Chepachet Village

Decentralized Wastewater

Demonstration Project

Chepachet Village Decentralized Wastewater Demonstration Project

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For More Information

Further information about alternative wastewater treatment can be found at:

Consortium of Institutes for Decentralized Wastewater Treatment: http://www.onsiteconsortium.org/

EPA Decentralized Wastewater Treatment Systems: http://cfpub.epa.gov/owm/septic/home.cfm

National Decentralized Water Resources Capacity Development Project: http://www.ndwrcdp.org/

National Small Flows Clearinghouse: http://www.nesc.wvu.edu/nsfc/nsfc_index.htm

University of Rhode Island Cooperative Extension Water Quality Program: http://www.uri.edu/ce/wq

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Chepachet Village Decentralized Wastewater Demonstration Project

A wastewater crisis turns into an opportunity for Glocester to not only improve water quality by addressing immediate septic system failures, but also to examine and plan for long-term water quality and development goals. This report presents the approach, results, and recommendations of the Chepachet Village Decentralized Wastewater Demonstration Project.

Chepachet Village, Glocester, R.I.

H.C. White's Mill c.1887. The mill was built c.1840 and burned down in 1897. It was a woolen mill that employed 400 workers at its peak.

Table of Contents

What is unique about Chepachet is the innovative approach local officials took to solve wastewater problems.

Chepachet is a historic mill village

Chapter 1 Introduction

Chepachet is a historic mill village that grew among industrial-era textile mills that harnessed waterpower from a tributary of the Blackstone River in Glocester, Rhode Island. The weaving looms are silent now, but the Main Street business district still serves town residents, while stonework mills renovated as antique shops and vintage cafes attract weekend visitors. However, this scenic charm can't hide another legacy of the past: failing septic systems have plagued Chepachet Village since the turn of the century. These problems are not isolated to Chepachet but are typical of densely developed mill villages, where housing is often clustered on small lots and along riverbanks, and where most construction predates modern septic system codes. What is unique about Chepachet is the innovative approach local officials took to solve wastewater problems.

The challenge

For those who live or work in older settlements, occasional problems with septic systems and stormwater drainage are an acknowledged fact of life. As problems flare in wet seasons, homeowners are likely to manage with basement sump pumps, septic tank pump-outs, trips to the neighborhood laundromat, and minor repairs as personal budgets and site conditions allow. For Chepachet residents, this low-key approach came to an abrupt end in 1999, when the R.I. Department of Environmental Management (RIDEM) performed a shoreline inspection and found one property directly discharging untreated sewage to the Chepachet River. RIDEM issued a notice of violation to the owner of the property. The owner blocked the cistern that was causing the discharge, but in a situation not uncommon in historical villages, other properties were also tied into that cistern, and their systems started backing up.

The gravity of the problem escalated. RIDEM did house-to-house investigations and sent notices of violation to owners, many of whom subsequently made septic system improvements. Others with the most difficult sites sought town assistance, unsure how to proceed with repairs given their small lots, surface drainage problems, land slopes, and shallow groundwater. Town officials turned to the University of Rhode Island (URI) Cooperative Extension for assistance, and the Chepachet Village Decentralized Wastewater Demonstration Project began.

Working with RIDEM, Rhode Island Independent Contractors and Associates, non-profit agencies, and URI, the town used alternative onsite wastewater technologies to repair failing septic systems on the most challenging multi-family and commercial properties and developed a conceptual plan for village wastewater management using computer-generated maps.

This booklet summarizes results of the Chepachet Village Decentralized Wastewater Demonstration Project and offers one approach other communities throughout New England can adapt to meet pressing wastewater treatment needs, while protecting public health and environmental quality. The methods focus on use of alternative onsite wastewater technologies and application of Geographic Information Systems (GIS) to support revitalization of historical village centers while preserving their unique natural and architectural features.

History

The town had already begun to address its wastewater management problems several years before RIDEM's investigation brought the issue to the forefront. The challenge it faced was substantial. Glocester began to be settled in the 17th century, when colonists established farms in the area. Villages sprang up in the town wherever streams and rivers provided waterpower for gristmills and sawmills, then later for larger yarn and textile mill complexes. The largest of these villages was Chepachet, where thriving commercial and manufacturing businesses developed.

Chepachet's age means that many of its buildings have old—and in some cases failing—septic systems, some of which are illegal under today's regulations. The homes and businesses that line Main Street are on small lots in a sloping area with a high water table, wetlands, and rocky soil, and Chepachet is miles away from any sewage treatment plant. These features make solving a wastewater problem difficult, but the fact that groundwater is the source of drinking water for the village makes finding a solution imperative.

In 1994, the town instituted the Glocester Wastewater Management Board. In 1997, it completed a $70,000 wastewater management study and was addressing some of the study recommendations when the RIDEM violation notices were issued.

Water quality concerns

The immediate problem of failing systems was not the town's only concern. It also wanted to improve water quality in the long term, and it recognized a problem with both storm water and wastewater. The town was interested in seeking a grant to fix the worst remaining problems, to deal with storm water, and to develop a village wastewater plan that corresponded with other goals for the town, including maintaining its rural character.

Protecting groundwater supplies is the town's top priority. All homes and businesses throughout Glocester rely on groundwater to supply private wells and small public wells. The entire Chepachet Village is situated on a particularly significant regional aquifer known as the Branch River Aquifer. Protection of this aquifer for existing and future groundwater supply is of the utmost importance. Since groundwater and surface water are connected, protecting groundwater supplies will also help maintain surface water quality.

The Chepachet River flows into the Branch River, a tributary of the Blackstone River. RIDEM has classified both the Branch River and portions of the Blackstone River as impaired due to poor aquatic habitat, high bacteria, and other problems. River sampling showed that the bacteria standards in the Chepachet River were violated when the cistern was flowing, but bacteria concentrations returned to normal when this discharge was stopped.

To prevent bacteria and phosphorus from reaching drinking water sources, not only must septic systems function properly, but there must also be adequate distance from the systems to the water. Groundwater is also susceptible to nitrogen contamination, but even properly functioning conventional septic systems do not remove nitrogen. Safe nitrogen concentrations depend on dilution in groundwater, which can be difficult in heavily populated areas.

Wastewater treatment and development issues

An area's wastewater treatment, though seemingly invisible, can have a great deal to do with the way the area develops. Sewering Chepachet, for instance, could open the area to more intense development that could destroy the character of the village. However, doing nothing to improve the village's wastewater treatment could bring its own development problems—by either inadvertently encouraging the building of businesses that require little by way of wastewater treatment (such as self-storage units and fast food restaurants) but that detract from village character, or by allowing the village to stagnate, driving current and potential businesses to nearby suburbs where they can thrive.

Project goals

With this in mind, the town approached the URI Cooperative Extension Water Quality Program and staff of the Onsite Wastewater Training Center and Nonpoint Education for Municipal Officials. URI and town staff worked together to design a grant application to RIDEM's nonpoint source pollution abatement program (Section 319 grant program). The town also applied for and received a Community Development Block Grant for matching funds. As part of the RIDEM grant, URI received a subcontract for remediating failures and demonstrating how alternative systems can provide a repair solution for the most difficult sites. The three components of this work were to:

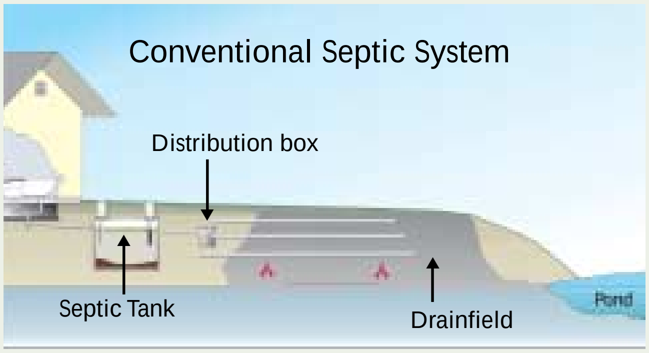
1. Devise immediate wastewater management solutions using onsite treatment
2. Assess Chepachet's pollution risks from septic systems and other sources as part of a long-term wastewater management strategy for the village
3. Promote adoption of improved wastewater management practices through community involvement and education, focusing on Chepachet Village and waterfront development clustered on several lakes located throughout Glocester

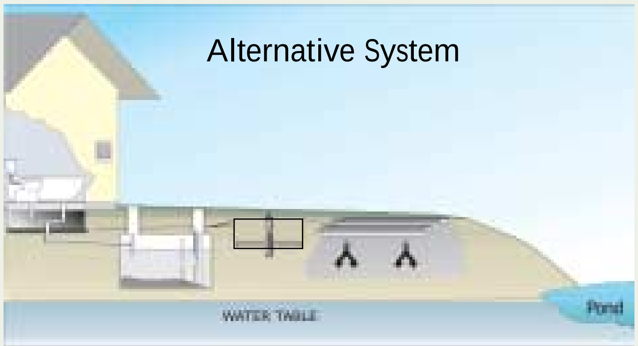
The water quality improvement goals were to:

- Eliminate untreated discharges of nutrients and pathogens from Chepachet wastewater into the Chepachet River and the Branch River aquifer
- Protect the high quality of local groundwater to meet current and future drinking water needs

River sampling showed that the bacteria standards in the Chepachet River were violated when the cistern was flowing, but bacteria concentrations returned to normal when this discharge was stopped.

Figure 1 Conventional Systems Vs. Alternative Systems





Conventional systems

With conventional systems, primary treatment occurs in the septic tank, where solids and grease are trapped, and bacteria, which thrive in the anaerobic (without oxygen) conditions of the septic tank, provide the chemical and biological treatment of the incoming waste. The liquid effluent flows to a distribution box that directs flow to a drainfield—also called a leachfield or soil absorption field—where it seeps into the underlying soil. The soil between the bottom of the drainfield and the underlying groundwater and the horizontal distance to nearby wells and surface waters remove bacteria and help to reduce or dilute other pollutants. The drainfield is commonly a series of trenches—perforated pipe encased in washed stone—or flow diffusers—bottomless concrete chambers honeycombed with holes that store the effluent and allow it to gradually seep into the ground.

Modifications of conventional systems

Conventional septic systems are safe, economical, low-maintenance, and environmentally sound wastewater treatment options for low-density areas with suitable soils. But for marginal sites with high water tables and slopes, extensive clearing and filling is needed, often with the leach-field constructed in a raised bed of gravel fill.

The large gravel mounds required for fill systems are expensive to construct, and the systems still provide only conventional treatment. The site disturbance involved often destroys landscaping and reduces the home's useable yard area. In any neighborhood the mounds can be eyesores, but they are especially so in historical village centers, where they are out of character with traditional landscapes. In Chepachet Village, where lots are small and where high water tables contribute to stormwater drainage problems, grade changes with the use of fill systems have diverted more runoff to neighboring properties and have aggravated nuisance flooding.

Alternative systems

Alternative or enhanced treatment systems cover a wide variety of treatment technologies and drainfield options. The key feature that sets these alternative systems apart is that they include an additional treatment step, generally after solids settle in a watertight septic tank. A pump is often used to convey the effluent to a treatment unit, which may be placed above or below ground.

The treated effluent is then usually pumped under pressure to an alternative drainfield. A pressure-dosed shallow trench in native soil places effluent in biologically active soils for additional pollutant removal by natural processes. Alternative drainfields can be smaller than conventional drainfields, and site disturbance is minimal. Where pumps are used to distribute effluent to the treatment unit and drainfield, an electrical control panel is used. Although separation distances to groundwater and setbacks to wells and surface waters are still important to protect public health and environmental quality, alternative systems rely on the sequence of treatment units and drainfield, described as a treatment train, to provide the necessary level of effluent treatment for each site.

Mound system installed as a repair

Figure 2 Alternative Septic System Demonstration Sites
Chepachet, Rhode Island

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0 50 100 200
Feet

1	Neighborhood restaurant with mixed-use retail, office, and residential
2	A large apartment building, duplex, and the Glocester Heritage Society on three lots
3	A multifamily house and cottage with rustic garden shop on one lot
4	First floor retail and apartments above
5	First floor offices and apartments above a vintage building

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Chapter 2 The Demonstration Systems

Five alternative septic systems were installed as part of the Chepachet Village project. Not only do they remediate septic system failures, but they also serve as demonstration systems to show other property owners how alternative septic systems may be installed on their own properties, how they work, and how they are maintained.

The systems are located in the center of the village, where conventional repairs were not feasible due to small lot size and other constraints. Two of the systems serve homes in the Tanyard Lane area, a long-standing problem area where septic system failures were concentrated. Two of the five demonstration systems are small systems of 600- to 660-gallons-per-day (gpd) design flow, serving buildings with ground floor retail and apartments above. Another system in the 600-gpd-design-flow range treats wastewater from an apartment building and cottage located on one property. A fourth system is a small cluster system with a design flow of 900 gpd serving three buildings on three different parcels. The largest of the five demonstration systems is a 2,700-gpd cluster system serving a restaurant and a small commercial block with retail and office buildings.

Textile filters

For each of the five demonstration systems installed in Chepachet Village, a textile filter was selected as the treatment unit. In each case, this technology was selected for several reasons:

- Small footprint that fits into limited spaces
- Consistently high level of treatment for biochemical oxygen demand (BOD) and total suspended solids (TSS), which allows use of alternative drainfields
- Consistent treatment seasonally and with different types of wastewater thanks to robust, reliable technology
- Easy-to-install modular units
- Recirculation mode that provides nitrogen treatment to protect drinking water wells and nearby wetlands and riverbanks
- Some bacterial reduction
- Relatively low operation and maintenance cost
- Opportunity to test new design not yet used in Rhode Island

This textile filter serves a multifamily house and a cottage.

Other options considered that provide comparable treatment were:

A recirculating sand filter

Pros:

- Proven
- Highly reliable
- Relatively low maintenance

Cons:

- Requires a larger area
- Requires on-site construction

A fixed activated sludge system

Pros:

- Modular unit, easily installed
- Very small footprint
- Low installation cost

Cons:

- Relatively high maintenance costs
- Uses an aerator that may generate too much noise for densely settled area
- Significantly higher energy use, adding about $40 per month to typical electrical bills
- Variable levels of BOD and TSS, increasing risk of solids entering drainfield
- Risk that aerator may be turned off, resulting in only conventional treatment, especially when paired with conventional drainfield

All systems used are considered small-scale systems. Prefabricated treatment units, known as package plants, were not considered cost effective at small flows and would have required reaching agreement to tie-in many other homes, at costs beyond the scope of this project.

