The most effective of these filters is AdvanTex Treatment System. This proposal provides an estimate of system sizing and costs based upon the information provided. This proposal does not constitute a design.

Table 5. Standard AdvanTex System Sizing

Permit Constituent or Parameter	Load Value (DMDF)	Loading Rate	AdvanTex Unit Size
Hydraulic	20000 gpd	50 gpd/sq.ft•d	400 sq.ft.
Biochemical Oxygen Demand (BOD5), mg/L:	30.04 lbs	0.08 lbs/sq.ft•d	376 sq. ft.
Total Suspended Solids (TSS), mg/L:	16.69 lbs	0.08 lbs/sq.ft•d	209 sq. ft.

Table 6. Orenco Pod Treatment Equipment

First Stage Treatment Unit(s):	(4) AX100
First Stage Pumping Setup:	(2) Duplex PF5007
Recirc Tank (Minimum):	15000 U.S. Gallons
Dose Tank (Minimum):	4000 U.S. Gallons

Table 7. Orenco AX-Max Treatment System Costs

Project Estimated Costs	***TOTAL***
Secondary Treatment Subtotal (Includes 15K Recirc Tank)	$ 101,866
Discharge System Subtotal (Includes 4K Dose Tank)	$ 29,800
Ancillary Equipment Subtotal	$ 28,889
Materials and Equipment Subtotal	**$ 160,555**
Shipping, Commissioning, and Operator Training	$ 38,030
Total Project Estimate	**$ 198,585**

All estimates are for budgetary purposes only. Actual quotes will be produced once the design and project plans are completed and provided by the designer. All estimates include Orenco provided materials and are F.O.B. Sutherlin or Winchester, Oregon.

Cost estimates do not include material and labor costs for site work, utilities, state or local taxes, permitting, inspections, administration, engineering, etc.

SCHEDULING / MANUFACTURING

Lead Times

Lead times are currently estimated at 6 – 8 weeks upon time of purchase order.

Payment Terms & Conditions

100% at time of purchase order unless otherwise negotiated.

Warranty

The integrated equipment package proposed will be warrantied against manufacturer's defects in accordance with Orenco Systems Inc. standard warranty of Five (5) years from time of purchase. If the equipment is used as part of a retrofit or replacement package, the warranty will vary between one to three years depending on the situation.

Proposal Period Validity

This proposal is valid for a period of sixty (60) days unless extended in writing by Orenco Systems Inc.

