

Touisset Point and Highlands  
Wastewater Management & Water Supply  
Impact Study

Final Report

Town of Warren  
Warren, RI

November 2007



Fuss & O'Neill  
Foundry Corporate Office Center  
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TOUISSET POINT AND HIGHLANDS  
WASTEWATER MANAGEMENT & WATER SUPPLY  
IMPACT STUDY  
Warren, RI

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## EXECUTIVE SUMMARY

### Project Background

Touisset Point and Touisset Highlands in the Town of Warren, Rhode Island, developed as summer cottage communities, but have evolved into year-round use over the last several decades. While the use of these homes has significantly increased— and in some cases expanded— the water and wastewater infrastructure supporting these properties has remained largely unchanged.

Most of the lots in these two areas are served by private wells and individual sewage disposal systems (ISDSs). Given the small size of the lots (often 3,000 square feet or less), many properties are nonconforming and lack the space needed for ISDSs to meet setbacks from wells, property lines and other lot features. Add to this the fact that most of the ISDSs are relatively old— many are cesspools or otherwise outmoded— and significant concerns arise regarding potential for cumulative and chronic pollution problems.

Fortunately, no violation of water quality standards has been found; however, intensity of land use in the area presents an immediate risk and signs of water quality degradation are apparent in groundwater. This study indicates that these signs need to be carefully considered by the Town and that the Town should consider developing a program focused on upgrading ISDSs and examining the adequacy of the existing water supply systems.

In response to water quality and infrastructure capacity concerns, the Town of Warren hired Fuss & O'Neill Consulting Engineers to conduct a study of the Touisset Point and Touisset Highlands areas.

### Findings and Recommendations

In general, this report recommends a septic system upgrade program that takes advantage of phased installation on a prioritized basis. The steps recommended are as follows:

- The Town should develop an assistance program to help replace cesspools and substandard systems as required by state law and to upgrade distressed conventional systems to innovative and alternative (I&A) technology.
- There are several financial assistance programs that communities may access to implement water supply and wastewater infrastructure enhancement programs. The Town should continue to explore financing for infrastructure upgrades and program planning.
- To ensure the proper function of ISDSs— especially I&A systems— the Town should develop an onsite wastewater management district to require proper operation and maintenance.

#### Recommended Program Development Steps:

- ISDS upgrade assistance program development.
- Integrated monitoring program development.
- Analysis of water supply improvement alternatives.
- Zoning ordinance revision.
- Operation and maintenance program development.
- Financial assistance development.



- Water quality in Touisset is showing signs of stress by development. The Town should establish an integrated monitoring program that includes sampling of the public and private wells and coastal water quality.
- Capacity of the existing water supply system appears to be stressed and demand is likely to rise as private wells continue to be replaced by Touisset Point Water Trust (TPWT). Working with the TPWT, the Town should further examine adequacy of the public water supply and upgrade or enlarge supply wells as needed.
- The Town should consider steps to prohibit unmerging of lots for the purpose of building new homes.

Among other implementation steps, this study recommends developing a wastewater management district and I&A system upgrade program.

A wastewater management district is a locally (e.g., municipally) run regulatory program authorized to conduct or require ISDS inspections for such purposes as routine maintenance, property transfer, and system function. These programs may also provide public education, technical assistance and financial assistance to system owners. Wastewater Management Enabling Legislation (RIGL 45-24.5) provides the authority for municipalities to establish wastewater management districts.

There are currently six wastewater management districts in Rhode Island. Wastewater management districts differ from wastewater management programs, in that "programs" are typically nonregulatory.

Technical Advisory Committee

This study was completed with the guidance of a technical advisory committee (TAC). It included two residents from the study area and met three times. The Town Manager, Town Planner, and DPW director also participated as well as staff members of Fuss & O'Neill. Below is a list of the TAC participants:

Town of Warren

- Michael Abbruzzi, Town Manager
- Michelle Maher, Planner
- John Massed, DPW Director
- Jane Harrison, Touisset Highlands Resident
- Fred Massie, Touisset Point Resident

Fuss & O'Neill

- Peter Grose, PE, Sr. Vice President
- Jim Riordan, AICP, Project Manager
- Amy Hunt, EIT, Project Engineer



## 1.0 BACKGROUND AND STUDY OBJECTIVES

Touisset Point and Touisset Highlands in the Town of Warren, Rhode Island, developed as summer cottage communities, but have evolved into year-round use over the last several decades. While the use of these homes has significantly increased— and in some cases expanded— the water and wastewater infrastructure supporting these properties has remained largely unchanged.

Most of the lots in these two areas are served by private wells and individual sewage disposal systems (ISDSs). Given the small size of the lots (often 3,000 square feet or less), many properties are nonconforming and lack the space needed for ISDSs to meet setbacks from wells, property lines and other lot features. Add to this, the fact that most of the ISDSs are relatively old— many are cesspools or otherwise outmoded— and significant concerns arise regarding potential for cumulative and chronic pollution problems.

Fortunately, no violation of water quality standards has been found; however, intensity of land use in the area presents an immediate risk and signs of water quality degradation are apparent in groundwater. A recent study indicates that these signs need to be carefully considered by the Town and that the Town should consider developing a program focused on upgrading ISDSs and examining the adequacy of the existing water supply systems.

This study examines current water supplies and wastewater systems in both the Point and Highland areas. This study has five main objectives:

- Determining the existence and extent of ISDS and well problems.
- Determining the net usable land in the Touisset Point and Touisset Highlands areas for septic system expansion and replacement.
- Calculating present and future water use and wastewater generation in the project area
- Assessing the extent of capacity problems for both wastewater disposal and water supply in the area.
- Identifying potential solutions, both conventional and alternative, and possible funding sources.

## 2.0 EXISTING SITUATION

### 2.1 Study Area

Touisset Point and Touisset Highlands are coastal areas in the Town of Warren on Touisset Peninsula. Touisset Peninsula is located east of the estuarine segment of the Kickemuit River and west of the Massachusetts line. The Point is approximately 2,200 feet south of the Highlands and the two are separated by conservation land owned by the Rhode Island Audubon Society as well as a vacant lot owned by GRF. Figure 1— Study Area depicts both Touisset Point and Touisset Highlands.