Drainfields

Alternative drainfields were used in all of the demonstration systems to:

- Enhance wastewater treatment
- Allow greater flexibility in siting the drainfields, given limited space and site constraints
- Maintain the scenic and historical setting, because alternative drainfields can be configured with minimal site disturbance

On three of the lots, shallow, narrow, pressure-dosed drainfields were used. On the other two, bottomless sand filters were used. An innovative, shallow, narrow drainfield allows for flexibility in siting because required separation distances to features such as slopes and trees are usually less stringent than with conventional drainfields. Although the total length of drainfield required may be comparable to a conventional drainfield, the ability to locate these in small areas of available land among buildings, plantings, and with less regard to topography changes greatly aids in drainfield siting. These can be used where the water table is at least 3 feet 10 inches from the ground surface.

Bottomless sand filters were used as the final drainfield in two of the systems. As with a mounded fill system, these are built above ground to provide treatment and dispersal of the effluent where adequate separation distance to groundwater is lacking, but these actually provide a much higher level of treatment in a much smaller space. The sand media used is a specified type of sand designed for additional removal of solids and bacteria. The bottomless sand filter can be built above the ground surrounded by a wooden frame, or set in the ground flush with the surface within a treated plywood frame. Treated effluent from a pre-treatment unit (in this case, textile filters) is sprayed over the top of the sand filter media, filtered by up to three feet of media or a combined thickness of sand media and underlying unsaturated soil, and then dispersed through the bottom into the natural soil.

Descriptions of the five systems installed in Chepachet follow, including site needs and constraints, along with technical specifics of the systems installed. All cluster systems collect septic tank effluent from different buildings using gravity collection, called STEG.

The shallow, narrow drainfield at the Purple Cat is installed into an island in the parking lot.

This bottomless sand filter fits into a small space at a property on Main Street.

1. Neighborhood restaurant and mixed-use retail, office, and residential buildings

- Purple Cat restaurant (100-seat)
- Strip mall with five units, including a florist occupying two units, a hairdresser, a travel agency, and an insurance agency
- Duplex with two one-bedroom units
- Office building housing a podiatrist

Tackling the wastewater treatment needs of a sit-down restaurant in an unsewered area is a challenge because these restaurants typically require a great deal of water for cooking and dishwashing compared to fast-food restaurants, which use throw-away packaging. Also, restaurant wastewater is high in biochemical oxygen demand (BOD), which is used as a measure of the organic matter (pollutants) in wastewater, total suspended solids (TSS), and fats, oils, and grease (FOG). The main challenge for any system that serves a restaurant is managing FOG inputs, to prevent them from escaping to the treatment unit or drainfield and cause system failure.

Additional factors taken into consideration when designing this system included the failure of the existing system, the capacity of the restaurant (100 patrons), the 1.6-acre lot size, and the close proximity of the well that supplies water for all the uses on the property.

To ascertain the capacity of the system required, the rate of wastewater flow was calculated by evaluating water-use records for the well. The observed flows were adjusted to represent the maximum capacity of the restaurant, and then multiplied by a factor of 1.5 to ensure ample capacity. The design flow for the system is 2,700 gallons per day, with the restaurant accounting for 90 percent of the flow.

The available area for the drainfield was extremely limited. Because of the need to maintain well separation distances, the only suitable area for the drainfield was the parking area near the building. The existing parking island provided a suitable location and was enlarged slightly to cover about 4,000 square feet, which accommodated a shallow, narrow drainfield.

Using a conventional septic system with a tank and a conventional drainfield would have required almost double this area—about 7,200 square feet—consuming more parking spaces. Heavy-duty flow diffusers could have been used and the area re-paved; however, this would not have provided adequate groundwater protection to nearby wells. A newer type of drainfield that uses rigid plastic folded in geotextile fabric, rather than gravel, underlying conventional distribution lines would have required less space—about

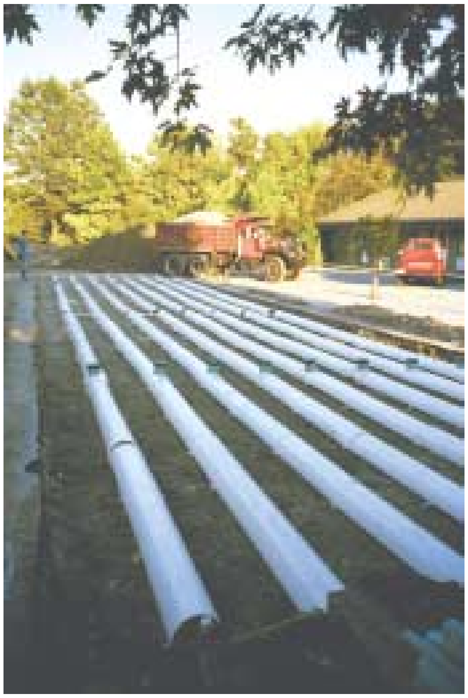
Ken Lavoie

Ken Lavoie, owner of the Purple Cat restaurant, where an alternative wastewater treatment system was installed, said that some property owners were reluctant to come forward to participate in the project. "People have a stereotypical belief they're [alternative systems] going to be nothing but trouble. But that's changing. These are good systems for the most part," he said. He explained that his restaurant needed to address problems with its system, so he signed on.

He said that the restaurant did not even have to shut down during the transition to the new system: "We installed the whole thing and then tied it in."

Lavoie downplayed any concerns he may have had about the system, though he has to inject a bacteria into his grease trap to break down the grease, which he said is one of the biggest causes of failure of any commercial, high-strength system. "It was more of a trying to prevent a problem. The grease content was higher than they (the inspectors) wanted to see," he said, "It's been a fine-tuning process."

Lavoie has been so satisfied that he is installing alternative systems on other properties he owns, and is considering taking a course at URI on maintaining the systems.



The Purple Cat drainfield

Views of buildings served by this system

Strip mall, duplex, and podiatrist office (left to right)

This drawover illustrates the drainfield for all sites. The one below shows the layout of the textile filters.

4,800 square feet—than would a strictly conventional drainfield. However, without a treatment unit, there would have been little additional protection of groundwater.

The treatment unit installed on this site provides enhanced treatment of nitrogen and bacteria, and reduces solids to the low level needed for a shallow, pressure-dosed drainfield. The system first routes restaurant kitchen wastewater through a three-compartment, 2,000-gallon grease trap, then combines this flow with wastewater from the restaurant bathroom facilities. This combined effluent flows to a 2,500-gallon, two-compartment septic tank. Wastewater from this tank flows by gravity to a 2,500-gallon recirculation tank. Wastewater from the strip mall, duplex, and doctor's office flows into separate 1,000-gallon septic tanks, then into the recirculation tank. A pump is used to time-dose wastewater from the recirculation tank to a four-module recirculating media (textile) filter.

To save space, these units are located directly above the 2,500-gallon septic tank receiving flow from the restaurant grease trap and above the 2,500-gallon recirculating tank. Wastewater recirculates between the recirculation tank and the textile filter several times a day. Finally, the treated wastewater is pressure-dosed to a shallow, narrow drainfield located in an island within the restaurant parking lot. The drainfield consists of eight 98-foot-long lines fed from the middle and set in four zones. Unlike conventional gravity-flow systems, which feed wastewater to the drainfield as water is generated, the textile filter and time-dosed drainfield system distributes flow in small doses over 24 hours, so the system isn't overloaded during periods of heavy water use. Instead, the treated wastewater is stored in larger tanks and continues to be metered out to the drainfield even during periods throughout the day when no water is used.

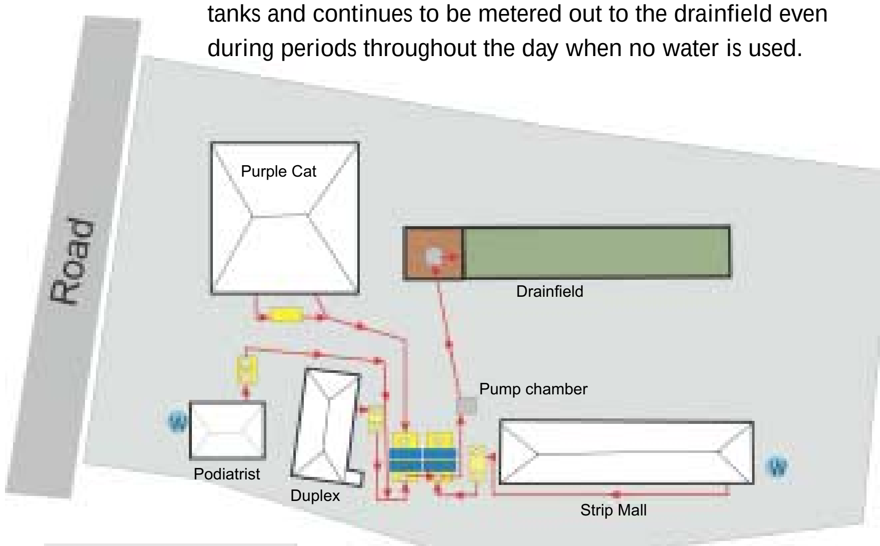


Figure 3 Schematic of the Purple Cat System

Front of apartment building

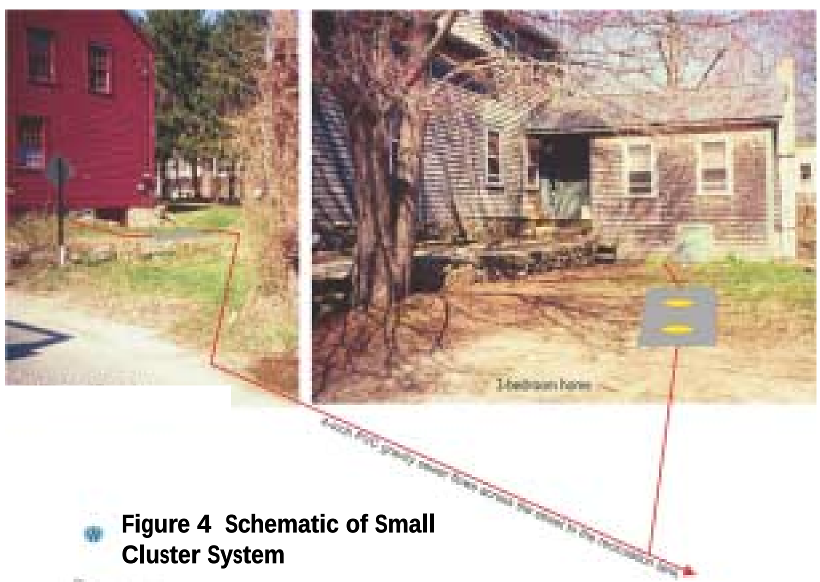
2. A large apartment building, duplex apartment, and Glocester Heritage Society on three lots

- Glocester Heritage Society
- Duplex with two one-bedroom apartments
- Apartment building with five one-bedroom units

This cluster system serves three buildings located on three different parcels on Tanyard Lane. The total design flow is 900 gpd. Each building has its own septic tank for primary treatment and solids settling. Septic tank effluent then flows to a 2,000-gallon recirculating tank located at the large apartment building. The heritage society has a flow of 150 gpd, which requires a 1,000-gallon tank. The duplex has a flow rate of 300 gpd and a 1,000-gallon tank. Finally, the apartment building has a flow rate of 750 gpd with a 2,000-gallon tank. From these septic tanks, the wastewater flows to a 2,000-gallon recirculating tank (B). From there, effluent is time-dosed to two textile filters (C). After recirculation for improved nitrogen removal, the wastewater is pumped from the textile filters to a 7-foot x 48-foot raised bottomless sand filter (D). This configuration maximized use of available space at the apartment building lot, while keeping the new leachfield 100 feet away from existing wells. It also allowed septic systems on the other two lots, which were within the 100-foot well radius, to be abandoned for greater well protection.

Although the treatment lot provided the most flexibility in siting a new system, space on this riverfront lot was also limited due to high water tables and steep slopes at the edge of the riverbank. To keep the natural and historic features intact, the treatment unit and drainfield were installed with very minimal site disturbance, and the drainfield was sited unobtrusively along an existing gravel parking area edged with a stonewall and existing vegetation.

Glocester Heritage Society



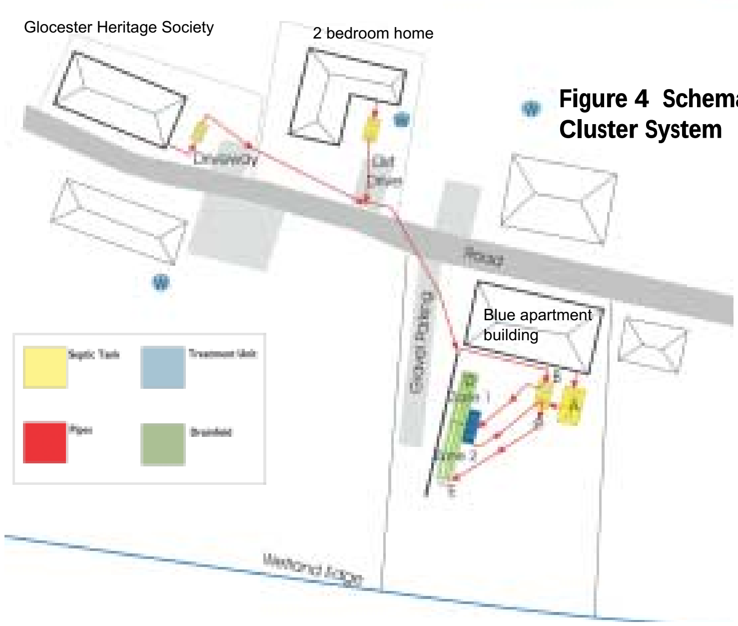


Figure 4 Schematic of Small Cluster System

Completed system at rear of apartment building

3. A multifamily house and cottage with rustic garden shop on one lot

- House with two apartments
- One-bedroom cottage
- Barn with retail garden shop (no running water, and not connected to septic system)

The existing system at this site consisted of a septic tank and a failed bed-type drainfield serving a house with two apartments, with a total of three bedrooms, and a one-bedroom cabin. The total design flow is 600 gpd. A separate barn houses a rustic garden shop that does not have running water and so is not connected to the septic system. A septic system repair was difficult due to the multiple buildings on a single parcel with limited space, nearby well and wetlands, and the water table less than three feet below the surface.

The alternative system for this site treats a 450-gpd-wastewater flow from the house and a 150-gpd flow from the cottage, with both flows entering a 1,500-gallon septic tank (A) where solids settle. From there, effluent is time-dosed under pressure to a textile filter (B), which is set to recirculate back to the septic tank for improved nitrogen removal. After recirculating several times a day, the treated wastewater is pressure dosed to a 7-by-25-foot bottomless sand filter (C) serving as a drainfield. This bottomless sand filter is raised five inches above existing grade to function in high-water-table soils and to provide additional bacterial removal. This is a single-pass design, where treated effluent is sprayed over the top of the sand filter, undergoes final treatment as it filters through approximately three feet of sand media, then discharges directly into the ground beneath the filter. By locating the drainfield in a narrow space near the front of the property, a setback of 100 feet from the well was achieved, without any disturbance to wetland buffers. An existing failed septic system, located much closer to the wetlands at the rear of the property, was properly abandoned by being pumped out and filled in, eliminating a potential source of contaminants to these surface waters.