AdvanTex Equipment List

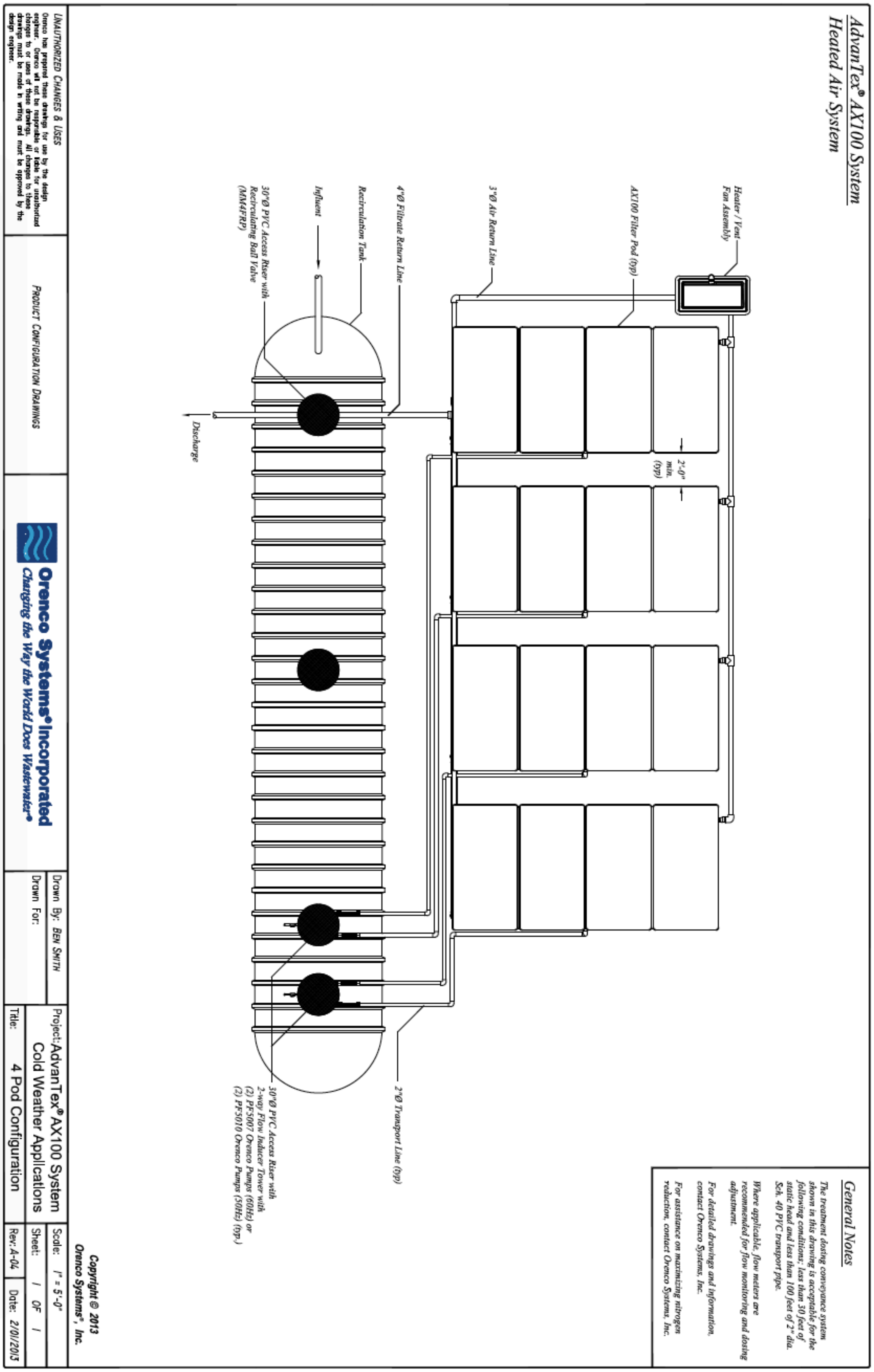
Qty	
Secondary Treatment Materials	
4	AX100
1	Recirc Tankage, Minimum 15000 U.S. Gallons - By Others
2	2 PF5007 DA Pumping system
1	Ventilation Assemblies with HEATER
	Float Assembly, Splitter Valve and Access Risers
4	Piping, fittings, glue
Discharge System Materials	
	Discharge Tank, Minimum 4000 U.S. Gallons - By Others
2	Discharge Tank Access Equipment (range 1'-4' bury)
1	Discharge Pumping Equipment
Ancillary Materials	
	Telemetry Control Panel
1	Effluent Flow Meter, 2-in Mag-MM
Shipping, Commissioning, and Operator Training	
	Commissioning and Operator Training
	Operation & Maintenance Manual
	Shipping (as percent of materials)

Xerxes Equipment List

Qty	Recirc Tank
1	**15,000 – 10’ Single Wall FRP Tank**
2	30” Dia (Nominal) Access Opening
	4” I.D. Inlet/Outlet Sanitary Tee
4	Straps
	Deadmen
	Turnbuckles

	Dose Tank
1	**4,000 – 8’ Single Wall FRP Tank**
2	30” Dia (Nominal) Access Opening
	4” I.D. Inlet/Outlet Sanitary Tee
	Straps
	Deadmen
	Turnbuckles

APPENDIX B: Sample System Layout



C-8. List of Links to Project Reports and Information

- MAPLE SHADE TOWN FOREST – OPINION LETTER ON PHASED CONSTRUCTION (2020)
- MAPLE SHADE TOWN FOREST – EQUIVALENT USER & FINANCING SCENARIO (2019)
- MAPLE SHADE TOWN FOREST – CONCEPTUAL LEACH FIELD DESIGN (2019)
- MAPLE SHADE TOWN FOREST – CONCEPTUAL PIPING DESIGN (2019)
- MAPLE SHADE TOWN FOREST – STATE OF VT INDIRECT DISCHARGE PERMIT – AQUATIC PERMITTING COMPLIANCE PRELIMINARY EVALUATION (2019)
- MAPLE SHADE TOWN FOREST- CAPACITY & FINANCING UPDATE (2017)
- MAPLE SHADE TOWN FOREST – WASTEWATER CAPACITY & ROUGH COST ESTIMATE (2015)
- TOWN OF WESTFORD & COMMON HALL (UNITED CHURCH OF WESTFORD) PROPERTIES – WASTEWATER CAPACITY REPORT (2014)
- TOWN OF WESTFORD PROPERTY (SPILLER LOT) – WASTEWATER CAPACITY REPORT (2012)
- TOWN CENTER AREA COMMUNITY WASTEWATER DISPOSAL ALTERNATIVE STUDY (2008)