## 2.2 Zoning

Zoning in the Point and Highlands is designated as R-40 with Residential Village Overlay District. R-40 is defined in the *Town of Warren, Rhode Island Comprehensive Plan* as partially or fully developed land with approximately one dwelling unit per 40,000 square feet (i.e., approximately one acre). Existing zoning is presented in Figures 2 and 3. Uses allowed by right in the R-40 zoning district include, but are not limited to:

- Agricultural uses such as raising animals and crops needs 100,000 sq. ft.
- Residential uses such as singly family dwellings and cluster development.
- Outdoor recreation.
- Public education institutions and other public and semi-public uses.
- Water supply reservoir and well fields.

(LBG, 1999)

Both the Point and Highlands are subject to a Residential Village (RV) Overlay District (Town of Warren Ordinances Chapter 32-77.1). The RV district allows for the modification of setbacks and building coverage within lots which emulate the configuration and dimensional profile of the prevalent building pattern rather the underlying district. The dimensional regulations to be applied are to be those of the lot size equal to or consecutively larger than the subject lot. For example, development of a lot with 12,000 square feet of area in the RV District must conform to the setbacks and building lot coverage for an R-15 district.

## 2.3 Soils

The following is a brief description of the soil types found in the two study areas, as described in the *Soil Survey of Rhode Island* (1981). Refer to Figure 4 for general location of soil-types in both the Point and the Highlands. The text below provides detailed descriptions of each soil group found in the Point and Highlands.

### Touisset Highlands Soils

- NeB –Newport silt loam, 3 to 8 percent slopes. Permeability is moderate in the surface layer and subsoil and slow or very slow at greater depths. Onsite wastewater systems need to be specially designed in NeB soil.
- NeC –Newport silt loam, 8 to 15 percent slopes. Permeability is moderate in the surface layer and subsoil and slow or very slow at greater depths. Onsite wastewater systems in NeC soil need to be specially designed to prevent wastewater effluent from rising to the surface.

### Touisset Point Soils

- QoA –Quonset gravelly sandy loam, 0 to 3 percent slopes. Permeability is moderately rapid to rapid at surface and subsoil layers and very rapid at greater depths. Onsite wastewater systems in QoA soil need to be carefully installed so as not to pollute groundwater.



- QoC – Quonset gravelly sandy loam, rolling. Permeability is moderately rapid to rapid at surface and subsoil layers and very rapid at greater depths. Onsite wastewater systems need to be carefully installed so as not to pollute groundwater in QoC.

## 2.4 Current Water Supplies

The Touisset area uses primarily private groundwater wells as a water supply. Most of these private wells extend over 100 feet deep into bedrock. Representative well depth in the Highlands is 150 feet deep. Well data indicates water quality is very good in the Highlands area (LGB, 1999).

A community water system, which is owned and operated by the Touisset Point Water Trust (TPWT), serves approximately 69 of the 139 homes on the Point. The community system includes two wells situated in close proximity to each other in a park area surrounded by dense development. They are shallow (approximately 45 feet deep) gravel-packed dug wells. The wells provide approximately 15 gallons per minute (gpm) and 65 gpm for a total cumulative capacity of 75 gpm.<sup>1</sup> Section 4.3 of this report provides a more detailed discussion of water quality and flow data for the TWPT water supply.

The Touisset Point Water Trust supplies water for many of the residents in Touisset Point via two shallow dug wells.

In contrast, residents of the Touisset Highlands obtain their drinking water from private wells installed at each home. Most wells in the Highlands are reported to be deep wells drilled into the bedrock.

## 2.5 Current Wastewater Systems

Wastewater systems in both the Highlands and the Point include conventional ISDS systems, some I&A technologies, and some cesspools. Our initial review of available information regarding these systems indicates that conventional systems and cesspools are the predominant types of ISDS used in both the Highlands and the Point. I&A technologies used in the area include bottomless sand filters (BSFs) preceded by pretreatment technologies as required in Rhode Island's ISDS regulations. Fixed activated sludge treatment (FAST) systems and the Advantex RX Denite System (RX-30),<sup>2</sup> two types of nitrogen-reduction systems, are also present.

More information on currently available wastewater systems in the study area is provided in Section 4.0 and Section 6.2.

## 2.6 Results of Site Visit

A site visit to both the Point and Highland areas was conducted on June 27, 2007 by Fuss & O'Neill, Jane Harrison and Adriane Bone, two Town residents, and John Massed, the Town's DPW Director.

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<sup>1</sup> Actually cumulative capacity may be lower as the wells may interfere with one another and likely respond to seasonal fluctuations in groundwater levels.

<sup>2</sup> ISDS applications containing the Advantex RX Denite System (RX-30) are no longer processed. This I&A technology is being phased out and a new, equivalent technology is taking its place.



Several observations of the site visit are described below:

- Homes are very densely packed, seemingly no more than one dwelling unit per 5,000 square feet.
- No odors or definitive evidence of surface sewage discharges were observed during the site visit. Although one terraced area in the Highlands, along the Kickemuit, appeared to be leaching flow (possibly leach field effluent), and green algal growth, often indicative of high water-borne nitrogen, was apparent.
- No illicit discharges were observed during the site visit.
- Adrian noted that in general, the community was very conscious of their water use. Car washing and lawn watering were frowned upon.
- An open field in the Highlands, reportedly owned by the Rhode Island Audubon Society was noted. This area appears to be well situated for construction of a community wastewater treatment system.

A complete summary of finding of the site visit is provided in [Appendix A](#).

## 2.7 Cesspool Phaseout

In 2007, the State of Rhode Island passed the Cesspool Act of 2007 (see [Appendix B](#)). Under this legislation all cesspools in Rhode Island must be inspected, and if failed these systems must be replaced with an ISDS meeting regulatory standards.

As described in RIDEM's "Frequently Asked Questions—Cesspools and the Rhode Island Cesspool Act of 2007" (2007) (hereinafter, Cesspool Phaseout FAQ), there are 3 possible scenarios under which a cesspool must be replaced:

The new Cesspool Phaseout law will require upgrade of many of the cesspools in the study area within the next 4-5 years. Because of the proximity of sensitive receptors— drinking water wells and the Kickemuit River— RIDEM will probably require that homeowners upgrade most of cesspools to I&A technology.

1. [The cesspool is] failed. This applies anywhere in the state and is required under current regulations.
2. [The cesspool] serves a commercial facility or multifamily dwelling. This applies anywhere in the state under the proposed new septic system rules.
3. As of June 2008, [the cesspool] is located within one of the three areas described below:
  - *Within 200 feet of the inland edge of all shoreline features bordering tidal water areas (i.e., Coastal Resources Management Council's jurisdiction)* [emphasis added].
  - *Within 200 feet of a public well* [emphasis added].
  - Within 200 feet of a waterbody with an intake for a drinking water supply.

