Town of Barnstable, Massachusetts

Comprehensive Wastewater Management Plan

Draft Report

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Comprehensive Wastewater Management Plan

Barnstable, Massachusetts

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DRAFT REPORT

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1 INTRODUCTION

Communities undertake wastewater planning to address some, or all, of the following issues:

- Public health concerns
- Protection of groundwater and drinking water resources
- Protection of surface waters, including nutrient loading
- Support of sustainable, community aligned, economic development
- Addressing aesthetics and convenience concerns attributable to wastewater issues

The primary focus of recent wastewater plans on Cape Cod has been nutrient removal, particularly nitrogen removal, as nitrogen has been causing eutrophication in coastal embayments. The prevalence of nitrogen has become an issue due to the widespread reliance on on-site septic systems as a means of addressing wastewater. The Cape Cod Commission (CCC), via its *Cape Cod Area-Wide Water Quality Management Plan Update*, or “208 Plan”, has been a strong proponent of wastewater planning for this reason. However, there are other important wastewater-related issues in Barnstable that also require attention. Those include, in no particular order, nutrient contamination of ponds (principally via phosphorus), Contaminants of Emerging Concern (CECs) affecting water resources and drinking water sources like, 1,4-dioxane, perflorinated compounds (including Perfluorooctane sulfonate–PFOS, and Perfluorooctanoic acid-PFOA), etc., and desired economic development that is limited or restricted due to the lack of wastewater solutions. As a result, Barnstable’s wastewater planning efforts address the required nitrogen issues, while at the same time also accounting for its other wastewater needs.

Comprehensive Wastewater Management Plans (CWMPs), and wastewater plans in general, are documents that provide the community guidance as it addresses wastewater challenges. CWMPs are often town-wide plans that identify water resource & water quality issues; suggest well thought out, efficient solutions to those issues; translates those solutions into the beginnings of projects; and recommends ways to fund and schedule those projects that makes sense for the community and solves the underlying problem.

The Town of Barnstable (Town) undertook the Comprehensive Wastewater Management Plan planning effort by appointing a Water Resources Advisory Committee (WRAC), which was staffed by 11 members including citizens and three Town Councilors, and was supported by the Department of Public Works (DPW) staff. Its purpose was “...to advise the Town of Barnstable on the completion and implementation of its Comprehensive Water Resource Management Planning Process, with the goal of protecting and restoring the Town’s fresh and saltwater bodies and it drinking water supplies, in compliance with the Cape Cod Commission’s Cape Cod Area-

Wide Water Quality Management Plan Update of 2015 (the 208 Plan)". The committee met from January 2016 until August 2017 when it presented its findings to the Town Council. During that time the committee:

- Assembled the data from previous planning efforts (wastewater and otherwise), and other available sources.
- Identified "holes" in the existing data, and then set about addressing those data gaps.
- Created a GIS-based tool (The Tool) that allowed the WRAC and DPW to evaluate on a lot-by-lot basis
    - Poor sanitary conditions and public health issues, such as
        - excessively or poorly draining soils
        - high groundwater
        - failed septic systems
        - lot density
        - inadequate set-back from private wells/property lines
        - direct discharge of sanitary wastewater to a water body
    - Water Supply Protection issues including identifying "impaired" or endangered wells and the sources of the impairments that are likely impacting them
    - Properties/areas causing nutrient enrichment in surface waters (both marine estuaries and freshwater ponds)
    - Convenience and aesthetic issues including needing mounded septic systems, septic systems located in the FEMA Mapped velocity zones, systems that require excessive pumping, or are in areas where it is very expensive to install on-site wastewater solutions
    - Areas where economic development was desired, yet difficult due to the lack of viable wastewater options.
- Utilized the Tool to understand the various wastewater needs and requirements, and devise solutions for those needs.
- Met with regulators from both the Department of Environmental Protection (DEP) and Cape Cod Commission.
- Facilitated the meeting of Town Staff with adjoining town's staffs to find efficiencies and areas where common solutions could be used to address regional wastewater needs.
- Conducted public meetings, had staff create public outreach programs utilizing the Town's local access television station, and did public outreach meetings with the village associations that requested them.
- Complied with the Cape Cod Commission's 208 Plan process, including the submission of "Bookends" Plan.
- Presented its recommended plan to the Town Council.

The CWMP is intended to document the results of those efforts and present the Town's preferred approach for addressing its wastewater and water resource needs.