Though a shared system would have been recommended even if different people owned the buildings, a single owner made the process simpler. Legal covenants need to be developed for system access and maintenance for systems shared by properties with different owners.

View of the main house and cottage from street

Cottage

The property owner used plantings and this wagon to disguise the unit's drainfield.

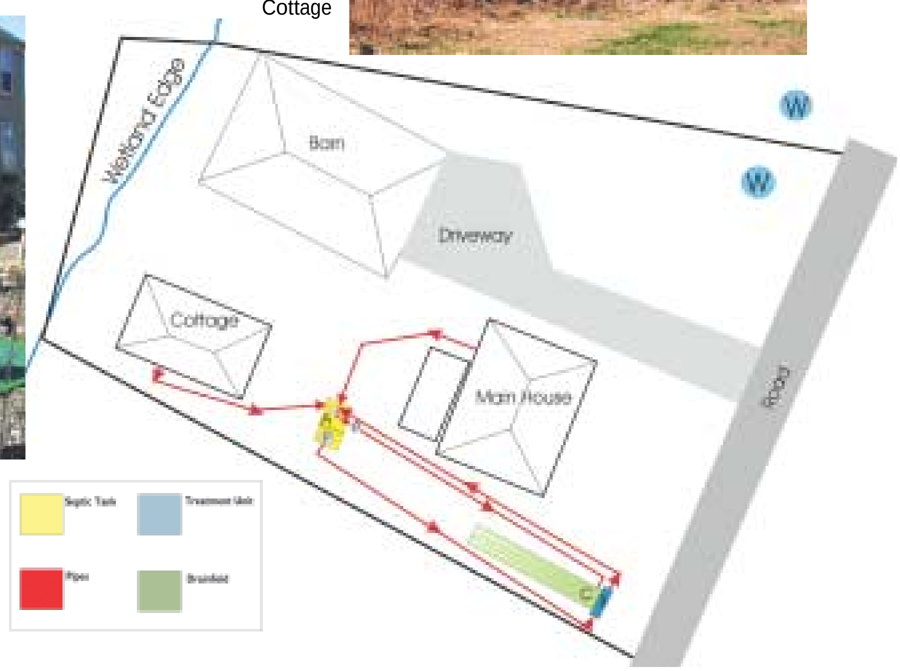


Figure 5 Schematic of Treatment System

4. First floor retail and apartments above

- Christy's Liquors
- Two apartments

This innovative system replaced the failed system for a building with a ground-floor liquor store and two apartments above, with a combined flow rate of 660 gpd. This retail/apartment building fronts on the main road; another office building and garage located on the adjoining lot are served by a different septic system on the north of the property. With parking at the front of the property and wetlands to the rear, available space for a replacement septic system was very limited. In addition, a well serving the property is located behind the retail/apartment building. Both lots are under common ownership, however, simplifying system siting.

The objectives at this site were to maintain existing uses, protect well-water quality, and avoid disruption to the nearby wetland and associated buffer. Since the other office building on the property had a functioning septic system, only the failed system was replaced. The tank and treatment unit were located behind the building, with the leachfield located behind the garage associated with the other office building on the adjoining lot. Keeping the leachfield in this area avoided the wetland buffer but situated portions of the leachfield within 100 feet of the existing well.

The wastewater from this building flows by gravity to a 1,500-gallon dual compartment septic tank (A) with an effluent filter, and then to a 1,000-gallon recirculating tank (B). From there, the wastewater is time-dosed to a textile filter (C) designed to accommodate up to 900 gallons/day. The treated wastewater is then pumped to the shallow, narrow, pressurized drainfield.

Kevin Kitson

Kevin Kitson, owner of Christy's Liquors, got involved with the wastewater management board, where he eventually became chairman, because of the wastewater problems in the village and as someone who goes fishing in the lakes. "I knew there was something we could do differently." The board worked to identify hot spots in Glocester, around lakes, and in high population areas.

To pursue solutions, the board realized it "had to get involved with people who are the best in the field," and approached URI and visited the Onsite Wastewater Training Center. Through the Chepachet Village Decentralized Wastewater Demonstration Project, Kitson's property, which he described as having a "horrendous problem" with a failed system, was selected for a demonstration system that serves the liquor store and two apartments, and has the capacity for serving the adjacent office building, which has its own septic system.

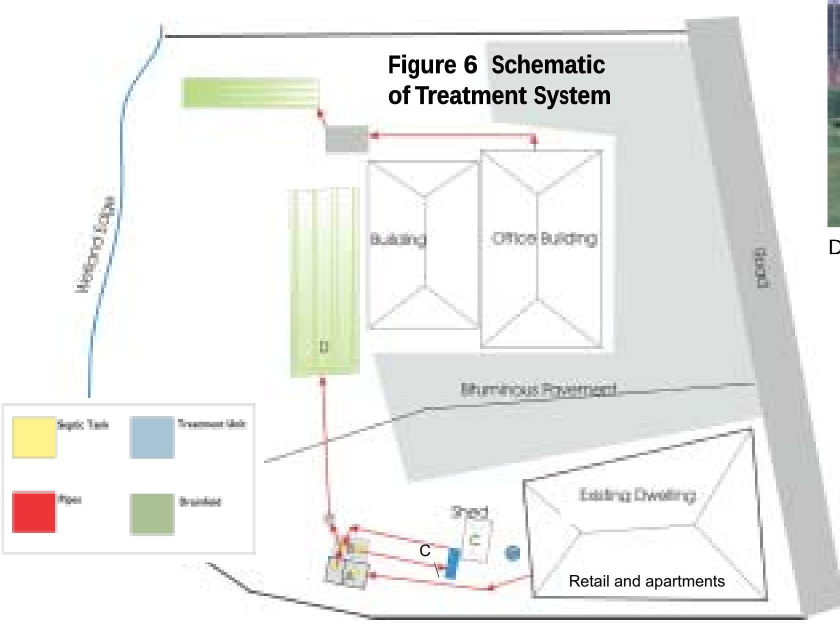
"The system has worked basically flawless ... the maintenance is minimal and the satisfaction is high. We don't put any type of chemicals in the system; it takes care of itself," Kitson says.

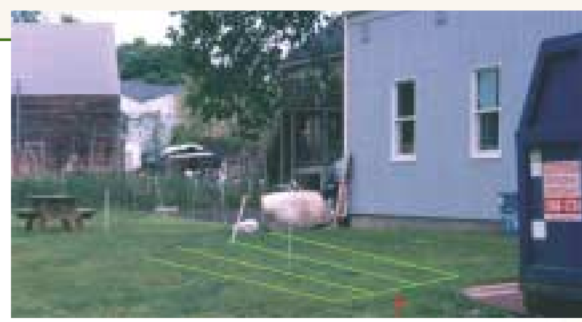
Some things Kitson has been able to fix himself, such as when someone in one of the apartments left the toilet running, setting off the high-water alarm. He was able to shut off the toilet and reset the system's alarm while the system handled processing the excess water. For other problems, he contacted the URI Cooperative Extension staff, who maintained systems during the project period, after which demonstration system owners had to contract with private companies for system inspection and maintenance.

Unexpected problems have arisen, however. When a parked car blocked access from the parking lot to a dumpster on the property, a driver from the company that handles the dumpster drove over the back yard to reach it, crushing the drainfield. Now a rock is blocking the drainfield from the driveway, and reflectors outline the periphery. Kitson plans to put up a fence to further protect the drainfield.

Despite this setback, Kitson is pleased with the system and the project, saying his attitude is, "If the business district thrives, it helps the town be a better place to live." And if there's a wastewater management problem, the concern is, "'Who's drinking someone else's effluent?'"

Figure 6 Schematic of Treatment System





Drawover showing drainfield location

View of building from Main Street

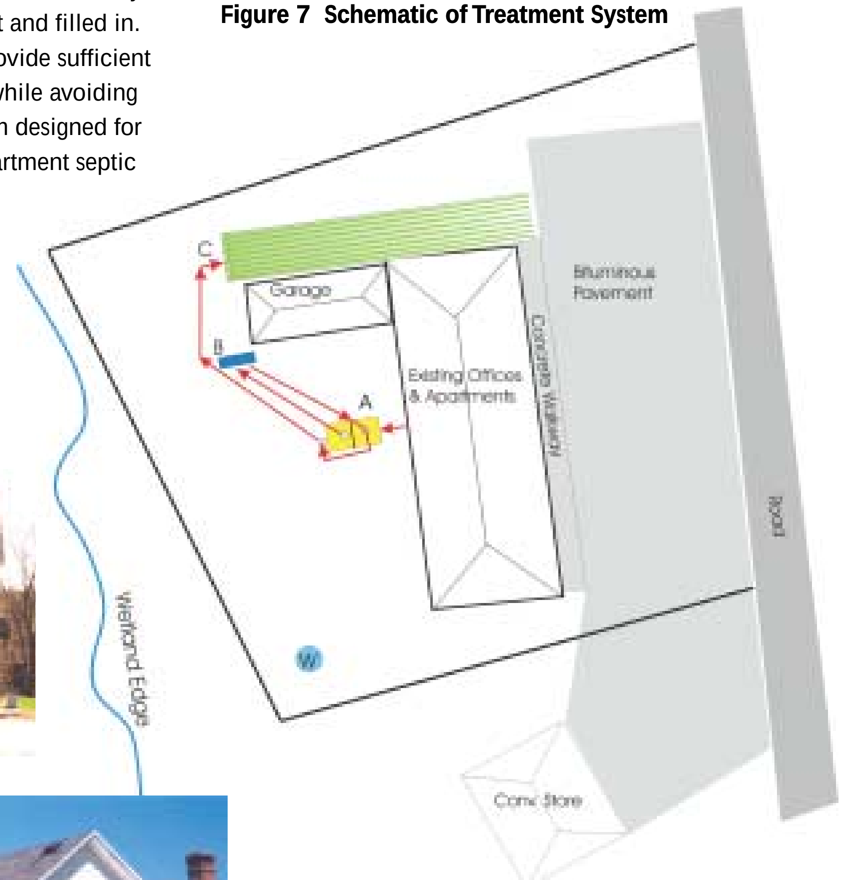
5. First floor offices in a vintage building with apartments above

- Two offices
- Two apartments

This system was designed to service two offices with a maximum of five employees each, and two apartments with a total of three bedrooms, for a total design flow of 600 gpd. The front of this building is occupied with paved parking, while the back of the property abuts a wetland edge. A well is located onsite, with an existing cesspool located nearby. For this repair, the cesspool was pumped out and filled in.

The design goals at this site were to provide sufficient treatment to protect drinking water quality while avoiding disturbance to the wetland buffer. The system designed for this site includes a 1,500-gallon dual-compartment septic tank (A) and a recirculating textile filter (B) located behind the building. From the textile filter, the treated effluent is time-dosed to a shallow, narrow, pressurized drainfield (C) located on the side of the building and garage. This configuration maximizes separation distance from the drainfield to both the wetland and the well. Even though not all current standards were achievable—in this case, the new leachfield is just within 100 feet from the well—this represents a great improvement over the pre-existing cesspool nearby, with every effort made to provide adequate treatment to protect public health and safeguard environmental resources.

Figure 7 Schematic of Treatment System



View of building from street

Location of drainfield (left photo) and textile filter and tank (right)

Planning for the future

Chapter 3 Village Wastewater Treatment Options

Construction of the demonstration systems provided an immediate repair solution for the most difficult sites and showed how new technologies could effectively overcome typical site constraints facing other septic system owners in the village. This lot-by-lot approach is the most efficient for short-term remediation, but town officials realized that a long-term strategy was needed to guide village wastewater treatment decisions. Ensuring that groundwater quality could be protected from collective inputs from septic systems in the densely settled village center was a serious concern. To address these issues, URI Cooperative Extension used computer-generated maps to evaluate sources of pollution to groundwater and to make initial estimates to determine if village properties were generally suitable for onsite wastewater treatment. This was a low-cost, rapid assessment designed to screen management options and direct more in-depth data collection. The two primary objectives of this assessment were to:

1. Evaluate pollution risks to local groundwater supplies from onsite systems and other sources, including stormwater problem areas
2. Determine suitability of onsite wastewater treatment systems to meet long-term village wastewater treatment needs

Overview of results

Results of this assessment suggest that onsite wastewater treatment systems can provide a realistic treatment solution for the future, using a combination of conventional and advanced onsite wastewater-treatment technologies. This is based on a scenario of limited future growth, since almost all village lots are developed, and the town's goal is to maintain current uses while allowing limited infill and expansion in keeping with the character of the area. The findings also indicate that alternative systems would be needed in several areas to overcome site constraints and to better protect wells and surface waters. The analysis identified potential sites where shared cluster systems could provide offsite wastewater treatment and dispersal.

Although characteristics of individual lots were considered, it is important to note that this is a preliminary analysis designed to identify management options for further analysis and locations where site-specific data is needed. Field investigations are needed to confirm these results and to develop a wastewater management plan for the village.

Using GIS to evaluate pollution risks in Chepachet Village

Approach

URI staff assessed the project area using GIS to identify areas where pollution inputs are likely to be greatest based on land-use and landscape features. Characteristics associated with potential water quality impacts were identified and rated based on their pollution risk potential. These risk factors—also considered indicators of watershed health—include estimated nutrient inputs from septic systems and amount of impervious cover as measures of stormwater runoff impacts. The results of this assessment, along with existing water quality information, helped identify appropriate wastewater treatment options to protect groundwater quality.

First, maps showing current land uses and natural features were developed. The local advisory committee checked these maps for accuracy and identified properties with high water use, such as multifamily apartments and restaurants. With input from the local advisory committee, the study area boundary was defined to include wellhead protection areas clustered in Chepachet. This included a conglomerate of wellhead protection areas for non-community wells serving restaurants and businesses in the village center, and another cluster of wellhead protection areas encompassing small community water supplies on the outskirts of the village, an area of 1,055 acres (see page 33)

Information about land use, soils, and shoreline features was extracted from the R.I. Geographic Information System (RIGIS) and refined using town parcel maps to identify the type of land use, including town-owned land and open space, as shown in the parcel use map (see page 35). Another risk factor developed from this data was average annual nitrogen loading to groundwater using a simple "mass-balance" approach widely used in similar studies.

Figure 8 Water Quality Issues and Existing Conditions

What level of nitrogen is healthy and safe?