Within the three 200-foot zones identified above:



- *All cesspools will have to be inspected within a 4-year time period, completed by January 1, 2012 [emphasis added].*
- *All cesspools found to be failed will need to be replaced within 1 year [emphasis added].*
- All cesspools found in already-sewered areas will need to be hooked-up to the sewer within one year of the sale of the associated property.

*All other cesspools will need to be replaced by January 1, 2013 [emphasis added].* As discussed in the Cesspool Phaseout FAQ:

A failed cesspool is one that meets any of the criteria below. Note that a cesspool can appear to function in a manner that disposes of the waste and still be considered a “failed cesspool” under the criteria below. In other words, a backup of sewage or leakage onto the ground surface are not the only criterion for failure.

- Cesspool fails to accept sewage, as evidenced by sewage backing up onto the ground surface or into the building it serves.
- The liquid level in the cesspool is less than 6 inches from the bottom of the pipe (i.e., building sewer) that drains into it.
- The cesspool has to be pumped more than 2 times per year.
- The cesspool has been shown to have contaminated a drinking water well, stream or wetland.
- The bottom of the cesspool is below the groundwater table at any time of year, resulting in direct connection between the waste in the cesspool and the groundwater.

Given the proximity to coastal waters and the Touisset Point Water Trust wells, we anticipate that the State will require innovative and alternative technologies such as nitrogen reduction followed by a bottomless sand filter for many if not all of the system upgrades resulting from cesspool replacements. [Figure 5](#) shows the approximate location of the TPWT wells and the 400-foot setback<sup>3</sup> as well as the coast and the required 200-foot setback.

### 3.0 ADVISORY COMMITTEE

#### 3.1 Purpose

A technical advisory committee (TAC) was established to allow for stakeholder input into wastewater planning process and to help bring about a technically sound and practicable approach to improved wastewater management. Therefore the TAC includes local residents and Town representatives as well as technical experts.

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<sup>3</sup> Because the TWPT wells are shallow dug wells in packed gravel and very susceptible to contamination, RIDEM will require that all cesspools are upgraded to I&A systems. Cesspools within 200 feet of the wells will need to be upgraded by January 1, 2012. Cesspools within the 200 – 400 foot ring will need to be upgraded by January 1, 2013.



Having an advisory committee does not eliminate the need for broad-based public participation. This project also includes a public participation program. The program is discussed in [Section 3.0](#).

### 3.2 Members

The TAC included the following members who are intended to provide technical support for the project and represent the Town as well as local area interest:

- Michelle Maher, Town Planner
- Jane Harrison, Resident of Touisset Highlands
- Rick Massie, Resident of Touisset Point
- John Massed, DPW Director
- Michael Abbruzzi, Town Manager
- Peter Grose, Fuss & O'Neill
- Jim Riordan, Fuss & O'Neill
- Amy Hunt, Fuss & O'Neill

### 3.3 Meetings

TAC meetings were held to review progress and to address and document key decisions at important milestones in the project. Three workshops were held with the TAC. These meetings occurred on:

- June 27, 2007
- August 7, 2007
- October 29, 2007

Meeting summaries are provided in [Appendix C](#).

## 4.0 PUBLIC PARTICIPATION PROGRAM

### 4.1 Public Informational Meetings

Two public informational meetings have been planned to show the results of this study to the public and especially to help answer questions and address concerns that residents of the study area as well as residents of the Town may have. The meetings are planned as follows:

- Touisset Point Fire Department (7:00 p.m., November 26, 2007)
- Warren Town Hall (time and date to be determined)

The meetings will be advertised publicly. Invitations with a fact sheet providing the general objectives and results of the study will be sent to residents of the study area (see [Appendix D](#)

This study includes a public participation program to provide information to the public and encouraging public involvement.

The program consists of two meetings. Prior to the meetings, residents of the study area were invited to the meeting and a fact sheet describing the project.



for a copy of the fact sheet). The meetings will consist of a brief PowerPoint presentation followed by an opportunity for comments, questions and discussion.

## 5.0 RESULTS OF DATA GATHERING

### 5.1 ISDS Data from RIDEM

An initial review of existing ISDS data was developed through RIDEM's online ISDS permit database. Despite providing insightful information, it should be noted that the online database contains records only from 1995 to the present and, therefore, provides only a representative sample of current wastewater systems in the Point and Highlands areas. Based on this review, it was determined that conventional ISDS systems are the most common wastewater systems in both the Point and the Highlands. Both cesspools and I&A systems such as bottomless sand filters, and FAST systems are also present. Information was available for approximately 53 parcels in Touisset that were listed as permit applicants on the RIDEM online ISDS permit database. Of these 53 parcels, 21 are served by cesspools, 26 are served by conventional ISDS, and 6 are served by I&A technologies.

Approximately 40 percent of systems reviewed in the online database are cesspools, approximately 49 percent are conventional systems, and the remaining 11% of systems are I&A systems. If these numbers are extrapolated to the remainder of the study area, approximately 79 of the 198 systems would be expected to be cesspools. I&A systems were very uncommon prior to 1995. If the extrapolation includes only cesspools and conventional systems in the same proportion as they exist in the online database, then 90 of the systems would be expected to be cesspools.

Based on information found in the RIDEM online permit database, 79 – 89 of the systems in the study area are thought to be cesspools.

System failures in the Point and the Highlands areas are subject to repairs or alterations, as required by RIDEM. A repair is necessary to correct a specific deficiency after system failure. In some cases this will mean replacing a cesspool with a conventional ISDS system or I&A system. It may also mean fixing an existing conventional ISDS system. Repairs do not involve work to significantly increase flow capacity of the current system. Alterations address a modification to a dwellings square footage or a change in the type of existing sewage disposal system. An alteration may also indicate an increase in flow capacity of an existing system (RIDEM, 2002).

System suitability determinations are made whenever alterations or upgrades occur. This particularly applies to an existing cesspool that may not be suitable to handle current wastewater capacities in a dwelling. In reviewing available ISDS permitting information, it appears that in some instances system suitability determinations found systems, such as a cesspool, to be effective for wastewater disposal needs. No alterations or repairs were made following these determinations.

### 5.2 Telephone Interviews

In trying to characterize the wastewater systems in both the Point and the Highlands, a telephone interview was conducted with a septic hauler at J and K Sanitation. This is the



primary septic hauler company utilized in Warren, as indicated by Brian Remy of the Warren Sewer Commission.