1.1 BACKGROUND

The Town of Barnstable is located in the middle portion of Cape Cod as shown in Figure 1-1. Its year-round population is 45,193 (*US Census 2010*) while seasonal population can grow to more than three times that amount. It is organized into seven villages, and contains eight watersheds (no geographic relationship to the villages) including the Popponesset Bay Watershed, Rushy Marsh Watershed, Three Bay System Watershed, Centerville River System Watershed, Halls Creek Watershed, Lewis Bay Watershed, Barnstable Harbor Watershed and a very small portion of the Scorton Creek Watershed. Of these watersheds, two are contained solely within the Town's borders (Centerville River System Watershed, Halls Creek Watershed), while the rest are shared with neighboring communities. Five of the eight watersheds have a Total Maximum Daily Load (TMDL) for nitrogen.

A TMDL is the maximum pollutant load a water body can receive and still meet water quality standards. TMDLs are created through a cooperative process involving multiple agencies. In the example of establishing TMDLs for nitrogen on Cape Cod, the process began with the Massachusetts Estuaries Project (MEP); a collaborative effort between DEP, University of Massachusetts School of Marine Science and Technology (SMAST), United States Geological Survey (USGS), and others. The MEP developed nitrogen thresholds for 89 estuaries in Southeast Massachusetts using a water quality model that predicts water quality changes resulting from land use decisions. The model is run with different watershed loading values to establish the "nitrogen threshold" condition, which is the upper limit of nitrogen loading that can enter the estuary and still meet water quality goals. Once MEP has established the nitrogen thresholds, DEP takes those numbers and prepares a draft TMDL for the water body. The draft TMDLs are then sent to the United States Environmental Protection Agency (USEPA) for approval, which once that happens, are enforceable. As of the writing of this CWMP, TMDLs are in place for Popponesset Bay, Scorton Creek, the Three Bay's System, the Centerville River System, Halls Creek, and Lewis Bay. The Town is waiting for the determination of TMDLs for Barnstable Harbor and is not expecting one for Rushy Marsh due to its size.

The Town draws its public water supplies from groundwater which is part of Cape Cod's Sole Source Aquifer. This water is distributed to its citizens via one of four different water purveyors, or private wells. Those purveyors include the Hyannis Water System which provides water to the Village of Hyannis and has 12 supply wells; the Barnstable Fire District which provides water to the Village of Barnstable by means of four supply wells; the Cotuit Water District which uses five wells to provide water to the Village of Cotuit; and the Centerville-Osterville-Marstons Mills (C-O-MM) Water District which utilizes 19 wells to supply water to the Villages of

Centerville, Osterville, and Marstons Mills. The Village of West Barnstable does not have a public water supply system, so properties there rely exclusively on private wells for their water. The Hyannis Water System is owned and operated by the Town, whereas the other three water purveyors are non-municipal water/fire districts.

The Town has 184 ponds, totaling 1,892 acres. Of these, 74 are named ponds and 25 are considered great ponds, which DEP defines as any pond or lake of 10 or more acres.

The Town's existing wastewater infrastructure includes the Barnstable Water Pollution Control Facility (BWPCF) located in Hyannis, a smaller wastewater plant in Marstons Mills referred to as the Marstons Mills Wastewater Treatment Plant (MMWWTP), the Red Lilly Pond cluster septic system, and their associated collection systems. The BWPCF treats an average daily flow of 1.67 million gallons per day (MGD) and has a maximum-month average daily flow of 1.97 MGD (2018 flow data). The BWPCF is permitted for a treatment capacity of 4.2 MGD and an effluent disposal capacity of 2.7 MGD. The Hyannis facilities' collection system dates back to 1937, and includes approximately 55 miles of sewer, which collects flows from approximately 2,300 acres of catchment area. Within that 55 miles are 1.5 miles of vacuum sewer, and 1.2 miles of low pressure sewer, with the rest being gravity sewer. The collection system also includes 27 pump stations and an associated 25.5 miles of force mains. Contributors to the sewers include a mix of residential and commercial users within portions of the villages of Hyannis and Barnstable. The MMWWTP is a much smaller facility, which serves the Marstons Mills schools and a 30-unit housing trust development on an adjacent property. The facility is permitted to treat 42,900 gallons per day (gpd). Of this, the school is allotted 30,000 gpd while the Housing Trust is allotted 12,000 gpd. The Town also maintains the Red Lily pond cluster septic system in Centerville. The system consists of a network of 17 grinder pumps and approximately 1,300 linear feet of low pressure sewer serving 17 of homes feeding into a communal septic system.