- 0.5 milligram/liter (mg/l)–Rhode Island's natural background concentration in groundwater; healthy coastal waters have this level or lower
- 1 mg/l–Sign of wastewater or fertilizer in groundwater (U.S. Geological Survey); increasing risk of bacteria and dissolved pollutants
- 5 mg/l–Drinking water action level triggering additional monitoring; widely used maximum limit for safety margin
- 10 mg/l–Drinking water standard maximum; acute health effects to infants (blue baby syndrome); suspected risk of miscarriage and other health effects

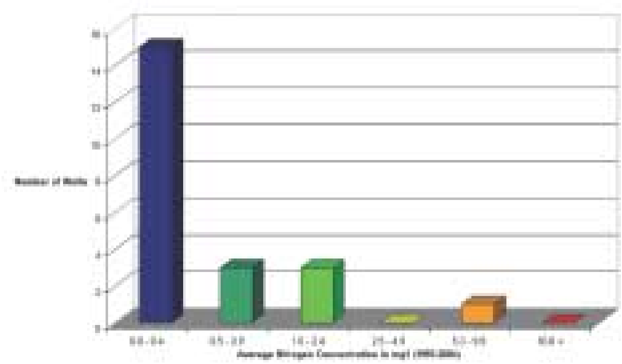
Existing water quality at public wells in the village

Twenty-two public wells are located within the village study area, operated by 15 water suppliers. These include a few community wells serving apartments or other housing, and other wells serving Main Street businesses, restaurants, and churches. Based on R.I. Department of Health (HEALTH) monitoring data collected from these wells for 12 years (1993–2004), public drinking water quality is generally very good, and all 22 wells met all public health standards.

To protect high-quality waters, it's important to monitor low levels of pollutants to identify where groundwater may be showing signs of impact. This allows a community to take action before drinking water standards are exceeded and cleanup is complex and costly. Nitrogen is widely used as a barometer of general water-quality conditions, because it is considered a signal of pollutants from human activities. As indicated in the bar diagram above, nitrogen concentrations in groundwater are naturally very low, at 0.5 mg/l or less. Levels at 1 mg/l indicate that groundwater is receiving wastewater or fertilizers, and therefore, other wastewater pollutants such as bacteria, viruses, and organic chemicals also may be present. The level of risk increases as nitrogen concentrations increase.

A review of the HEALTH public well samples showed that 81 percent of the samples from 18 wells had nitrogen concentrations below 1 mg/l, and of these, 87 percent were less than 0.5 mg/l, close to natural background levels, in spite of dense unsewered development as shown in Figure 9. Of the remaining samples above 1 mg/l, only 2 percent had nitrogen concentrations greater than 3 mg/l. Only one well reported higher nitrogen concentrations, ranging from 3.3 mg/l to a maximum of 7 mg/l, with an average of 5.1 mg/l for the 12-year period. These levels are below the 10 mg/l maximum drinking water standard. Bacteria were not detected in any public well. Two wells had trace amounts of organic solvents that could have originated from careless use or improper disposal on the land or in septic systems.

Figure 9 Chepachet Public Well Data



These results showed that onsite wastewater inputs had not seriously affected public well-water quality. The results further demonstrated that onsite systems can be safe long-term wastewater treatment options, since flows are not expected to increase substantially and treatment performance would improve with a town wastewater management program overseeing regular system maintenance and repairs.

It is important to note that private well data were not available. Private wells are considered to be at higher risk of contamination from densely clustered or substandard septic systems because they are often shallower than public supplies and draw groundwater from smaller areas with less opportunity for dilution of pollutants. In addition, inadequately sealed or poorly maintained wells can allow surface runoff to enter and contaminate these supplies with bacteria.

Pollution risks

Land-use characteristics and natural features of the study area are summarized in the following table. These represent some of the key threats in the study area. Each threat is assigned a rating from low to extreme risk.

These results represent averages for the entire study area. Since this study area includes wellhead areas that extend beyond the village center, pollution risks are likely to be greater in the village center, where development is concentrated along Main Street and Tanyard Lane.

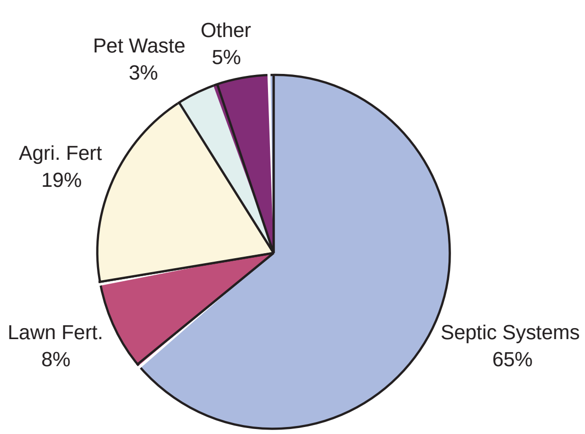
MODERATE RISK

Estimated nitrogen concentration in ground water recharge (mg/l)

Estimated inputs of nitrogen in groundwater recharge are moderate, averaging 2.9 mg/l when dilution with rainfall after plant use, evaporation, and runoff have been accounted for. This is an average annual estimate for the study area, based on the amount entering from septic systems, lawn fertilizers, farm fertilizers, and other sources.

Although most public well-monitoring data shows that the majority of public wells have very low nitrogen levels, estimated nitrogen levels are high enough to warrant concern for individual wells. As nitrogen inputs increase, the potential that bacteria and other wastewater pollutants will be present in groundwater also increases, especially where systems are substandard and located in poor soils.

Figure 10 Estimated Sources of Nitrate-N to Groundwater Recharge



Impervious cover

Impervious areas include roads, parking lots, and rooftops that prevent rainwater from infiltrating the soil. There is a strong association between the amount of impervious area and stream-water quality, with impacts to aquatic habitat likely to occur as impervious cover exceeds 10 percent. Impervious cover also restricts groundwater recharge, decreasing water supply volume and reducing stream flow in dry weather. Reduced recharge also means that less infiltrating water is available to dilute septic system effluent and other pollutants from land-use activities. The estimated impervious cover in the study area is already at 14 percent, which is above the 10 percent "safe" threshold and is considered a moderate risk to nearby wetlands and streams.

This honeycomb pavement pattern allows for groundwater recharge.

HIGH RISK

High-intensity land use

Nineteen percent of the study area has dense residential, commercial, or industrial development, representing a high risk to groundwater from wastewater discharges. These include nonresidential high-strength waste, the potential use of hazardous materials, and high runoff. The relatively high proportion of these uses indicates the need to target these properties for regular septic system inspection and maintenance. Commercial systems with high-strength waste and high flows would be a priority for considering the use of advanced treatment systems.

Septic systems per acre

The number of septic systems per acre, 0.53 system, is considered a high risk to groundwater and nearby surface waters based on the potential for cumulative impacts within the study area. This does not take into account risk of contamination from individual wastewater plumes within close proximity to wells or discharges from large flow systems.

Estimated phosphorus to surface runoff

Phosphorous inputs to runoff are estimated to be in the high range, at 0.8 pound per acre annually, based on nutrient loading coefficients for different land uses in the study area. In each case, these are average annual values, representing nutrient sources at the point where phosphorus is likely to enter stormwater runoff. These do not take into account natural uptake that may occur in the environment.

EXTREME RISK

Soils

Soils in the study area are poor and tend to generate nuisance flooding. In fact, 50 percent of the study area is mapped has having slowly permeable "hardpan" that restricts downward water movement, and 35 percent of the area has a shallow water table, ranging from 1.5 feet to 3.5 feet below ground surface. Because of the potential for surface runoff and improper septic system function, this is considered an extreme risk to nearby surface waters and shallow groundwater.

Shoreline high-intensity land use

Sixteen percent of the riparian buffers within 150 feet of streams, rivers, and other surface waters are developed with high-intensity land use. Because these shoreline areas are the last line of defense against pollutants entering surface waters from overland flow and shallow groundwater flow, any shoreline development weakens this defense system and creates the potential for direct pollutant inputs to surface waters.

Pollution risk assessment summary results

While there is very little information on private well-water quality, HEALTH monitoring data shows that public well-water quality is still remarkably good, with only a few wells having elevated nitrogen levels that are still within drinking water standards. However, the findings of the pollution risk study demonstrate that onsite wastewater treatment systems are a serious threat to groundwater quality due to a combination of densely clustered systems, poor soils, and inadequate setbacks between septic systems and surface waters. Although data on the age of septic systems and repairs was incomplete, many systems are likely to predate adoption of state minimum standards in 1970 and are probably cesspools or other substandard systems. With these systems, bacteria and other wastewater pollutants can enter groundwater without proper treatment. Private wells are at greatest risk, especially those that are shallow and located less than 100 feet away from onsite systems.

The results also show that surface waters are at risk from polluted runoff associated with impervious areas and high water tables. Shoreline buffers along the Chepachet River and other surface waters have been disturbed, and cesspools and other substandard or failing septic systems located nearby likely are contributing bacteria and nutrients to wetlands and surface waters.

Given that the village is largely developed, and major increases in wastewater flows are not expected, onsite wastewater treatment systems appear to be a viable treatment option capable of protecting groundwater quality if basic management actions are taken, as described in Chapter 5. Recommended wastewater management controls are designed to address specific pollutants of concern and the pathways these pollutants travel to local water resources:

- For groundwater, the primary wastewater pollutants of concern are bacteria and nitrogen. For surface waters, the primary concerns are bacteria and phosphorus.
- To treat bacteria, systems must be properly functioning, with adequate separation distance to shallow groundwater and with setbacks to wells and surface waters.
- Removal of phosphorus also depends on proper separation distances to groundwater and setbacks to surface waters, especially with sandy soils or large-flow wastewater treatment systems. In these cases, the maximum capacity of the soil to retain phosphorus can be reached more quickly.
- Even properly functioning conventional septic systems do not remove nitrogen, so safe concentrations depend on dilution in groundwater. Since public-well data shows nitrogen levels are generally good, maintaining setbacks between wells and septic systems can help ensure that adequate dilution occurs, especially where large-flow onsite systems are used.

Evaluating suitability for onsite wastewater treatment

Approach

The second part of the map assessment was designed to determine where onsite wastewater problems were most likely to occur and where conventional systems or alternative systems would be appropriate solutions. This analysis narrowed from the wellhead protection areas to the village center where septic system problems are concentrated and where parcel mapping was available. This covers an area of approximately 630 acres (as shown in the study area map on page 34).

Assuming all existing systems will eventually fail and need to be replaced or upgraded, the purpose of this analysis was to estimate where conventional onsite systems might function properly and where either modification of conventional systems or advanced treatment would likely be needed. To account for future growth, the analysis considered all lots—those with existing buildings and those not yet developed. Researchers assumed vacant buildable lots will be developed based on town zoning, with single-family homes constructed in residential zones. Researchers also assumed that protected open space and wetlands would not be developed.

Each parcel was evaluated considering suitability for onsite treatment based on the following options:

1. Suitable for standard conventional septic system
2. Marginally suitable for conventional septic system—Requires either small fill mound (< 2 ft.), large mound of fill (> 2 ft.) , or alternative system. The depth of fill needed is estimated since the actual size and height of the fill required is based on depth to water table, soil permeability, and available area. A larger leaching area is needed for slowly permeable soil.
3. Unsuitable for conventional system—Requires alternative system using on-lot system or offsite treatment. Areas with high water tables of less than 1.5 feet below ground are likely to be wetlands or associated buffers and therefore unsuitable for development. Offsite treatment options include small cluster systems serving small groups of homes or businesses, or a large cluster system with central collection and treatment, serving much of the village. This map analysis identified potential locations for shared systems; however, site-specific field investigation is needed to determine suitability of these sites.

This review was conducted at two levels. First, parcels were categorized based on suitability for basic function of onsite systems given wastewater flow, the amount of space available for onsite treatment given lot size, soil permeability, and separation distances to groundwater. Second, parcels were evaluated based on proximity to public wells, wetlands, and surface waters, where a higher level of treatment might be needed to protect water quality.

It is important to note this is a preliminary screening using RIGIS mapping and lot size. Specific information was not available for actual site conditions, building footprints, other structures and paved areas, or the location of existing onsite systems and private wells. Field investigations would be needed to verify results and refine management options.

The decentralized approach to selecting treatment systems

This lot-by-lot assessment is designed to select the simplest, lowest-maintenance wastewater option wherever possible, based on the following principles:

Rely on conventional systems wherever possible. With suitable soils, adequate space, and proper setbacks to wells and surface waters, conventional systems work well and are less expensive to install and maintain than alternative systems.

Selectively use advanced treatment to overcome site constraints, protect nearby wells and surface waters, and avoid excessive site alteration to maintain scenic character and avoid drainage problems. Advanced treatment systems have great advantages for problem sites, including providing a much higher degree of treatment, functioning more reliably on marginal sites, and dramatically reducing site disturbance. However, use of advanced technologies brings other risks. They have higher maintenance requirements and associated costs and are certain to fail if not properly inspected and maintained. Limiting use of advanced treatment systems to the most essential sites minimizes the cost to local governments responsible for overseeing maintenance. It also avoids risk of impact should these technologies fail due to improper design, use, or inadequate maintenance.

Consider use of cluster systems for the most difficult sites to provide suitable drainfield locations where two or more adjacent lots require use of advanced treatment systems. Sharing treatment unit(s) and drainfields can reduce construction and maintenance costs and may be the only treatment option for very difficult sites. Selective use of cluster systems keeps the total volume of wastewater requiring off-site treatment low, which simplifies drainfield siting.

Keep wastewater flows small and provide treatment and dispersal close to the source. Small-scale systems keep collection costs low, provide greater flexibility in locating drainfields, and reduce risk of impact if a system fails. In contrast, central collection to a large cluster or clusters requires a larger leachfield site with greater setbacks to wells and sensitive features. However, maintenance of one large system is often easier for local and state regulators to manage. Perhaps most importantly in this developed village, decisions about system upgrades are likely to be made individually by system owners as repairs are needed or required by town regulations, as homes are sold, and as personal finances allow. Unless local governments provide either incentives or require collective repair of systems using shared systems, repairs and upgrades are likely to continue to be made by individual system owners.

Map analysis methods and results

1. Create map database

Map data was collected from RIGIS focusing on land use, soils, and other natural features. The town provided parcel mapping with land-ownership boundaries and use. The town wastewater management commission reviewed and field-checked draft maps for accuracy. High-consumption water users such as restaurants were identified.

2. Map parcel characteristics influencing wastewater flow and site suitability

Determining the land area needed for the leachfield is based on several factors, beginning with the building use and associated wastewater flow. Parcel characteristics and natural features were then mapped to analyze the potential for both vacant and developed lots to support a new or replacement septic system based on wastewater flow, lot size, and soil constraints.