The following key points concerning the types of existing systems and any issues with these systems were made by the interviewee:

- All new homes have a conventional system.
- Cesspools are abundant on Bayview Road, Brownell, and Bradbury Street, and in the Point.
- At rough estimate, more septic tanks exist than cesspools. However the distribution is close to equivalent. (This is inconsistent with the preliminary findings of our ISDS permit record data gathering. See [Section 5.1](#), above.)
- There is not a high failure rate of wastewater systems.<sup>4</sup> Only about 20 individual systems may be problematic. This was a rough estimate.
- The most frequently observed problem seems to occur in the new alternative technology, particularly bottomless sand filters (BSF). The filter connected to the outflow pipe (i.e., effluent filter) in the septic tank clogs. Some may clog every six months and create backups in individual systems.
- A main issue in the study area seems to be that, with the first septic tanks systems installed during the early 1970s, not much attention seemed to be paid towards the location of installation. Some leach fields exist in very water-abundant areas (i.e., areas with high groundwater).
- J and K Sanitation do not get emergency calls concerning wastewater systems very often. With the few emergency calls the company does get, these calls are mainly because the system of concern is an older septic system.

### 5.3 Data on the Existing Community Water System

#### *Flow Data*

Flow data provided by the TPWT for October 2006 to September 2007 was reviewed. The data indicates average water consumption or average day demand of 11,370 gallons per day (gpd). This average level of consumption is approximately 10% higher than the 10,000 gpd consumption indicated in the draft *Touisset Build-Out Study* (LBG, 1999) and may represent increased consumption due to tie-in of homes with failed and inadequate wells on the Point. Flow data ranged from a single day withdrawal of 5,523 gpd to 21,019 gpd.

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<sup>4</sup> "Failure in this case, probably refers to hydraulic failure (e.g., an inability to accept wastewater). This would not necessarily include treatment (i.e., the ability of a system to reduce pollutants to a level that is protective of public health and the environment).

Table 1  
Touisset Point Water Trust Monthly Flow Data for  
October 2006 to September 2007

Date	Average	Min <sup>1</sup>	Max <sup>2</sup>	Ratios for System <sup>4</sup>	
				Max/Avg <sup>3</sup>	Max/Min
Sept. 2007	13329	9480	16483	1.24	1.74
Aug 2007	14025	11872	16958	1.21	1.43
Jul 2007	13482	11288	15831	1.17	1.40
Jun 2007	12516	9369	17012	1.36	1.82
May 2007	12839	11080	17264	1.34	1.56
Apr 2007	11891	10167	13594	1.14	1.34
Mar 2007	12236	11014	12910	1.06	1.17
Feb 2007	12266	7945	14161	1.15	1.78
Jan 2007	7896	5796	11955	1.51	2.06
Dec 2006	7634	5523	9012	1.18	1.63
Nov 2006	6914	6002	8899	1.29	1.48
Oct 2006	11415	5929	21019	1.84	3.55
Avg.	11370	8789	14592	1.28	1.66
Min	6914	5523	8899	1.29	1.61
Max	14025	11872	21019	1.50	1.77

**Notes:**

- <sup>1</sup> "Min" stands for minimum and refers to minimum one-day flow recorded for the month.
- <sup>2</sup> "Max" stands for maximum and refers to maximum one-day flow recorded for the month.
- <sup>3</sup> "Avg" stands for average daily water use in a given month.
- <sup>4</sup> The ratios of *maximum:average* and *maximum:minimum* water are used to show whether fluctuations in water are typical as compared to other systems.

Typically, maximum-day demand should be approximately two times average day demand; and maximum-day demand should be approximately four times minimum-day demand. Lower system ratios are found at TPWT (see Table 1). This creates a suspicion that something may be suppressing peak demand.

Table 2, below, shows the calculation of anticipated demands based on the data provided by TPWT. If the TWPT wells cumulatively yield 75 gpm, there is approximately 108,000 gallons available per day.

Although no water shortages have been reported, lower than expected peak use suggests that water use may be limited by the ability of the TPWT wells to produce flow and meet high demands.



Table 2  
Average and Peak Water Demands for  
Homes Served by Touisset Point Water Trust (2006)

Average Day Demand (gallons)	Maximum Day Demand (gallons)	Peak Hourly Demand (gallons)
11,370	22,740	1,895

Review of TWPT information resulted in the following observations regarding the predicted and actual data:

- The data appears to be derived from periodic readings that may have occurred over variable amounts of time (e.g., daily, weekly, etc.). Readings that are taken in this manner provide good average data, but tend to modify actual maximum day peaks. Therefore, peaks may be more pronounced than indicated by the data.
- The wells are shallow dug and installed in close together. As a result, they may interfere with each other. This could reduce actual flow from the expected combined flow of 75 gpm. The actual combined yield of the wells operating together has not been measured in the field.
- Although no water shortages have been reported, residents served by the wells may be controlling their water consumption behavior to account for perceived limitation on supply.
- As consumption nears peak yield water pressure may drop and reduce the potential for individual homes to consume water. This may create an artificial ceiling on peak hourly and maximum-day usage.

#### *Water Quality Data*

Anecdotally, well water quality problems are minimal in the Point, with high iron content being the only reportable issue. While that issue is not part of this study, it could be addressed further if it becomes a concern to consumers. However, a review of the annual Water Quality Reports filed with the Rhode Island Department of Health for 2001 to 2006 reveal some emerging concerns.

Somewhat elevated levels of nitrate in TWPT water signal a warning that substandard ISDSs may be adversely affecting water quality. Upgrade to I&A systems could help to alleviate this problem.

Data for the two wells were reviewed to understand each well's raw water quality and assess whether ISDS could possibly be affecting the operation. Although there were no positive bacteria results for the wells, the presence of nitrates in the general range of 5 to 7 mg/l and the presence of elevated salt levels (50 -200 mg/l) could be the result of the following:

- Elevated nitrates could mean that discharge from adjacent ISDSs infiltrates the wellhead areas. Since most ISDSs in the area lack nitrogen treatment capability and since nitrogen tends to be persistent in groundwater this could result in elevation of nitrate levels.
- The separating distance between the existing wells and the Kickemuit River, a saltwater body, may not be sufficient to prevent saltwater intrusion. In other words, the wells may be under the direct influence of the Kickemuit River.
- The wells and their protective radius may not be free of all contamination including road salt and fertilized lawns.