1.2 WASTEWATER PLANNING SCOPE

Traditionally, CWMPs are developed for communities by consultants, and usually organized into four phases:

- Needs Assessment
- Identification, Screening and Evaluation of Alternatives
- Develop and Formalize Recommended Plan
- Environmental Notification and Form Filing (MEPA and Cape Cod Commission 208 Consistency processes)

A listing of the tasks found in each phase is included in Table 1-1.

The Town of Barnstable generally adopted this same approach, but diverged from it in the following key ways.

- The Town is fortunate to have a highly qualified technical staff, with a number of licensed engineers, many of whom have previously worked as consultants addressing wastewater issues for communities. As a result, the Town elected to utilize these resources and create the plan in-house vs. hiring consultants.
- The Town had previously engaged in a number of wastewater planning efforts, some quite recently, that were leveraged to provide a strong foundation to this report.
- With the CCC development of the 208 Plan, much of the work that was traditionally required in the Identification and Evaluation of Alternatives Section was included in Chapter 4 of that document. As a result, the Town elected to leverage that work in its planning process and report development.
- The Town created its own GIS-based tool to evaluate, on a parcel-by-parcel basis, the various wastewater needs of the community. This was used to formulate the plan, though ultimately the plan's results will be confirmed by the SMAST MEP model.

Table 1-1: The phases of the CWMP

PHASE	TASKS

Phase I: Needs Assessment	• Document property type, seasonality, land use, soil conditions, watersheds and environmentally sensitive areas
	• Document existing water quality in each watershed
	• Identify the water use for each of the parcels
	• Formulate a GIS Tool for parcels that evaluates:
	    • Sanitary Conditions/Identified public health issues
	        • excessively or poorly draining soils
	        • high groundwater
	        • failed septic systems
	        • lot density
	        • inadequate set-back from private wells/property lines
	        • Title 5 variances
	        • Flood Zones
	    • Water Supply Protection
	        • Identified "impaired" or endangered wells and neighborhoods likely impacting them
	    • Surface Waters - Nutrient Enrichment
	        • Marine – SMAST Modeling and CCC 208
	        • Freshwater – Town sampling and study of ponds
	    • Convenience and Aesthetic Issues
	        • Identified Mounded septic systems, velocity zones,

	and excessive septage pumping ◦ Wastewater needs to allow Sustainable Economic Development • Identify existing municipal and private wastewater infrastructure • Identify requirements and potential collaboration potential with adjoining towns that share watersheds with Barnstable
Phase II: Identification, Screening, and Evaluation of Alternatives	• Using the CCC 208 Plan Chapter 4, identify all technically feasible options to address the wastewater needs ◦ Traditional and non-traditional alternatives ◦ Structural and non-structural alternatives • Compare alternatives with respect to the following factors: ◦ Efficacy of the solution, and probability of success ◦ Proximity of the issue to existing infrastructure ◦ Capital and O&M costs ◦ Speed of impact on the problem ◦ Ability of the solution to address more than one wastewater need ◦ Perceived public and political perception and acceptance • Meet with adjoining towns that share watersheds with Barnstable to identify synergies
Phase III: Formulation of Plan	• Identify the best alternative or combinations of alternatives for each sub watershed and watershed • Craft a plan and schedule for implementation • Prepare conceptual designs of traditional and nontraditional components • Develop capital cost estimates • Develop financial strategy and impacts on users and non-users • Consult with the public through workshops, hearings and reports • Submit Draft CWMP Table of Contents to DEP for review • Submit Draft CWMP to DEP for review
Phase IV: MEPA and DRI Reviews	• Prepare Environmental Notification Form and Environmental Impact Reports • File 208 Consistency application • Respond to comments

1.3 SUMMARY OF PREVIOUS RELEVANT WASTEWATER PLANNING IN BARNSTABLE

1.3.1 INJECTION WELL PILOT TESTING EVALUATION MARCH 2003

A pilot test was executed in 2003, to evaluate the feasibility of injecting treated wastewater into the subsurface using an injection well. The pilot test was conducted in two phases. Phase I used treated effluent, ending in 11 days as a result of well plugging of the injection zone. The plugging was attributed to the buildup of bacteria at the formation face of the injected zone. Phase II used potable water, where approximately 7 million gallons were injected and was sustained for approximately three months.

From the results, the study demonstrated that filtration and disinfection must be enhanced to levels greater than those used during the pilot test before it can be considered as an alternative for the Town. A copy of the report has been provided in Appendix H.