Building use

The first step was to identify each lot's use—commercial, residential, one-family, two-family, etc. These different types of buildings have different wastewater flows. A two-family home where people shower, do laundry, and wash dishes every day will have a much higher flow than an antiques store with a toilet for the two employees who are there only during the day. The flow is crucial in determining how large a treatment unit and drainfield are required. Standard design flows for various uses were based on the RIDEM individual sewage disposal regulations. To determine suitability for future development, vacant lots were identified and potential use was based on the zoning classification for that particular lot as shown in the parcel use map on page 35. Results indicate that 82 percent of lots are already developed—53 percent as single-family homes, 8 percent as duplexes or apartments, 13 percent as commercial, and the remainder as institutional and vacant.

Lot sizes

The next step in the Chepachet analysis was to examine lot sizes for each parcel to see if septic systems would fit on each lot. Although suitable land area is more important than gross land area, lot size is an important feature in determining if a septic system can fit on each lot. As shown in the parcel size map on page 36, lots were categorized in ranges from less than 5,000 square feet to larger than 80,000 square feet. Approximately 88 percent of all lots are larger than 10,000 square feet in size, indicating most would be large enough to accommodate an onsite system if soils are suitable.

Soil characteristics

The next step was to examine the soil characteristics in Chepachet. URI staff categorized the soils based on two key features readily available in the RIGIS database: soil permeability—rapid, moderate, slow, or wetland—and also by the depth to water table—shallow (1.5 to 3.5 feet) or deep (> 6 feet). This is shown in the map on page 37. These are important characteristics in determining both the size of a drainfield area and whether a mound-type drainfield is needed to maintain the necessary separation distance to groundwater.

Soil permeability determines how large a drainfield needs to be. Since water passes through it less quickly, a slowly permeable soil requires more area to infiltrate each gallon of wastewater, and thus a larger drainfield, than a moderate or rapid soil does. Water tables less than 1.5 feet from the ground surface, which are generally wetlands, were considered unsuitable for conventional onsite treatment systems.

Depth to water table determines whether a site requires a mounded septic system with additional fill. RIDEM regulations stipulate that a 3-foot separation distance be maintained between the bottom of the drainfield and the water table. Since the shallowest conventional trench drainfield is approximately two feet deep, the water table must be at least five feet deep to avoid a mounded system. If the water table is shallower than this, the drainfield needs to be raised above the natural ground surface, forming a mound. Therefore, a lot with a 5-foot water table would accommodate a conventional septic system trench without surface mounding, as long as the lot is large enough to fit the linear feet of drainline required.

3. Develop drainfield-sizing templates based on RIDEM design flows for the range of uses in the village and potential system designs

Based on soil data, URI staff calculated the drainfield size that would be required for various types of drainfields commonly used, located on three different soil types classified by permeability and water table depth. Templates were developed for three-bedroom homes, two-family homes, and various commercial systems based on estimated flows.

4. Evaluate suitability for onsite wastewater treatment based on drainfield sizing templates, soils, and lot sizes

Combining lot size and usage and soil type was the final step in determining what type of system would be needed for each residential property.

A key was developed to review suitability of each residential lot based on its use as a single-family or multi-family home, depth to water table, soil permeability and lot size.

There were two ways to immediately rule out a lot as capable of supporting a septic system. The first was if it was on wetland soil. The second was if the lot was smaller than the minimum possible lot size, approximately < 6,800 square feet for single-family homes, and < 8,300 square feet for two-family homes. This second qualification was a bit more complicated than the first. The minimum size for each lot varied based on if the lot was on slow, moderate, or rapidly permeable soil and if it contained a two-family or three-bedroom house.

Researchers also determined whether a mound was required and how high the mound needed to be. If the soil had a water table of less than six feet, it may have needed at least a low mound. If the lot was also extremely small, a large mound was required, since the smaller but deeper drainfield would be used. If the lot had a deep water table, no mound was necessary in most cases. However, if the lot was very small and the small, deep drainfield was used, a low mound would probably be necessary.

Because building footprints were not available, the building location was estimated for small lots. For large lots, digital orthophotos were used to evaluate building location and potential areas for onsite systems. Where different soil types were located on one parcel, the drainfield-sizing template was used to evaluate whether the more suitable soil type could accommodate a leachfield.

This analysis was conducted for residential lots only. Wastewater flows from commercials systems are highly variable, ranging from small retail stores with flows less than that of a one-bedroom apartment, to large-flow and high-strength waste from restaurants and laundromats. These commercial uses were identified and ranked by parcel size, and large-flow systems were mapped, but otherwise these were not evaluated because of the lack of site-specific information.

5. Evaluate results based on hydraulic function

After finishing the initial analysis, the researchers mapped out their results, as shown in the map on page 38. It is important to note these results estimate suitability for onsite treatment based only on potential drainfield function, and drainfield function was based on lot size and soils, not on environmental factors.

Results for residential lots

- The majority of residential lots—60 percent (102 lots)—were estimated to be capable of accommodating a conventional septic system.
- An additional 30 percent (52 lots) were considered marginally suitable with at least a small amount of filling needed to raise the drainfield.
- Only 10 percent (17 lots) were found to be unsuitable for a conventional septic system due to either site conditions or, in one case, need for a large fill mound. These sites are likely to require either an advanced wastewater treatment system or an offsite leachfield.

Figure 11

Summary Suitability Rating for Residential Lots

RATING	Soils and lot size	Environmental Constraints	Number of lots	Percent
GOOD - FAIR	Suitable	None	59	35%
	Small mound	None	28	16%
	Subtotal		87	51%
POOR	Suitable	> 1	43	25%
	Small mound	> 1	24	14%
	Subtotal		67	39%
UNSUITED	Small mound	> 1	1	1%
	Unsuitable	> 1	16	9%
	Subtotal		17	10%
Total lots			171	100%

6. Conduct second-tier analysis of environmental constraints

In order to preserve public health and environmental quality, additional analysis of environmental constraints for onsite treatment was essential. Natural features requiring setbacks from onsite systems were mapped and buffered using setbacks partially based on current RIDEM individual sewage disposal regulations, as shown in the map on page 39 and in Figure 11. Because regulatory setbacks vary greatly depending on the type of wetland, type of well, and size of septic system, they were generalized from RIDEM regulations and do not represent regulatory minimum distances in all cases.

- A 400-foot separation from a public well
- A 50-foot separation from a wetland
- A 200-foot separation from a body of water (a 50-foot distance was also mapped, as lots falling within this buffer would pose an even greater health risk to rivers and ponds)

Constraints results

The number of residential lots within each type of buffer zone was identified and results summarized below:

• **Good to fair suitability**: Factoring in environmental constraints dramatically reduces the number of lots potentially suitable for conventional onsite treatment. Approximately half of the residential lots (87 lots) were estimated to be either suitable or marginally suitable for onsite treatment without environmental constraints, compared to 90 percent suitable based on soils and lot size alone. Of these unconstrained lots, 35 percent were suitable without modifications, and 16 percent were likely to require a small amount of filling.

• **Poor suitability:** Thirty-nine percent (67 lots) were categorized as poorly suited for conventional onsite systems due to one or more environmental constraints. Advanced treatment may be necessary to protect wells and local water resources on many of these sites. The design flow from these sites is estimated to be 40,050 gallons per day.

• **Unsuitable:** A total of 17 lots (10 percent) are estimated to be completely unsuited for onsite treatment. In all cases, this was due to both leachfield function and environmental constraints. Advanced technologies or off-site treatment are likely to be the only alternatives for these sites. The total flow to be accommodated is estimated to be 13,050 gallons per day.

• **Forty-four percent of all residential lots (67) were mapped as having one or more environmental constraints**. These constraints were fairly evenly split among the three categories examined: 400 feet to a public well, 200 feet to a water body and/or 50 feet to a wetland.

• **Multifamily lots are more likely to have limitations for onsite wastewater treatment using conventional systems.** Thirty percent of multifamily lots are unsuited based on hydraulic function, and 85 percent (17 lots) are likely to be unsuitable when environmental constraints are considered.

• **Commercial (35 lots) and institutional uses (18 lots) have not been taken into account because of the wide range of flows possible.** Flows from these uses may range from less than a single family dwelling, to high-volume, high-strength waste from restaurants and other high-water-use consumers.

• **Onsite systems, private well locations, and the required 100-foot setback between these sites are not shown.** Systems with less than a 100-foot setback may also require advanced treatment.

7. Potential locations for cluster systems

The final step in the analysis was to identify potential locations for cluster systems. The shared-system sites map on page 40 shows locations of lots previously identified as unsuitable for onsite treatment using a conventional system or a large mound. This also includes three lots with large flow systems where conventional systems may not be feasible.

As a first step in identifying options for cluster system siting, vacant lands with suitable soils for onsite treatment were mapped. The shared-system sites map shows results, with one vacant residential parcel and one vacant commercial parcel. Since both of these are located within the larger wellhead protection area, neither is ideal from a resource protection perspective. There is one promising site located just north of the wellhead protection area boundary. This town-owned parcel may be developed, but portions of the lot may be available for locating a cluster treatment system.

Because a large proportion of residential lots (49 percent) are ranked as poorly suited or unsuitable for onsite treatment, a shared cluster system may be more cost effective than individual repairs over the long term. The total flow from the poorly suited and unsuitable sites, estimated to be 53,100 gallons per day, could be collected by small diameter lines and treated at one or more cluster systems. The treatment unit could be sized to accommodate additional growth and expansion of the village. There are several advantages in using a cluster system. These include: potentially lower cost, improved groundwater protection, more efficient system maintenance, and depending on the type of treatment unit, a higher level of treatment compared to small-scale systems. The main disadvantage is that planning and constructing a community wastewater treatment system require public support and greater investment of time and effort by the town, with feasibility studies, financing arrangements and incentives, landowner agreements, and long-term management of the utility. Another option requiring less town oversight would be to let system owners continue to find onsite solutions individually but provide support and incentives for those seeking to construct a small cluster system with neighbors.

Suitability for onsite wastewater treatment summary

This map analysis indicates that approximately half of residential lots may be suitable for onsite wastewater treatment using a conventional system or modified design with at least a slightly raised drainfield. Another 40 percent of residential lots may be suitable for drainfield function but have environmental constraints due to proximity to public wells, surface waters, or wetlands. Use of advanced treatment systems on these sites would help ensure proper treatment and avoid excessive site disturbance and filling. The remaining 10 percent of lots are considered unsuitable due to both poor leachfield function and environmental constraints. These are highly likely to require advanced treatment technologies using either onsite or off-site cluster systems. This assessment did not address sites where advanced treatment may be necessary due to inadequate setbacks between onsite systems and private wells. In addition, large-flow discharges from commercial and institutional buildings such as restaurants and schools are likely to require advanced treatment.

Photo courtesy the John H. Chafee Blackstone River Valley National Heritage Corridor Commission

These results suggest that onsite systems can meet wastewater treatment needs for Chepachet Village, but more importantly, that the level of groundwater protection will vary greatly depending on whether advanced technologies or conventional systems are selected as repairs on marginal sites.

For Chepachet, the risk is that conventional systems will be widely preferred for repairs on marginal sites over advanced technologies when the choice is left to system owners and designers. Although a conventional repair is a major improvement above a cesspool or hydraulically failed septic system, standard septic systems still rely on good soil conditions and setbacks for proper treatment. Without these basic conditions, conventional systems are more likely to discharge improperly treated effluent to groundwater. Clearing and filling for raised leachfields increases the potential for runoff to neighboring properties. And existing homes and businesses may renovate and expand, potentially increasing wastewater flows, using conventional systems with an alteration permit rather than advanced treatment.

Because RIDEM regulations are minimum standards that do not take into account cumulative impacts of multiple systems on small village lots, the town has the authority to establish stricter standards to protect groundwater supplies, especially where cumulative risks are documented.

Tours were conducted of alternative system sites and included information on selecting the proper system for a property.

Top and bottom: Field tours conducted at the URI Onsite Wastewater Training Center, Kingston, R.I.
Center: Field workshops on installing risers

Chapter 4 Public Education

URI staff trained town staff and worked with them to encourage the public to participate in the project and to encourage other Blackstone Valley communities facing similar wastewater management issues to use the project as a model.

URI staff held a series of meetings with Glocester wastewater management program staff to determine Chepachet Village's wastewater management needs, present and discuss study results, identify management options, form recommendations, and determine further outreach steps.

URI staff taught Chepachet Village homeowners about septic system inspection and maintenance and alternative systems through workshops that showed what to expect when a septic system is inspected. Outdoor training programs included an overview of conventional systems, the basics of Rhode Island's standardized inspection procedure, demonstration of pumping out a septic tank, and how to properly install an access riser and effluent filter. Tours were also conducted of alternative system sites and included information on selecting the proper system for a property, making a system blend into a landscape, risk and resource protection, system performance, and system monitoring, operation, maintenance, and electrical needs. A workshop also was conducted showing how larger systems can serve businesses and multifamily homes.

Articles in *The Providence Journal* and local newspapers helped inform other municipalities about the project and its possible application to their own communities. Officials from those municipalities were invited to participate in tours of the demonstration systems.

URI staff taught Chepachet Village homeowners about septic system inspection and maintenance and alternative systems through workshops

Field workshop for homeowners in septic system maintenance and installation of tank risers, Glocester, R.I.


Main St. Chepachet.

Chapter 5 Summary and General Recommendations

The advanced wastewater treatment systems constructed under this project demonstrate how alternative technologies can solve wastewater problems on even very difficult sites. Performance monitoring shows that all systems are functioning properly and providing a high level of wastewater treatment to protect groundwater supplies and the nearby Chepachet River. Continued performance can be expected, provided systems are regularly maintained by qualified, trained maintenance providers. This is essential since all advanced technologies will fail without routine maintenance.

The map analysis of pollution risks to the Chepachet wellhead protection areas indicates that onsite wastewater treatment systems and other land-use activities are serious potential threats to groundwater supplies. The quality of public water supplies is still generally very good, and because the village is largely developed, only limited additional growth is expected. Onsite wastewater treatment systems are therefore considered suitable to meet future needs while also protecting groundwater supplies, provided that systems are properly maintained and substandard systems upgraded, with selective use of advanced treatment systems where treatment failure is most probable and where improperly treated effluent is most likely to affect wells. Using advanced treatment on marginal sites will better protect groundwater resources than repairs using conventional systems with variances from minimum standards. A cluster system can be more economical than onsite advanced treatment units on individual lots. However, the logistics of planning a community system to serve existing homes can be daunting, requiring consensus among town officials and landowners on the location, design, financing, and management of a community system. Meanwhile, pollution risks from onsite systems are serious enough to warrant immediate action, as outlined in recommendations that follow.