The following table summarizes the levels of Nitrogen and Sodium detected in the two wells on Touisset Point.

Table 3  
Touisset Point Water Trust  
Consumer Confidence Report - Nitrate and Sodium  
2001-2006

Year	Nitrate (mg/L)		Sodium (mg/L)	
	Well 1	Well 2	Well 1	Well 2
2001	6.8	5.4	139	80.5
2002	6.3	6.5	190	95.8
2003	6.5	6.5	98.5	120.2
2004	7.08	6.57	105	87.1
2005	6.6	6.6	73.8	80.3
2006	6.2	6.3	240	115

To put these numbers in perspective consider the following:

- Ambient nitrate levels in the Kickemuit Reservoir over the past 5 years are reported to be 0.8 mg/L. Levels in the TPWT wells are an order of magnitude greater.
- RIDOH is required to notify area physicians when more than 20 mg/L of sodium is found in drinking water; and water suppliers are required to notify the general public when sodium concentrations exceed 100 mg/L.
- Although Rhode Island is not one of them, a number of states have established preventative action limits for nitrates. Wisconsin has established a level of 2.0 mg/L for nitrate. Levels of nitrate greater than 10 mg/L are known to cause Blue Baby Syndrome.
- Nitrate is known to cause water quality degradation in saltwater systems. A number of recent studies (e.g., Buttermilk Bay on Cape Cod) have established ambient nitrate limits of less than 0.5 mg/L to protect estuarine ecology.



Generally, the levels of nitrate and sodium in the TWPT well water could be characterized as fairly strong bellwethers of an impending condition of impairment to groundwater and estuarine resources.

#### 5.4 Existing Materials

The following materials described below were used to assist in development of this study:

- *The Town of Warren, Rhode Island Comprehensive Plan*. This plan provides general information regarding water supply, current and future land use, zoning requirements, soils, groundwater, and sewage treatment in the Town of Warren. Some information specifically addresses these items in the Touisset area.
- *Town Maps*. A number of maps detailing zoning, land use, potential land use, soils, wetlands, and water supply, among other features, were provided in conjunction with the comprehensive plan.
- *Draft Report Touisset Build-Out Study*. This report was prepared for the Town of Warren by the Louis Berger Group and provides information on potential land use changes or build-out scenarios, current water supplies, zoning, soils, and impacts of build-out on the environment. The study specifically refers to Touisset Neck, and while including the Highlands, does not directly address the Point.
- *Soil Erosion and Sediment Control & Stormwater Management Report*. This report was prepared for Touisset Farms and does not contain information pertinent to this review and study.

## 6.0 IDENTIFYING POTENTIAL FUTURE NEEDS

### 6.1 Potential Land-Use Changes

The study area includes many small lots (commonly about 3,000-square-foot each), some of which have been built individually and some of which have been merged to create larger lots. The Town has instituted R-40 (approximately one-acre) zoning with Residential Village Overlay (see [Section 2.2 for discussion of zoning](#)) in the area, and merged lots have the potential to be unmerged only by special-use permitting under the zoning process. The Town believes that due to the involved nature of this process, significant changes to the existing built conditions in the Point and Highlands are unlikely; however, creating a fail-safe to prevent unmerging would be beneficial.

#### 6.1.1 Potential Increases in Density

As of 2007, the Point has approximately 139 housing units and the Highlands has approximately 59 housing units. Lots of record in these areas total 258 and 126, respectively. Many of the homes in the Point and Highlands are sited on multiple lots or merged lots. Under



zoning law these merged lots could, theoretically, become unmerged. Although increases to density in the study area are unlikely (see [Section 5.1](#), above), the Town may prefer a fail-safe to the existing special-use permitting process.

To reduce the risk of water resource impairment, the Town would like to minimize land-use changes and density increases in the study area to the greatest extent possible. The Town would also like to provide the most effective and feasible wastewater infrastructure to minimize potential undesirable side-effects (e.g., water pollution) of land-use changes on public health and the environment. Both a community wastewater system and I&A technologies could reduce existing potential pollution risks from wastewater.

### 6.1.2 Other Land Use Changes

While significant changes to land use in the Point and Highlands areas are unlikely, land use changes in neighboring areas could occur. For example, a large area of land in Touisset Neck is developable, as identified in the *Touisset Build-Out Study Draft Report* prepared by the Louis Berger Group. Existing land uses such as pasture, cropland, orchards, groves, nurseries, and abandoned fields could be converted to medium density residential uses (i.e., one-acre zoning).

As discussed in a TAC workshop conducted on June 27, 2007, a reverse occupancy trend has been occurring in the Touisset area. While over the past several decades many of the existing seasonal homes in the area have been developed into year-round use, the now permanent dwellings are again being utilized primarily as seasonal homes. This reverse trend may have both positive and negative effects on the functioning of septic systems. Reduced resource impairment may occur as a result of reduced wastewater loading; however, septic systems—especially I&A systems—tend to function more efficiently after a start-up period, (approximately 2 to 6 months).

## 6.2 Estimate future water and wastewater flows

Estimated water use for the Point and Highland areas is calculated using the design flows from *RIDEM Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems*. The study area is comprised of approximately 198 homes. For calculating design flow, this study assumes that the average home has three bedrooms. In accordance with RIDEM design standards, this study assumes two persons per bedroom with an average water usage rate of 75 gallons per person per day, the average water usage and wastewater flows are approximately 44,550 gpd. These flows can also be used to represent future flows as additional development in the Point and Highlands is unlikely.

## 7.0 IDENTIFY ALTERNATIVES FOR ADDRESSING CURRENT AND FUTURE NEEDS

### 7.1 Current on-site systems

Most of the current on-site septic systems have not been fully evaluated, and it is not known if they are fully adequate. The following information was considered in addressing this question.



### 7.1.1 Soil Type

The following are soil types found in the Point and Highlands, as previously described in [Section 1.3](#):

- NeB – Newport silt loam, 3 to 8 percent slopes.
- NeC – Newport silt loam, 8 to 15 percent slopes.
- QoA – Quonset gravelly sandy loam, 0 to 3 percent slopes.
- QoC – Quonset gravelly sandy loam, rolling.

NeB and NeC soils generally have moderate to slow permeability as vertical depth increases. Sewage disposal systems in these soils should be specially designed to prevent wastewater discharges from rising to the ground surface. QoA and QoC soils typically have moderately rapid to rapid permeability as vertical depth increases and so sewage disposal systems should be installed so as to not pollute groundwater. Newport soils appear to occur only in the Highlands and Quonset soils only on the Point.