1.3.2 LAKE WEQUAQUET, LONG POND AND CAPE COD COMMUNITY COLLEGE SEWER EXTENSION PRELIMINARY DESIGN REPORT; SEPTEMBER 2003

In 2003, a sewer extension evaluation was performed for the neighborhoods surrounding Lake Wequaquet, Long Pond, Bearse Pond and Shallow Pond in the Town of Barnstable, as well as Cape Cod Community College. Four sewer extension alternatives were developed in order to determine the most economical preliminary sewer design to serve the area.

Alternative 3, a combination of gravity and low pressure sewers, was the recommended alternative. This alternative provided the lowest construction cost and lowest 50-year life cycle cost. In addition, this alternative was expected to have the least significant impact on the environment and the neighborhoods surrounding Lake Wequaquet and Long Pond. A copy of the report has been provided in Appendix I.

1.3.3 PRELIMINARY EVALUATION OF THE CAPE COD COMMUNITY COLLEGE FOR TREATED WATER RECHARGE; NOVEMBER 2003

An evaluation was completed in 2003, regarding the use of Cape Cod Community College for the recharge of treated municipal wastewater. After reviewing a few locations, it was decided a wooded area on the northeast side of the college property would be the site for the investigation.

The investigation resulted in the conclusion that the College has the potential to be a suitable site to discharge treated effluent. If open sand beds are utilized a recharge capacity of approximately one million gallons per day is possible. If leaching trenches are used, the recharge capacity is reduced to approximately 660,000 gallons per day. A copy of the report has been provided in Appendix J.

1.3.4 PRELIMINARY EVALUATION OF THE LORUSSO PROPERTY FOR TREATED WATER RECHARGE; NOVEMBER 2003

A preliminary evaluation was completed of the Lorusso property, located along the power lines, just south of Route 6, for the recharge of treated effluent. The property is approximately 11 acres and is comprised of lightly vegetated, undulating terrain.

It was found the site contains soils that are finer grained but that the deeper subsurface soils would have the capacity to receive the recharged water. The report concluded the Lorusso Property had potential to be a site to discharge treated effluent. A copy of the report has been provided in Appendix K.

1.3.5 EFFLUENT MITIGATION INVESTIGATION PROJECT – CANDIDATE SITE EVALUATION AND COMPARISON; DECEMBER 2003

In 2003 a study was completed to identify specific sites for effluent discharge. The evaluation was completed on four sites. Out of the four sites two were chosen to be most favorable.

The sites chosen were the McManus site and the Cape Cod Community College Site. Both were identified for the ability to support sand bed technology, which provides a low cost alternative on a dollar per flow basis. They also offered an estimated capacity of over 1.5 MGD. A copy of the report has been provided in Appendix L.

1.3.6 PRELIMINARY EVALUATION OF THE MCMANUS PROPERTY FOR TREATED WATER RECHARGE; MAY 2004

The Town of Barnstable consulted with Stearns & Wheler (now known as GHD) for an evaluation of the McManus site, located between 1860-1910 Iyannough Road (Route 132), to determine its suitability for wastewater reclamation through groundwater recharge.

The report found that the site has advantages due to its proximity to the WPCF, not being located in Barnstable Fire District Well #3 and of being comprised of relatively clean sand. It was reported that the site did have disadvantages of irregular topography, and the potentially low hydraulic conductivity in the deeper sand. It was concluded it should be considered a viable remote discharge site, despite the disadvantages identified. A copy of the report has been provided in Appendix M.

1.3.7 PRELIMINARY EVALUATION OF THE BARNSTABLE MUNICIPAL AIRPORT FOR TREATED WATER RECHARGE; MAY 2004

An evaluation was preformed to see if the Barnstable Municipal Airport property would be an acceptable location for the recharge of treated effluent.

The evaluation concluded the Airport had potential to be an ideal site to discharge treated effluent. Soil type, topography, distance from sensitive receiving water, and proximity to the WPCF all contributed to this conclusion. A copy of the report has been provided in Appendix N.

1.3.8 BENCHMARK EVALUATION TO INVESTIGATE GROUNDWATER MOUNDING DOWNGRADIENT OF THE HYANNIS WPCF; FEBRUARY 2005

In 2005, an evaluation was performed to determine the Benchmark Elevation at which groundwater mounding may occur at parcels in the vicinity of the Hyannis Water Pollution Control Facility (WPCF). Its primary objective was to determine the amount of wastewater that could be discharged at the Hyannis WPCF without causing potential flooding to structures or septic systems due to resultant groundwater mounding.