All estimates of pollution risk and onsite system suitability presented in this report are based on available GIS mapping and are intended for planning purposes only. In all cases, site investigation is necessary to verify actual conditions, including soil suitability, actual onsite system location and condition, well location, and wetland edge. Much of this information can be obtained through a town septic system inspection program, whereby landowners are required to have systems inspected and results are provided to the town. Inspection results are useful for developing a wastewater management strategy for the village; however, site-specific assessment is needed to determine need for conventional, advanced, or off-site treatment as systems are repaired and upgraded. The following recommendations for system upgrade and treatment are designed to address the most serious threats to groundwater within Chepachet Village wellhead protection areas. Controlling these site-specific risks will provide a high level of protection for individual wells, help maintain the quality of surface waters and wetlands, and help ensure the long-term quality of Chepachet's groundwater resources.

Recommendations

Priorities for system repairs and upgrades in Chepachet Village

The town should adopt the following onsite wastewater management practices and treatment standards for the village:

Ensure basic septic system maintenance

- Establish requirements for regular inspection of all systems, with tank pumpout and other maintenance scheduled as needed
- Basic system repairs as needed
- Immediate repair or replacement of failed systems
- Annual renewal of maintenance contracts for advanced treatment systems

Phase out cesspools

- Set a timeframe for replacement of all cesspools such as five, 10, or more years from first inspection identifying locations of cesspools); or
- Require cesspool removal within one year of property transfer

Establish siting standards for new construction

- Prohibit new system construction or expansion on water table sites less than two feet below ground surface, and within buffers to wells, wetlands, and surface waters.

Establish standards for advanced wastewater treatment

The following are recommended locations for use of advanced treatment systems with new system construction and replacement of cesspools and failed systems:

- All large-flow systems located within the wellhead protection area (defined as > 2,000 gpd)
- 200 to 400 feet from a public well (depending on HEALTH regulations)
- 100 feet from a private well (or for repairs, 80 feet from a drilled well)
- 100 feet from a surface water body or wetland and 200 feet from a river greater than 10 feet wide for new construction and repairs; for repairs consider reducing to 50 feet where water tables are greater than four feet and no filling is required
- Where water tables are less than four feet from the surface, require advanced treatment for new systems and repairs to avoid extensive filling and alteration of drainage patterns. Performance standards can be established to allow conventional systems where stormwater management and site design requirements are met.

** Note: These recommendations apply to Chepachet Village only. They are intended to address groundwater protection needs based on available water quality information, current and future development, and site conditions. Stricter buffer protection and siting standards would be recommended for sensitive surface waters such as the Scituate Reservoir watershed and watersheds of recreational lakes.*

Preventing pollution from land-use activities

Controlling development impacts in Chepachet Village calls for an integrated approach to manage onsite wastewater treatment systems, control stormwater runoff, and protect wetland buffers to maintain the natural water quality function of shoreline zones.

The following are basic pollution prevention measures needed to protect groundwater supplies and interconnected surface waters from the combined effects of land-use activities in Chepachet Village.

The town should:

Promote private-well care

- Encourage private-well testing by hosting private-well workshops offered by URI Cooperative Extension
- Consider subsidizing the cost of coordinating the sampling of private wells, and use generalized results to evaluate existing conditions and raise awareness of the need to maintain wells and septic systems
- Encourage private-well owners to upgrade dug wells to drilled wells, especially when located within 100 feet of a septic system

Control use of underground storage tanks and hazardous materials

Leaking underground storage tanks and improper disposal of hazardous materials are major threats to Rhode Island groundwater. The town should review existing zoning standards to ensure that new or expanded underground fuel storage tanks are prohibited and that commercial use of hazardous materials is properly regulated. Town staff or volunteer boards should periodically check with RIDEM to determine compliance status of existing facilities.

Manage stormwater to control runoff volume

- Update land-development standards to maintain runoff volume at pre-development levels, and to restore infiltration with redevelopment projects
- Require use of nonstructural stormwater treatment techniques that can fit in small areas and blend in with the existing natural or architectural features of the village
- Employ alternative permeable pavements to minimize runoff
- Limit impervious cover and apply the most stringent stormwater controls on substandard lots with high water tables where runoff and nuisance flooding are most likely to occur

Protect and restore wetland buffers

- Enforce maximum protection of wetland buffers to maintain water-quality function
- Consider wetland buffer restoration with redevelopment projects on parcels located within wetland buffers

Expand public education

- Continue to promote public awareness of recharge areas and basic actions residents can take to protect their own groundwater and maintain onsite systems
- Start by making results of this assessment available to village residents

Final note: Developing a village wastewater management plan

This project provides a preliminary assessment of existing conditions and demonstrates how alternative systems can be used to provide a high level of groundwater protection while preserving historic and scenic qualities that give Chepachet Village its unique character.

Although this report offers recommendations for further town action, these represent the professional judgment of URI staff and not town policy. Town officials can use findings of this report to develop a plan for management of onsite systems in Chepachet Village. A village wastewater management plan will allow town officials, with the input and involvement of residents, to outline town goals for the area; establish priorities for system repair, upgrading, and maintenance; identify specific actions; and propose a timeline for implementation. Adopting the plan as an element of the town comprehensive plan will provide the town with the authority to adopt ordinances and development regulations necessary to implement the plan's recommendations for long-term protection of groundwater supplies.

Technical documentation

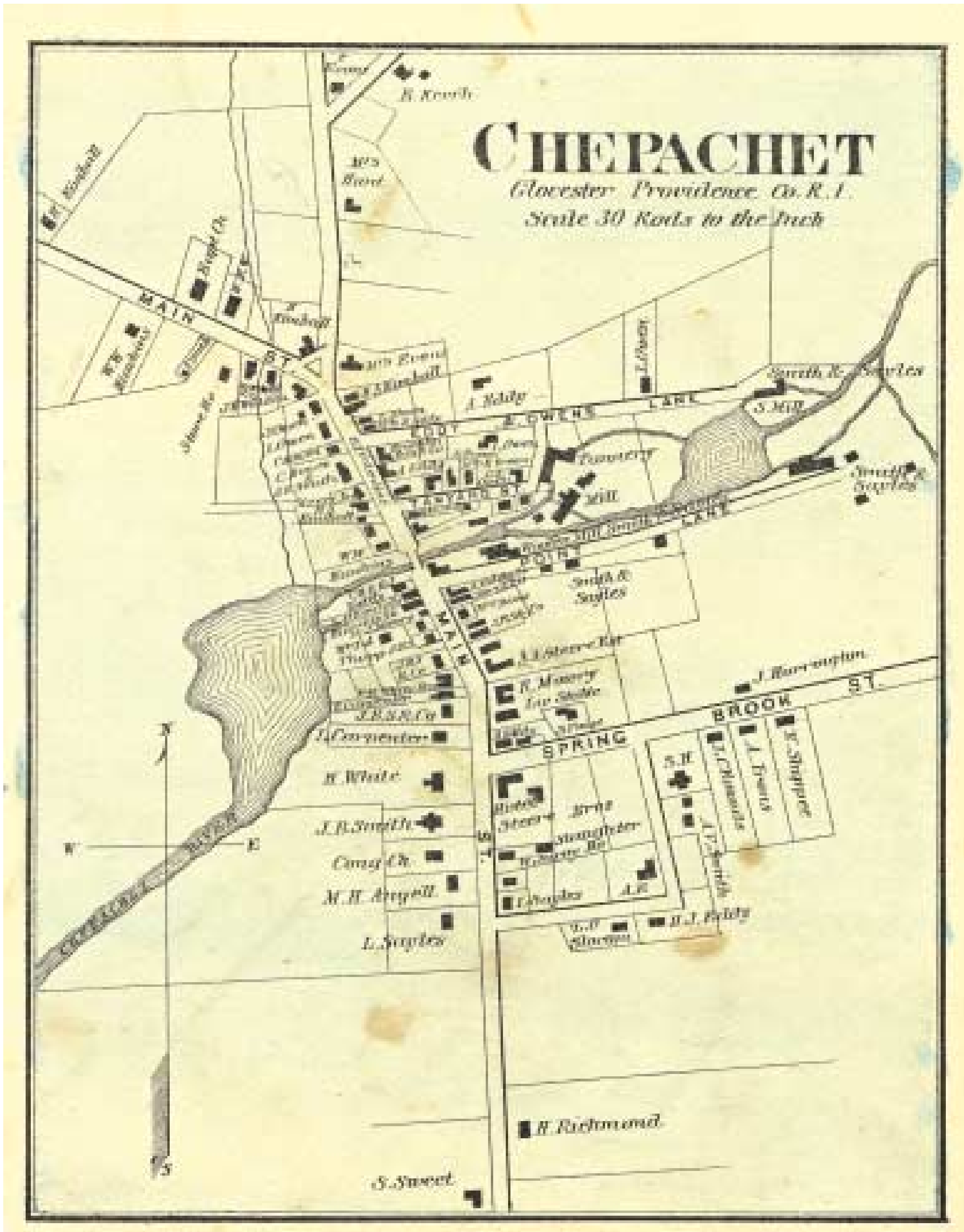
These reports are available online at http://www.uri.edu/ce/wq/

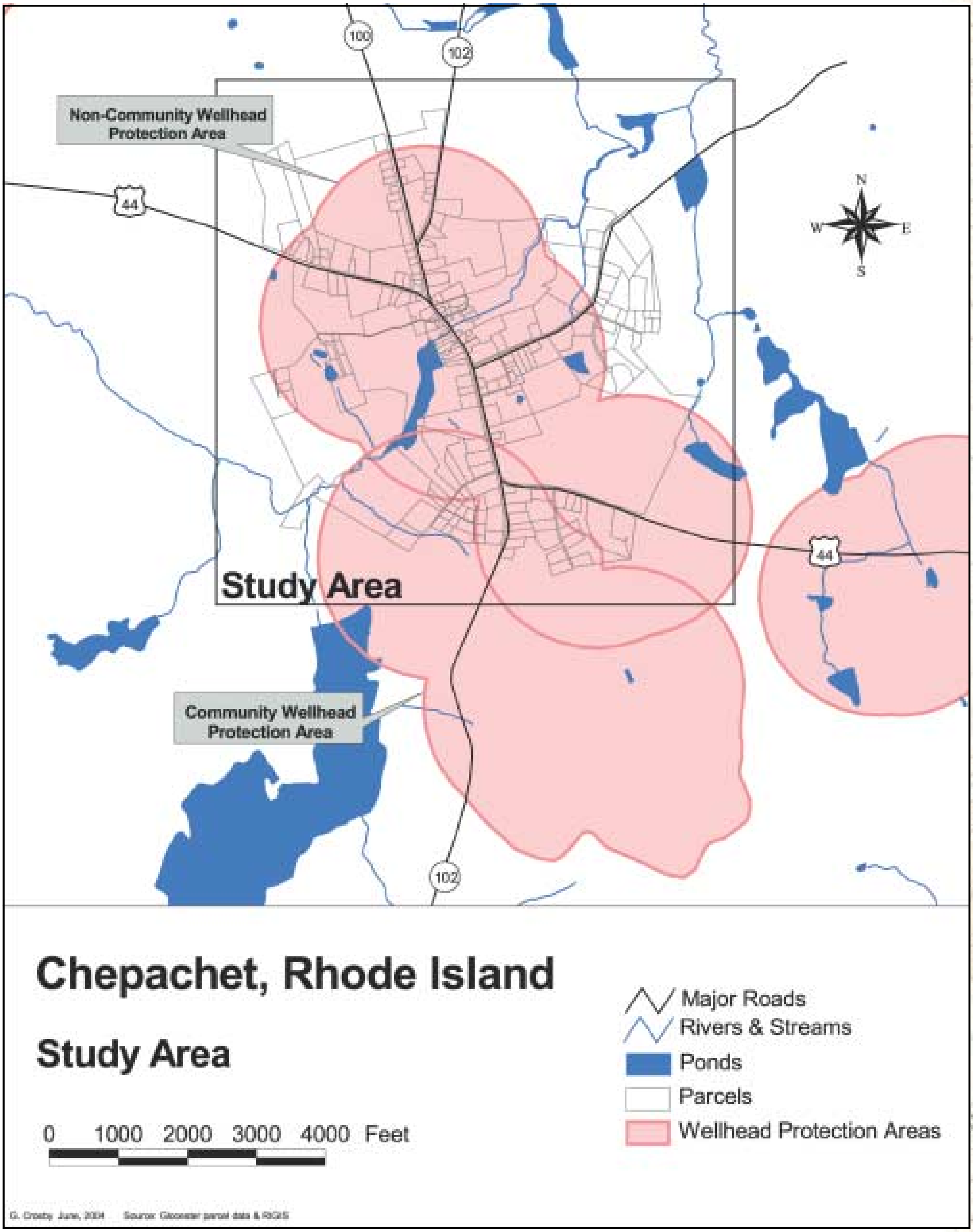
- Summary of Alternative Onsite Wastewater Demonstration Systems Treatment Performance and Operation and Maintenance Needs Chepachet Village, Glocester, Rhode Island
- Map Analysis of Chepachet Village Pollution Risks and Wastewater Treatment Options
- Summary of URI Home*A*Syst Educational Efforts: Glocester 319 Wastewater Management Project Component 3: Community Involvement and Education

Demonstration systems were constructed by Rhode Island Independent Contractors and Associates (RIICA)