### 7.1.2 Available Space

Available space for siting a community system was considered with the Town. The following was observed:

- As discussed throughout this report the study area is essentially built out and no land is available to site a community system.
- There is no Town-owned land in or near the study area.
- Unbuilt space in the study area is limited to Audubon property, GRF property, and nearby farmland. If a community system is desired, the Audubon Society could be approached as potential partner as the current use of the land as open space could essentially be preserved if a community system was sited there.
- At this point, the Town is not inclined to pursue purchase or taking of land rights.

### 7.1.3 Environmental Concerns

ISDSs within the Point and the Highlands areas of Touisset can impact their surrounding environment. For this reason it is important and necessary, to ensure these systems are adequate for minimizing environmental concerns. This study identifies the following environmental concerns associated with on-site septic systems in the Point and Highlands:

- Kickemuit River – This estuary has a water quality classification of SA, indicating that it is designated for shellfish harvesting for direct human consumption. Primary and secondary recreational uses are also allowed. However, the Kickemuit River is an impaired water as designated by the Rhode Island Section 303(d) list of impaired waters. The cause of this impairment is pathogens. The presence of pathogens signals potential contributions from inadequate sewage disposal— although no link has been found to the Point and Highlands areas. Improper or inadequate sewage disposal may cause negative health and environmental effects.



- Touisset Point Community Well and groundwater—As mentioned in [Section 1.2](#), the Touisset Point Water Trust utilizes a community well for its drinking water supply. Improperly designed and installed sewage disposal systems can contaminate this water supply through leaching into the groundwater supply. Groundwater within the Point and Highlands are classified as GAA or GA, indicating it is suitable for drinking water use without treatment. Proper separating distances between ISDSs and drinking water supplies, in addition to proper vertical distances to groundwater, should be maintained and established to minimize contamination of this groundwater supply throughout both the Point and Highlands. There are a number of parcels in the Point and Highlands where sewage disposal systems are less than 100 feet from wells. While there have been no positive bacteria results from the community wells, information provided by the Touisset Water Trust shows elevated levels of nitrogen in the drinking water wells. This is most likely attributed to adjacent ISDS's discharge not allowing for full treatment and getting mixed in with well water.

#### 7.1.4 Estimated Flows

Estimated flows for a community system would include the entire study area in the Point and Highlands and would therefore be designed using the same estimated flows as in [Section 5.2](#).

#### 7.2 [Available Upgrades to On-site Systems](#)

RIDEM has approved a number of I&A technologies to be used for onsite wastewater disposal. The approval of these technologies is based on RIDEM procedures and regulations adopted in 1996. One I&A technology, BSFs, have been used in recent system upgrades ostensibly to relieve constraints due to small lot size and high groundwater in the Point and Highlands areas.

Other technologies, such as pressurized shallow narrow drainfields (PSND), may also be applicable to assist in relieving these constraints. Appropriateness of these technologies would need to be assessed on a case-by-case basis. Rhode Island's regulations require that BSF and PSND be preceded by pretreatment, equivalent to a recirculating sand filter, in order to reduce biological oxygen demand. Several such technologies are available. Typically, upgrades in the Touisset area have incorporated FAST systems for BOD pretreatment.

A mound system is also an alternative leach field systems that may relieve sewage disposal constraints associated with shallow groundwater in the study areas. This system is applicable in areas where natural soil has a shallow permeable horizon or in areas where more permeable horizons do not exist. The appropriateness of this technology would need to be assessed on a case-by-case basis.

The University of Rhode Island— Onsite Wastewater Training (URI-OWT) Center has developed a system for the selection of I&A technology to address site constraints and protect sensitive receptors such as wellheads and estuaries (see [Appendix E](#)). In the vicinity of these nitrogen sensitive resources, URI-OWT recommends systems such as recirculating sand filters, Advantex, RUCK, and FAST as treatment components and PSND and BSF for drainfields.



This study concurs with these recommendations. Given costs considerations, the Advantex and FAST are good examples of practical treatment to use in the study area.

Descriptions of the aforementioned technologies are provided in [Appendix F](#).

### 7.3 [Community Wastewater Systems](#)

#### 7.3.1 Available Locations

The Town does not own any land in the area. While the Town could procure land or property rights, or take property through eminent domain, such approaches may not be practicable.

Possible locations for a community wastewater system (treatment plant and subsurface disposal facilities) include conservation land owned by the Rhode Island Audubon Society and privately owned farmland for which property rights would need to be secured.

Utilizing conservation land owned by the Rhode Island Audubon Society would be dependent on factors such as land availability, proximity of individual water supply wells to this location, and costs of piping wastewater effluent to the system. The use of private farmland as a potential site for a community wastewater system will not be actively pursued at this time (see [Section 6.1.2](#)).

### 7.4 [Conventional Sewering](#)

Warren has existing conventional sewers and a treatment plant; however, the closest sewer lines are approximately a mile from Touisset Highlands and approximately 1½ miles from the Point. This is a direct distance estimate. Actual pipe runs would be significantly longer as they would need to follow the road. To run sewers to the Highlands or Point will require traversing the entire peninsula.

Sewers would likely increase development pressures and hence pollution risks. Based on very rough opinions of cost, the cost to extend sewers to the study area would likely range from \$3 to \$5 million. Furthermore the Town's wastewater treatment facility does not have capacity to treat much more beyond its current flow, and costs for increasing the plant capacity would be significant.

### 7.5 [Integration of Water Supply](#)

Existing public wells appear to be somewhat stressed (see [Section 4.3](#)) by the level of existing development in the Point. As water lines will require trenching that is segregated from sewer lines, we would not anticipate significant economies of scale to be realized by extending sewer and water service together. Not including the TPWT, the closest public water is approximate one to 1½ miles from the study area. We anticipate that installing water lines from existing supplies will present similar costs as sanitary sewerage. To develop a reliable opinion of cost to tap existing water supplies will require more thorough analysis than is within the scope of this report.



## 8.0 SHORT LIST OF ALTERNATIVES

### 8.1 Alternatives and Selection Factors

To help the Town of Warren establish a focus for continued planning and implementation, three basic alternatives are examined using a decision matrix. The alternatives include:

- Conventional sewerage.
- Community systems.
- Continued use of ISDS, relying primarily on I&A systems.

This section of the study examines three basic alternatives for improved wastewater management using a decision matrix. The results of this analysis point to I&A systems as the most cost effective, flexible and least disruptive alternative for improving wastewater infrastructure in the study area.

Neither “no action” nor reliance on conventional systems were included as viable options as environmental factors and strong anecdotal evidence demonstrate significant water quality threats and insufficient disposal capacity using conventional technology. Additionally, regulatory requirements for setbacks are expected to force many owners to upgrade their systems to I&A technology.

Evaluation criteria include infrastructure cost, operation and maintenance cost, level of Town responsibility, land required, risk of increased development pressure, available funding options, need for water line extension, and likelihood of improved water quality. Relative opinions of cost were used.

### 8.2 Results of Analysis in Summary

Table 5 provides our analysis of alternatives based on the selection factors discussed in Section 7.1. Our analysis shows that the community system option and convention sewerage option to have relatively similar benefits and detractions. I&A systems, however, tend to present the lowest level detractions and reasonable likelihood of improving water quality. Therefore, we recommend I&A systems as the preferred alternative and encourage further analysis of this option. Section 7.2 provides a more detailed discussion of our analysis of each factor.

Table 4  
Touisset Wastewater Alternatives  
Selection Factors

Alternative	Infrastructure Cost	Operation & Maintenance Cost	Town Responsibility	Land Required	Development Pressure	Funding Options	Water Line	Improve Water Quality
I&A Systems	M	L	L	No	L	CSSLP Local Bond Grants	Limited reduction in need for I&A systems	M
Community system	H	H	H	Yes	L	SRF Local Bond Grants	Unnecessary	H
Conventional Sewer	M-H	H	H	Limited (Pump stations)	H	SRF Local Bond	Unnecessary	H

Notes:

H – High  
M – Medium  
L – Low  
CSSLP – Community Septic System Loan Program  
SRF – State Revolving Fund

### 8.3 Discussion of Selection Factors

The following sections describe the factors taken into consideration to assess which wastewater disposal approach may be appropriate for the Point and Highlands.

#### 8.3.1 Infrastructure Costs

An order-of-magnitude cost analysis of alternatives showed that all alternatives proposed will cost within an order of magnitude of each other— probably in the range of \$3 –\$6 million dollars. (More accurate opinions of cost will need to be developed in a subsequent step based on additional information.)

If it is assumed that all residential units in both neighborhoods would tie-in to a sewer or community system or would receive an innovative/alternative (I&A) system, conventional sewer line appears to be the lowest cost alternative. However, if upgrades are needed at the treatment plant conventional sewers could become significantly more expensive than I&A systems.

If no treatment plant upgrades are needed, I&A systems for all homes in both neighborhoods would appear to cost about 10-20% over the cost of conventional sewers. Cost for the I&A system alternative could be reduced substantially by limiting I&A system installation to just those residences within 200 feet of coastal features and within the 400-foot community well radius. The number of I&A systems necessary could be limited further if the Touisset Trust Well Field is abandoned and all homes are connected to public water supply or new well installation; approximately 12 fewer homes would then need I&A systems.



The community system alternative appears to be the most expensive alternative. At this point, we have not included cost of land in our community system cost opinion. However, cost of land may add 100% to the community system cost as we anticipate needing approximately 5 acres to site the treatment works and soil absorption system.

### 8.3.2 Operation and Maintenance (O&M) Cost

While sewers are anticipated to be the most expensive alternative to operate and maintain (approximately 7% of infrastructure cost), community system O&M costs closely approach conventional system O&M costs. It is anticipated that O&M for either conventional or community systems would be the responsibility of the local sewer authority.

I&A systems will generally be less expensive to operate and maintain, but present the complexity of being decentralized (i.e., instead of one system to operate and maintain, the I&A system alternative presents over 100 little systems). This can be overcome to an extent by leaving responsibility for system O&M in the hands of homeowners; however, we strongly recommend municipal tracking, if not stronger management, of O&M to ensure that these systems achieve their anticipated value. I&A system O&M cost is expected to be greater than the cost of two pumpouts per year as currently subsidized by the Town for the Touisset area. This study approximates O&M costs for I&A systems to be twice as much as the current disposal system costs. O&M expenses for these systems include regular inspections, chemicals, and energy for pumps and timers, in addition to regular pumpouts. RIDEM requires all I&A systems to have an operation and maintenance contract for the life of the system.

### 8.3.3 Town Responsibility

This study assumes that responsibility for design, construction and O&M for either the community system or conventional sewer alternatives would be the Town's. Since ownership of individual systems is currently decentralized, this study assumes that responsibility for upgrade and O&M would also be decentralized. To ensure effective implementation, the Town should establish a tracking system and provide financial assistance (e.g., loans through the community septic system loan program (CSSLP)).

### 8.3.4 Land Required

It is anticipated that there will be no land acquisition for installation of I&A systems and minimal land acquisition for conventional sewer pump stations. A community system would require land to house treatment works and a disposal field.

### 8.3.5 Development Pressure

It can reasonably be assumed that neither a community system sized for the Point and Highlands, or installation of I&A systems in the Touisset neighborhood will add to development pressure on the peninsula. Conventional sewerage will probably add significantly to development pressure as it will simplify wastewater disposal for new homes. Conventional sewers also make possible development at high density, notwithstanding zoning regulations.



### 8.3.6 Funding Options

Towns typically fund conventional sewers through either locally issued general obligation bonds or the State Revolving Funding (SRF) or some combination of both.

Towns may also fund community systems and I&A systems in this manner— I&A systems enjoy a special set-aside under SRF, referred to as CSSLP. CSSLP allows towns to access 2% loans for residents. Towns act as a go-between for the State and homeowners; however, loans may be administered by the Rhode Island Mortgage and Housing Financing Assistance Commission (RIMHFAC) to carry this burden on behalf of towns.

Both community systems and I&A systems enjoy grant eligibility that is unlikely to be available for conventional sewerage. Grants can be used to reduce the overall cost of implementation to the Town and its residents.

### 8.3.7 Water Line

If the Town opts to pursue conventional sewerage, expansion of public water service should also be considered as the two will both require piping to be drawn from north of the peninsula and would be expected to achieve some limited economies of scale (primarily paving).

For the community system alternative, a treatment works and dispersal system would be installed nearby, but not within, the Highlands and Point. There is no apparent economic advantage to include public water service with wastewater service in Touisset. A community system would substantially reduce the risk of contamination to the Touisset Trust Well.