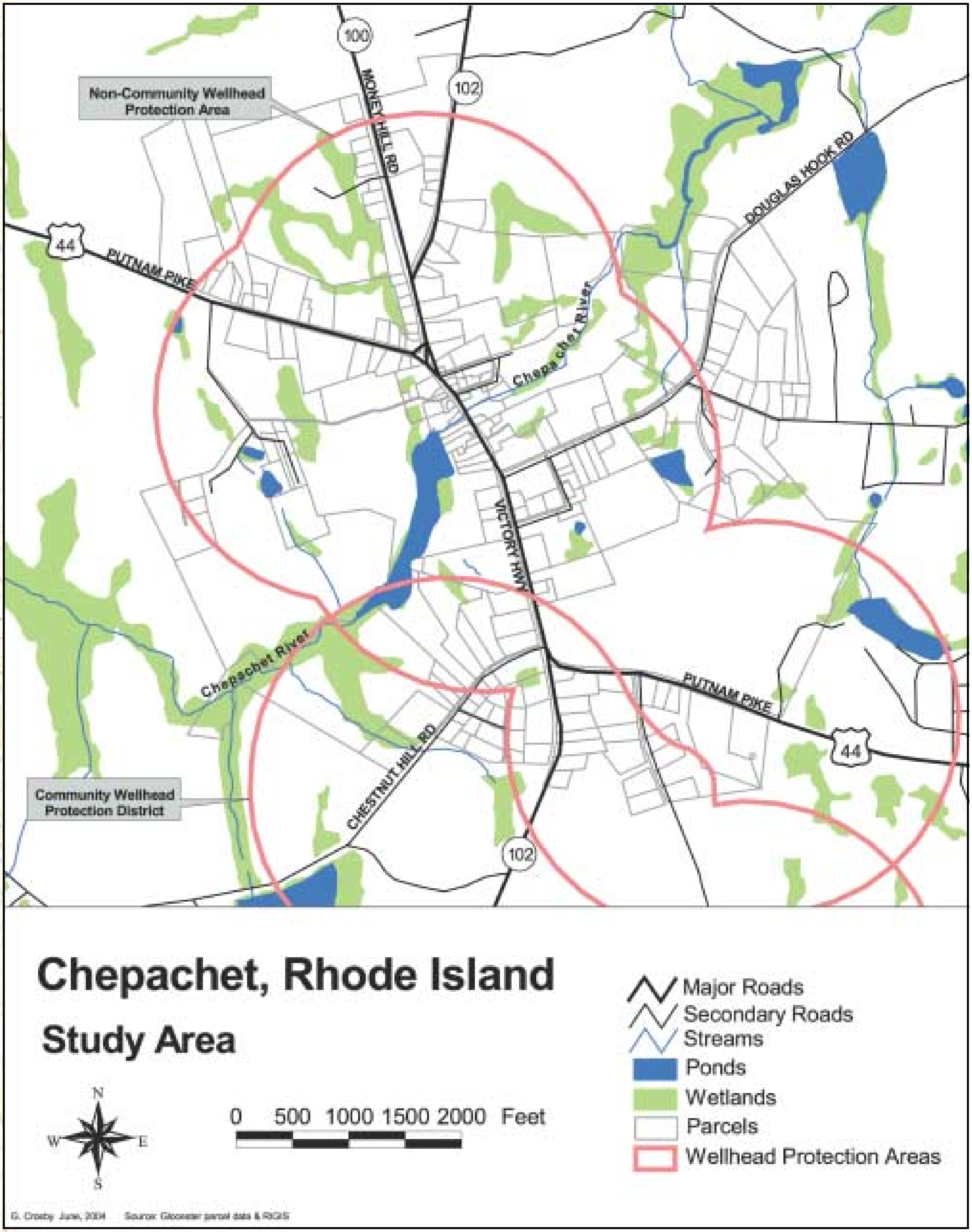
Demonstration system construction was conducted as a hands-on training opportunity for septic system installers, as a partnership between URI and RIICA. RIICA recruited members to participate in the installations, often at reduced labor costs. URI staff, including system designers, researchers, and students, were part of the construction team, providing construction oversight, helping to troubleshoot unexpected problems encountered, documenting the process, and providing an extra set of hands for sealing tanks, shoveling, or raking.

Maps

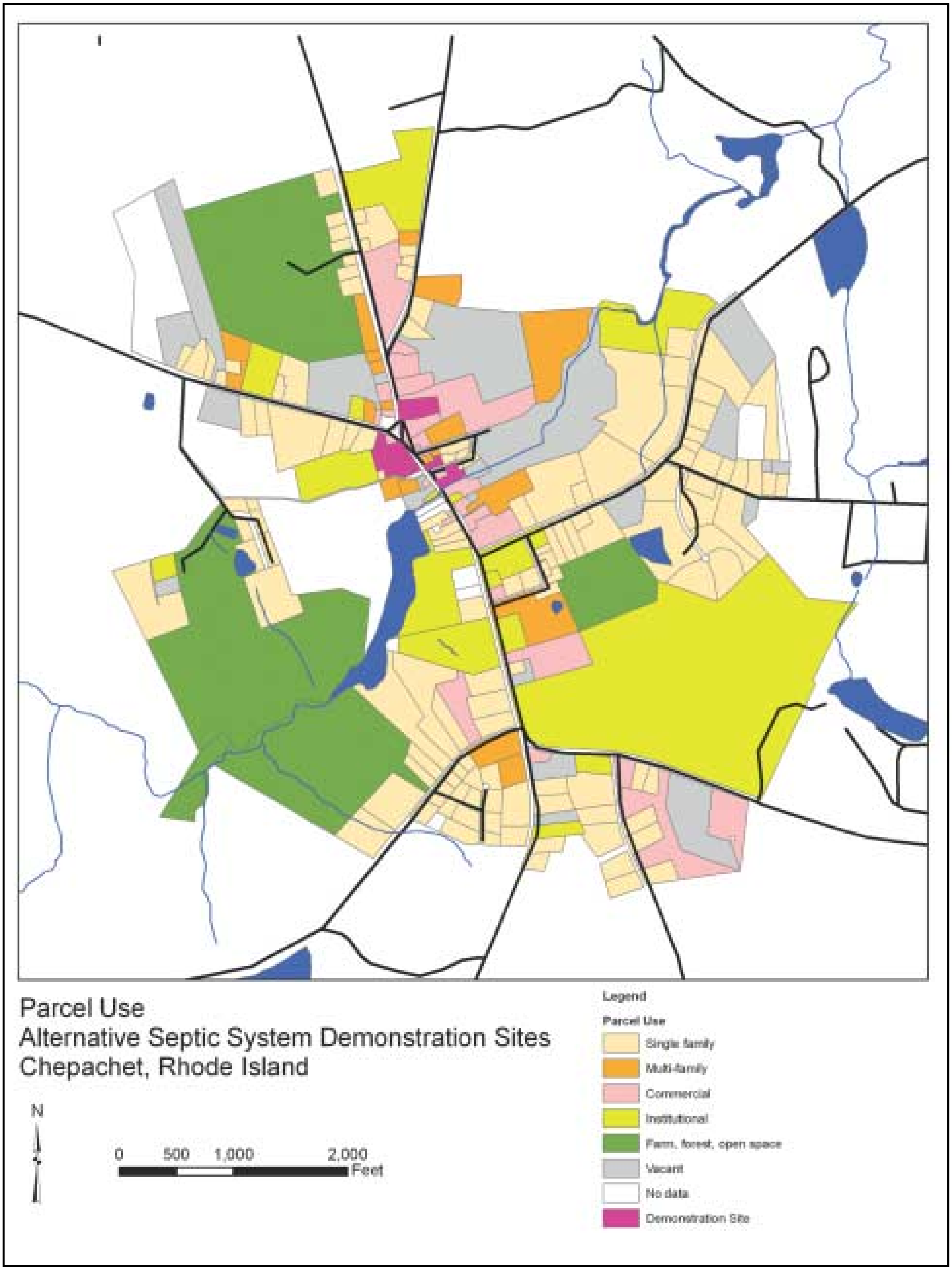

CHEPACHET
Glocester Providence Co. R.I.
Scale 30 Rods to the Inch
MAIN ST
SPRING
BROOK ST
LANE
Tannery
Cong Ch.
M. H. Angell
L. Sayles
H. White
J. B. Smith
L. Carpenter
H. Richmond
S. Sweet
Smith & Sayles

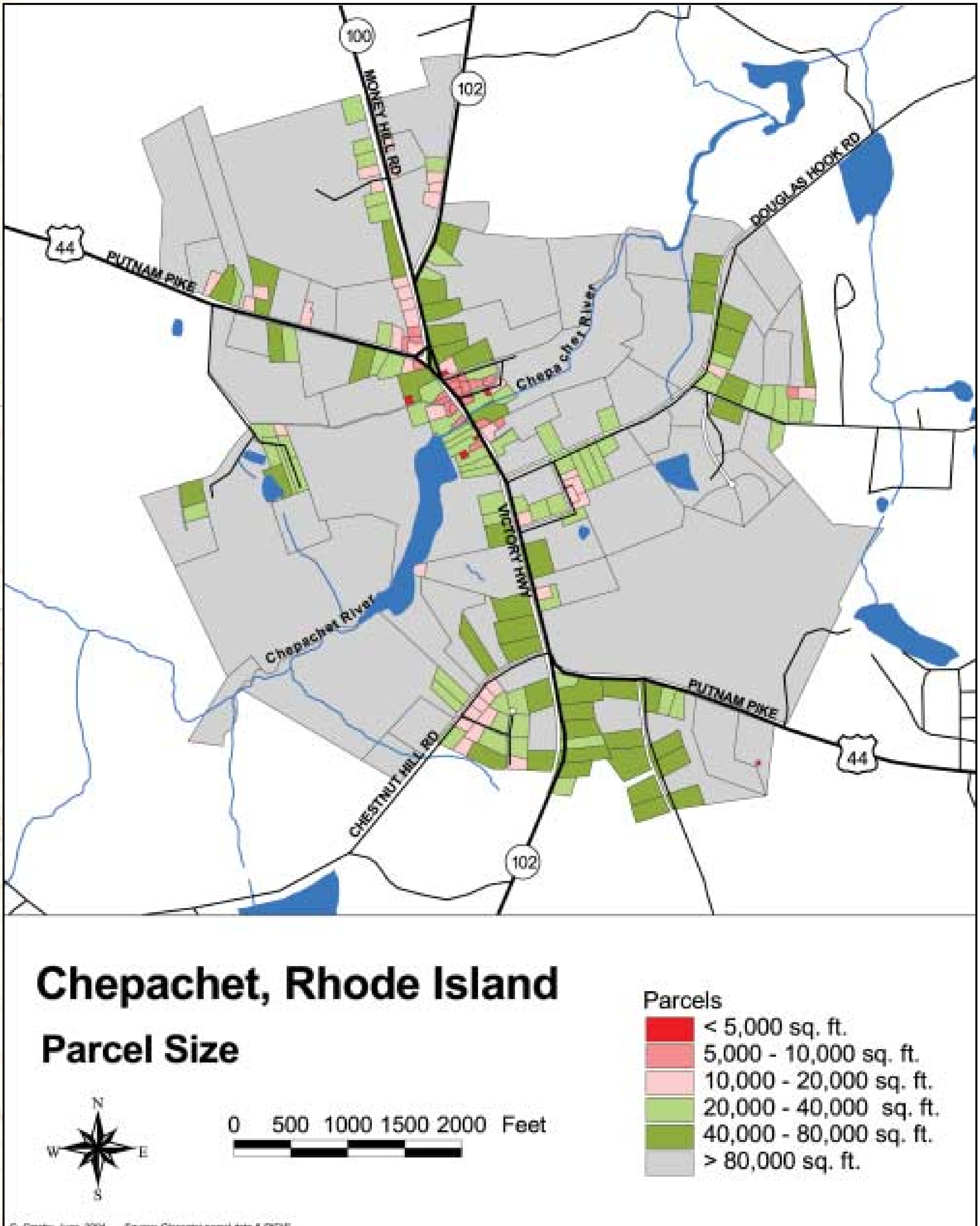


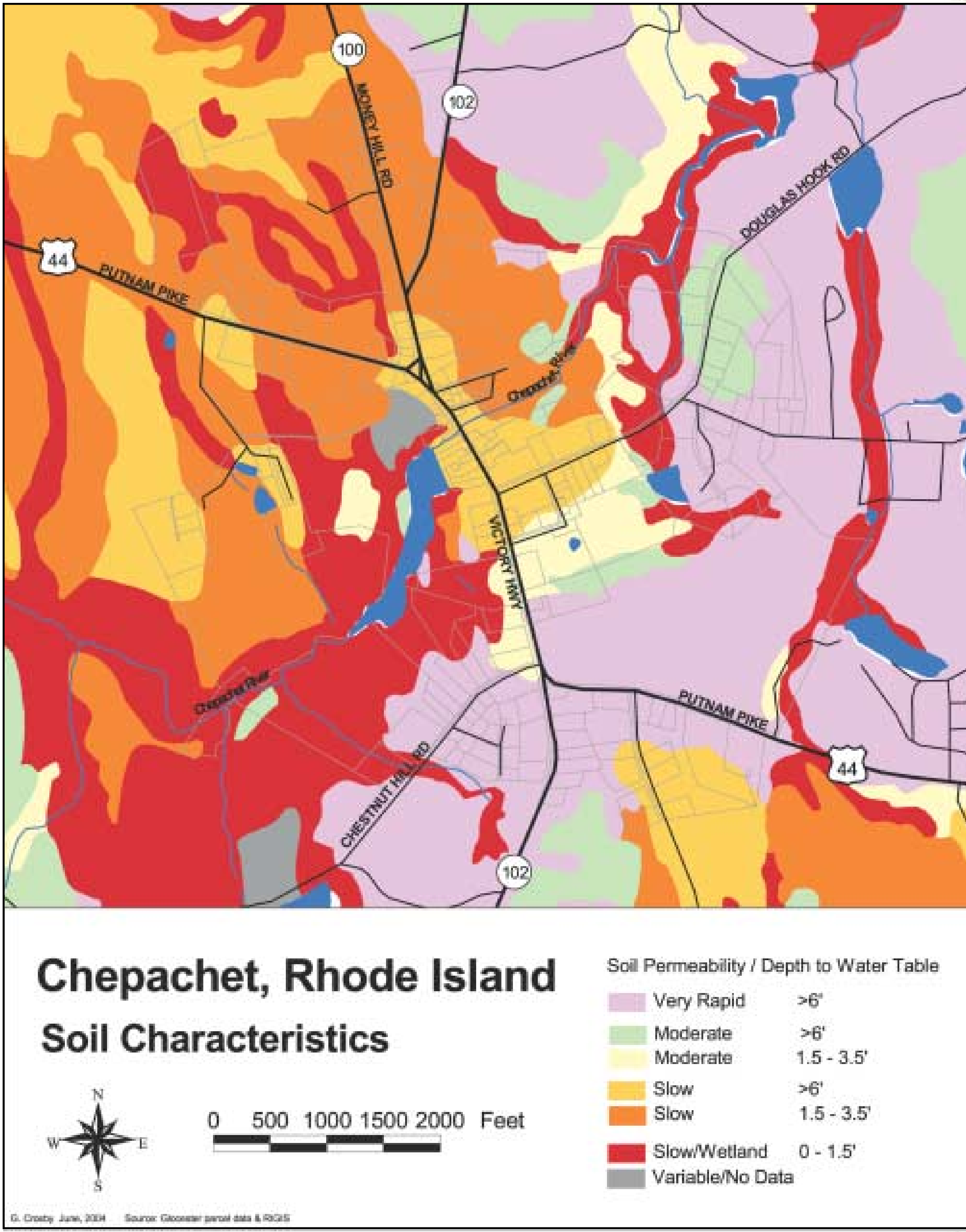
Non-Community Wellhead Protection Area
Community Wellhead Protection Area
Study Area
100
102
44
N
S
E
W
Chepachet, Rhode Island
Study Area
0 1000 2000 3000 4000 Feet
Major Roads
Rivers & Streams
Ponds
Parcels
Wellhead Protection Areas