Adding public water to Touisset Point would reduce the number of I&A systems that would be needed from a regulatory perspective, thereby reducing wastewater infrastructure costs. The Touisset Trust wells are shallow gravel-packed wells and at significant risk for contamination. Drawing water from a source outside the peninsula would also remove the risk of potable water contamination by local wastewater. If the Town chooses the I&A system alternative, this study recommends regular monitoring with serious consideration of adding public water service to the Point and Highlands areas.

### 8.3.8 Water Quality Improvement

At this time, there is no known evidence of violation of water quality standards due to wastewater contamination. That said, many homes in the Point and Highlands rely on substandard ISDSs. Any of the three alternatives discussed here will relieve this condition and will reduce the threat of wastewater contamination to nearby water resources. I&A systems can improve nitrogen and pathogen treatment. Conventional sewers and community systems allow for significantly enhanced nitrogen and pathogen treatment over I&A systems. I&A systems should be adequate for wastewater treatment in the study area as there are currently no known water quality violations; however, if the Town prefers a higher level of risk reduction, both community systems and conventional sewers offer it.



## 9.0 RECOMMENDED PROGRAM

### 9.1 Conceptual Description of Recommended Program

One important advantage of using I&A systems that is not addressed by the evaluation process discussed in [Section 8.0](#) is the flexibility of I&A system implementation. Treatment plants have limited capacity and so a treatment plant for the study area would probably be sized large enough to accommodate tie-ins on an as-needed basis. This means the cost for a treatment works must be planned and paid up front.

Not so for ISDSs. ISDSs can be converted to I&A systems on an as-needed basis without any implication for existing treatment systems. Significant present-day cost savings can be realized by as-needed installation of these systems on a prioritized basis.

This plan recommends developing an I&A system program to help manage wastewater in the Touisset study area. Next program development steps involve decision making about water supply upgrades and ISDS upgrade financing as well as establishing an operation and maintenance program for ISDSs.

This plan recommends an I&A system implementation program that takes advantage of phased installation on a prioritized basis. The steps recommend include the following:

- Develop a local assistance program to help phase out cesspools, substandard systems and distressed conventional systems to I&A technology. Cesspools will need to be upgraded under the new Cesspool Phaseout Act. Cesspools along the coast will need to be upgraded. Conventional systems on undersized properties should also be upgraded. Given environmental and drinking water quality concerns in both the Highlands and Point, we recommend a program to facilitate upgrade of existing systems to denitrification where indicated. To ensure benefit at the earliest point possible, this study recommends development of a priority replacement and assistance strategy in the next phase of wastewater management planning.
- There are several financial assistance programs that communities may access to implement water supply and wastewater infrastructure enhancement programs. Some options have been discussed in this report. This study recommends continued exploration of financing mechanisms.
- To ensure the proper function of ISDSs— especially I&A systems— the Town should develop a wastewater management district. Such a program would be intended to foster regular inspection and maintenance of ISDSs in accordance with a given standard such as that describe in *Septic System Checkup* and as recommended by I&A treatment system vendors.
- Water quality in Touisset is showing signs of stress by development. This study recommends establishment of an integrated monitoring program that includes the public and private well and coastal water quality. This would be focused on baseline data and trends— during implementation and post-implementation. Over the long term, monitoring data could be used to determine the effectiveness of I&A system implementation. Such a program should be carefully thought out. This study recommends developing program components in the next phase of wastewater management planning.
- Capacity of the existing water supply system appears to be stressed and demand is likely to rise as private wells continue to be replaced by TPWT. This study recommends



that the Town further examine adequacy of the public water supply and upgrade/add to supply wells as needed. This step should occur in the next phase of wastewater management planning as it has implications for the number of systems that may need to be replaced and the order (i.e., priority) of their replacement.

- Carrying capacity of land in the Highlands and Point is already stressed. This study recommends that the Town prohibit unmerging of lots for the purpose of building new homes.

## 9.2 Anticipated Project Costs

Table 5 provides a suggested order-of-magnitude budget for phase 2 of onsite wastewater management program development, as described above in Section 9.1, for the Touisset study area.

Table 5  
Touisset Onsite Wastewater Management  
Program Development Cost

Program Item	Order-of-Magnitude Costs
Integrated monitoring program strategy	\$8,000
Analysis of water supply improvement options	\$13,000
ISDS assistance improvement program development	\$13,000
Operation and maintenance program development	\$5,000
Financing plan options	\$5,000
Total	\$44,000

## 10.0 IMPLEMENTATION

### 10.1 Implementation Schedule

Table 6 provides a suggested schedule of next steps.

Table 6  
Touisset Onsite Wastewater Management  
Program Development Schedule

Program Item	Month Number
Seek funding for phase 2 of program development	Month 1
Develop integrated monitoring program plan	Month 3
Analyze water supply improvement options	Month 3
Develop ISDS assistance improvement program	Month 5
Draft zoning ordinance revision	Month 5
Develop operation and maintenance program	Month 7
Develop financing options	Month 7
CSSLP Plan approval <sup>1</sup>	Month 9
Establish CSSLP eligibility	Month 11

Notes:

<sup>1</sup> A plan is required to establish eligibility for the CSSLP program.

### 10.2 Phase 2 Program Development Financing Plan

This study recommends that the Town of Warren seek grant assistance from the RIDEM Nonpoint Source (NPS) Management Program. The NPS management program administers a competitive granting program. Historically, this has included assistance for onsite wastewater management program development. It is believed that all the implementation steps discussed in Section 9.1 of this report would be grant eligible. Generally, grants for onsite wastewater management planning are offered with a 50% matching requirement. A grant round is anticipated before the end of this year (2007).

Development of an onsite wastewater management plan that is accepted by RIDEM will lay the groundwork to establish eligibility for the Community Septic System Loan Program (CSSLP). This program is designed to provide low-interest (2%) loans to homeowners who are interested in upgrading their septic systems. Towns must establish eligibility through a plan and loan agreement before their resident homeowners can become eligible for CSSLP. We believe financial assistance eligibility will go a long way to motivating owners to upgrade their systems.

### 11.0 REFERENCES

Town of Warren, Rhode Island. (1991). *Town of Warren, Rhode Island Comprehensive Plan*. Author.

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RIDEM Division of Groundwater and ISDS. (2002). *Rules and Regulations Establishing Minimum Standards Relating To Location, Design, Construction and Maintenance of Individual Sewage Disposal Systems*. Author.