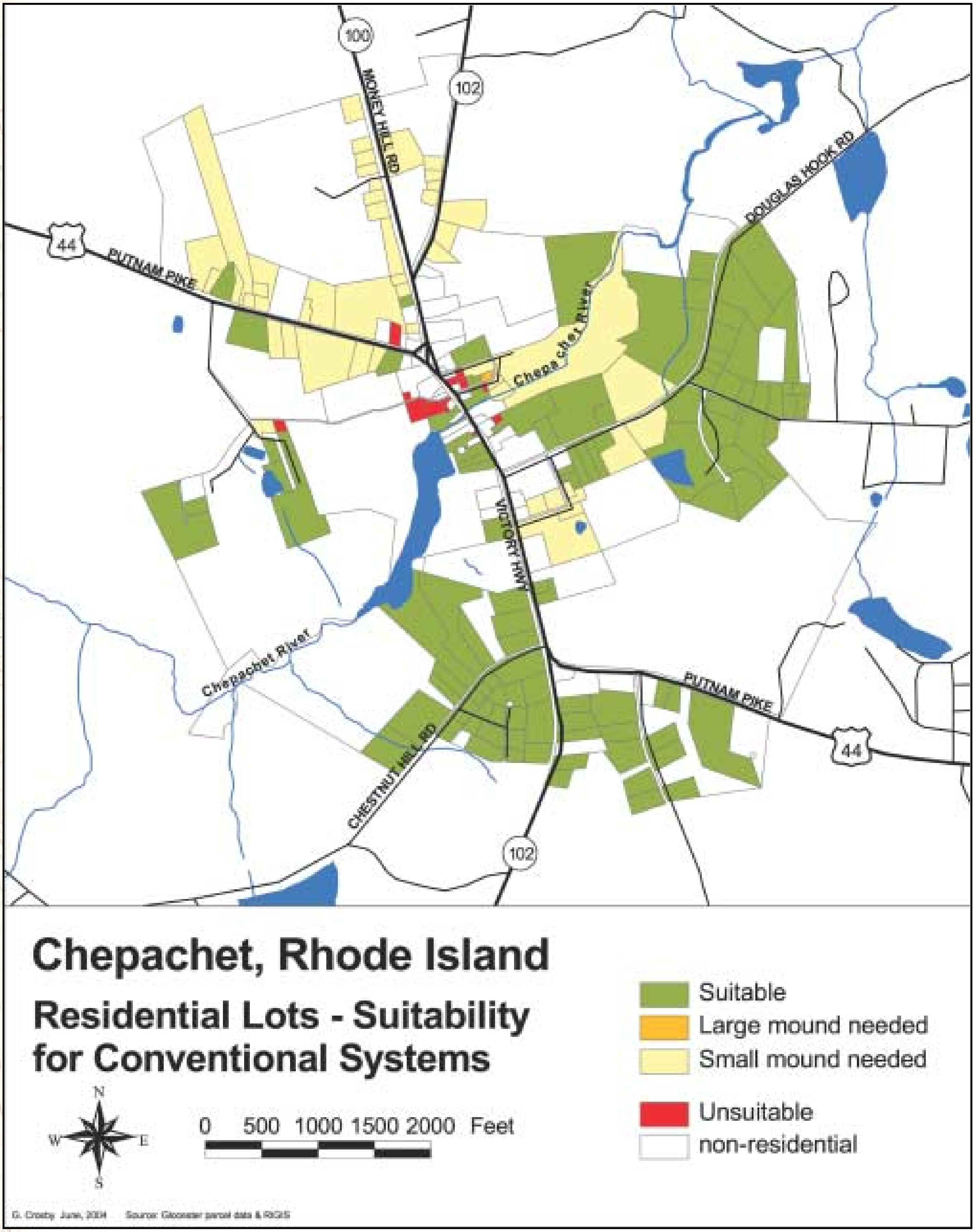


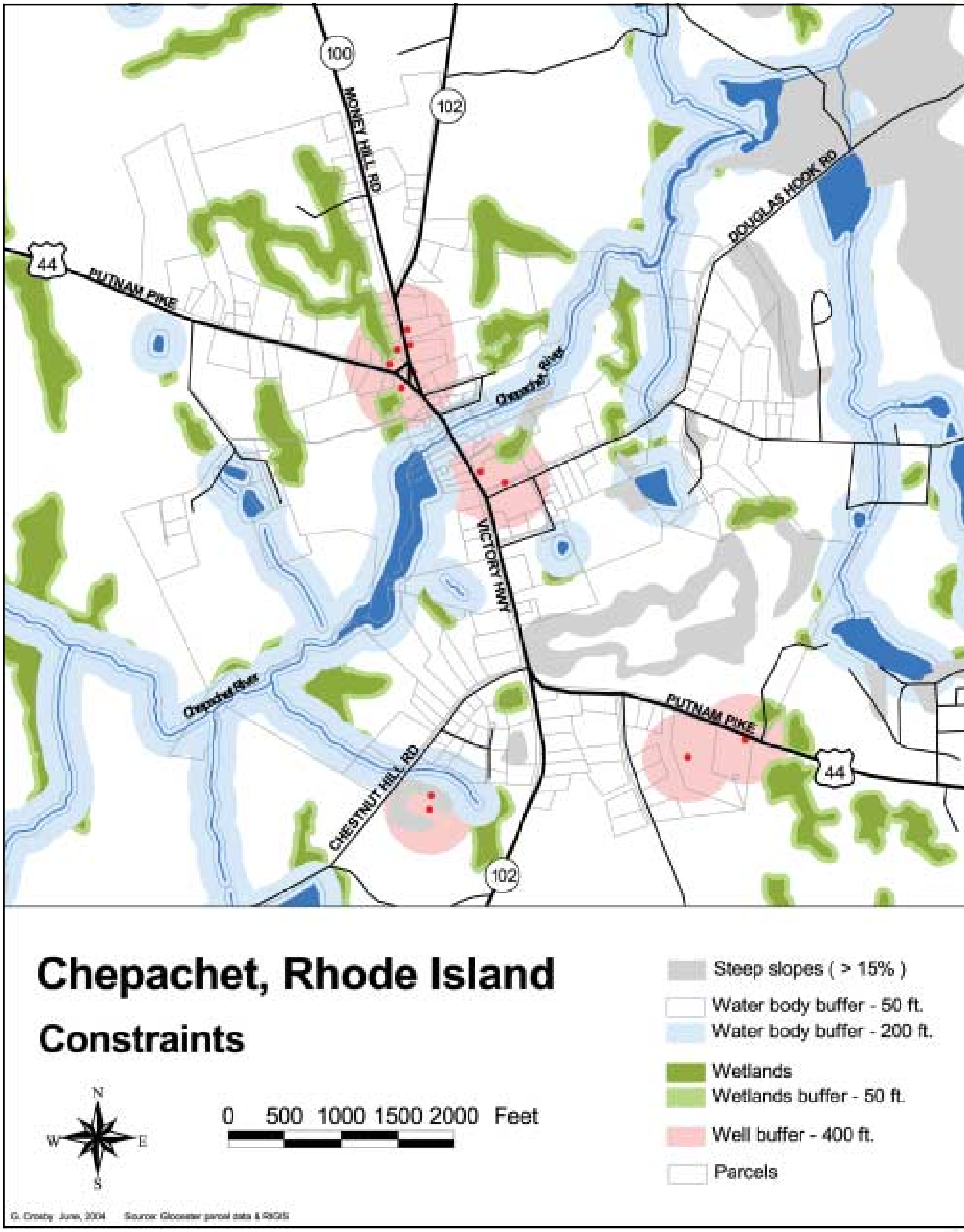
Non-Community Wellhead Protection Area
100
102
MONEY HILL RD
44
PUTNAM PIKE
DOUGLAS HOOK RD
Chepachet River
VICTORY HWY
Chepachet River
PUTNAM PIKE
44
CHESTNUT HILL RD
Community Wellhead Protection District
102
Chepachet, Rhode Island
Study Area
N
W
E
S
0 500 1000 1500 2000 Feet
Major Roads
Secondary Roads
Streams
Ponds
Wetlands
Parcels
Wellhead Protection Areas

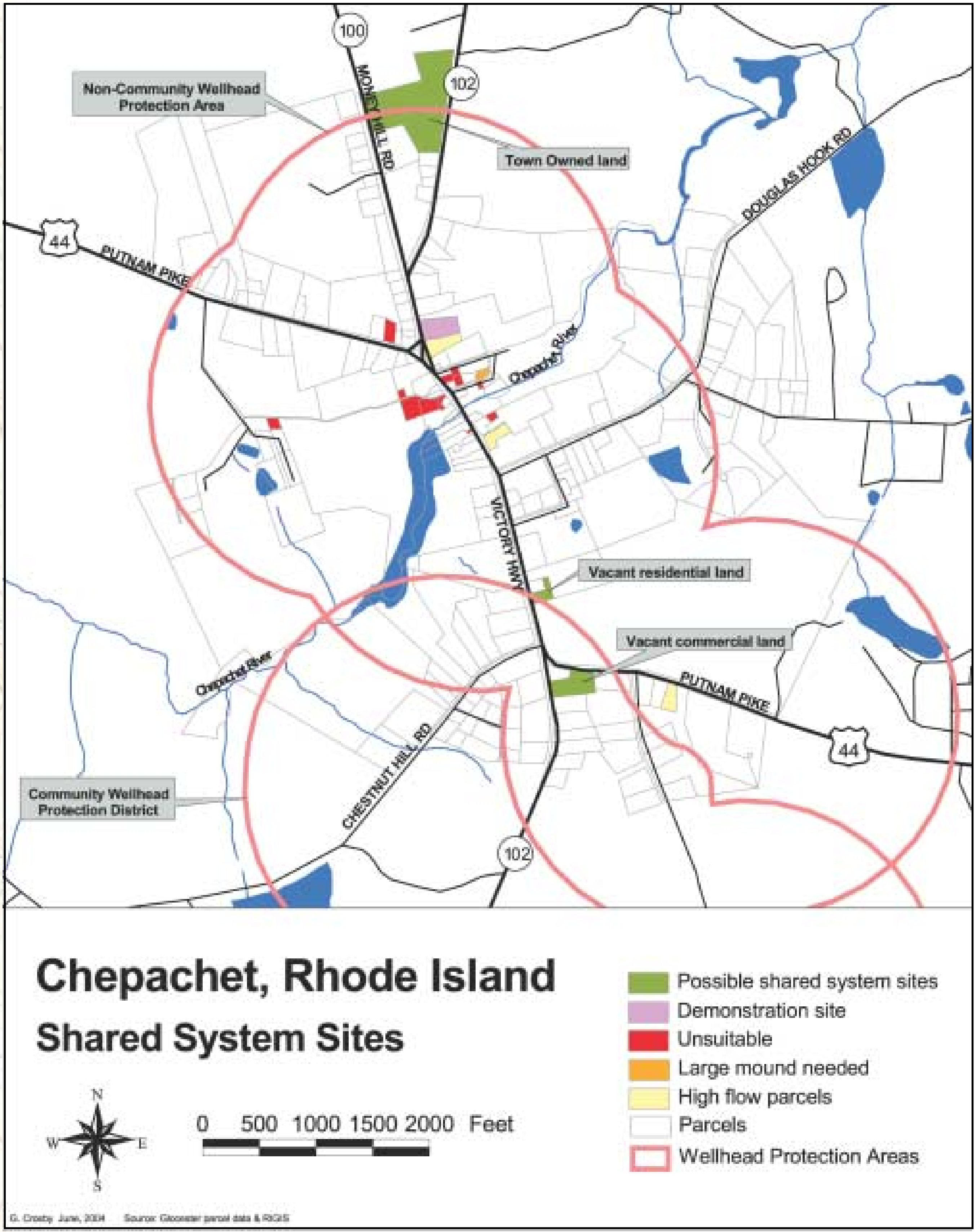

Parcel Use
Alternative Septic System Demonstration Sites
Chepachet, Rhode Island
N
0
500
1,000
2,000
Feet
Legend
Parcel Use
Single family
Multi-family
Commercial
Institutional
Farm, forest, open space
Vacant
No data
Demonstration Site


100
102
MONEY HILL RD
44
PUTNAM PIKE
DOUGLAS HOOK RD
Chepachet River
VICTORY HWY
Chepachet River
PUTNAM PIKE
44
CHESTNUT HILL RD
102
Chepachet, Rhode Island
Parcel Size
N
W
E
S
0 500 1000 1500 2000 Feet
Parcels
< 5,000 sq. ft.
5,000 - 10,000 sq. ft.
10,000 - 20,000 sq. ft.
20,000 - 40,000 sq. ft.
40,000 - 80,000 sq. ft.
> 80,000 sq. ft.


100
102
MONEY HILL RD
44
PUTNAM PIKE
DOUGLAS HOOK RD
Chepachet River
VICTORY HWY
PUTNAM PIKE
44
CHESTNUT HILL RD
102
Chepachet, Rhode Island
Soil Characteristics
N
W
E
S
0 500 1000 1500 2000 Feet
Soil Permeability / Depth to Water Table
Very Rapid >6'
Moderate >6'
Moderate 1.5 - 3.5'
Slow >6'
Slow 1.5 - 3.5'
Slow/Wetland 0 - 1.5'
Variable/No Data


100
102
MONEY HILL RD
DOUGLAS HOOK RD
44
PUTNAM PIKE
Chepachet River
VICTORY HWY
Chepachet River
PUTNAM PIKE
44
CHESTNUT HILL RD
102
Chepachet, Rhode Island
Residential Lots - Suitability for Conventional Systems
Suitable
Large mound needed
Small mound needed
Unsuitable
non-residential
N
W
E
S
0 500 1000 1500 2000 Feet
G. Crosby June, 2004
Source: Glocester parcel data & RIGIS


100
102
MONEY HILL RD
44
PUTNAM PIKE
DOUGLAS HOOK RD
Chepachet River
VICTORY HWY
Chepachet River
PUTNAM PIKE
44
CHESTNUT HILL RD
102
Chepachet, Rhode Island
Constraints
N
W
E
S
0 500 1000 1500 2000 Feet
Steep slopes (> 15%)
Water body buffer - 50 ft.
Water body buffer - 200 ft.
Wetlands
Wetlands buffer - 50 ft.
Well buffer - 400 ft.
Parcels
G. Crosby June, 2004 Source: Glocester parcel data & RIGIS


100
102
MONEY HILL RD
Non-Community Wellhead Protection Area
Town Owned land
DOUGLAS HOOK RD
44
PUTNAM PIKE
Chepachet River
VICTORY HWY
Vacant residential land
Vacant commercial land
Chepachet River
PUTNAM PIKE
44
CHESTNUT HILL RD
Community Wellhead Protection District
102
Chepachet, Rhode Island
Shared System Sites
N
W
E
S
0 500 1000 1500 2000 Feet
Possible shared system sites
Demonstration site
Unsuitable
Large mound needed
High flow parcels
Parcels
Wellhead Protection Areas
G. Crosby June, 2004

Main Street, Chepachet, Rhode Island