The evaluation found that the Town of Barnstable should base its effluent management plans on criteria other than a specific defined Benchmark Elevation and the resultant limited flow rate. It was determined that the Town should pursue remote discharge sites for monthly flows greater than 2.5 MGD during periods of high groundwater to accommodate needed additional capacity. It was also recommended the Town carry out a monthly groundwater elevation monitoring program in the area surrounding the BWPCF so that potential impacts can be predicted. A copy of the report has been provided in Appendix O.

1.3.9 EFFLUENT DISPOSAL AND REUSE PLANNING GUIDANCE DOCUMENT AND CASE STUDY REPORT; FEBRUARY 2005

A case study was performed in 2005, with the purpose to assist communities in completing the process of finding suitable land for discharging treated wastewater and to determine which of the many disposal technologies best meets the community's needs. A copy of the report has been provided in Appendix P.

1.3.10 INFILTRATION LOADING TESTS, MCMANUS SITE; OCTOBER 2005

A preliminary evaluation was completed that determined the McManus Site to be a favorable location for treated wastewater recharge. It was determined that further testing was needed to evaluate the sites hydrogeologic suitability and infiltration capacity.

The Town determined that subsurface leaching trenches would be a preferred recharge technology for this site. It was estimated that if leaching trenches were laid out in 200-foot by 100-foot fields there would be room for 35 leaching fields. Based on that estimate it was determined that the site would have capacity of 1.6 MGD. A copy of the report has been provided in Appendix Q.

1.3.11 FINAL WASTEWATER FACILITIES PLAN AND FINAL ENVIRONMENTAL IMPACT REPORT FOR THE TOWN OF BARNSTABLE; MARCH 2007

The 2007 Wastewater Facilities Plan summarizes the technical evaluations, project decision-making, and recommended plan to address the wastewater needs in Barnstable that were identified in 1993. The plan was developed for the 20 year planning period of 1994 through 2014.

One recommendation was to extend sewers to the Wastewater Areas of Concern (AOC) in the eastern portion of the Town to address the water quality problems in these areas. There was also a recommendation to upgrade and expand the Hyannis Water Pollution Control Facility, which was undertaken and has been completed. A copy of the report can be found as Appendix 1-1 of the Needs Assessment Report in Appendix R.

1.3.12 NEEDS ASSESSMENT REPORT COMPREHENSIVE WASTEWATER MANAGEMENT PLANNING (CWMP) PROJECT TOWN OF BARNSTABLE, MA; MAY 2011

Refer to Section 2.1 for a summary of the Needs Assessment Report. The complete Needs Assessment Report is included in Appendix R.

1.4 PUBLIC REVIEW AND PUBLIC PARTICIPATION

As discussed, the plan was created via a public process. The WRAC's meetings and workshops were conducted in the Town Council Meeting room and televised for the general public to be able to witness what was occurring. Additionally, those meetings were archived on the Town's website allowing citizens to review them at a later time. The plan, and aspects of the plan, was presented to Town Council on a number of occasions, particularly August of 2017, and again in January 2019. The Town Manager also included in his Town Manager Updates to the Town Council monthly updates on the plan documentation during the calendar year 2019 meetings. These too were televised and archived. The DPW presented the plan to any organizations that requested such a briefing. As of the writing of this section, that included the Cotuit Village Association (twice), the Marstons Mills Village Association, the Hyannis Village Association, Wequaquet Lake Protective Association, and the Barnstable Clean Water Coalition (formerly known as the Three Bays Preservation). It is expected that public meetings such as these will continue for as long as the plan is being executed in the Town of Barnstable. The plan has also been briefed to Town Boards and Committees. To date, this has included the Board of Health, and Comprehensive Financial Advisory Committee, though others are expected to occur during 2019. Finally, in concert with the local public access television station, Channel 18, a video presentation is being created that will document the needs and the plan which will be aired on Channel 18, available on the Town's Websites, and also able to be clipped into short segments that can be shared via social media to ensure the widest possible decimation of information regarding the plan. Refer to section 4.

1.5 ENVIRONMENTAL REVIEW PROCESS

The environmental review process will include a DEP, MEPA and CCC review of this CWMP document. Please see section 8 for the Environmental Impact Report.

1.6 ORGANIZATION OF CWMP

The Comprehensive Wastewater Management Plan has been prepared to summarize and document the Town's recent wastewater planning efforts. These efforts have built on decades of prior wastewater planning which have been summarized in Section 1.3. The report text, tables and figures are contained within Volume 1 of this document. All figures are provided at the end of the section in which they are referred to. The appendices are provided in subsequent volumes.

This Report is divided into 8 Sections:

1. Section 1 introduces the CWMP and summarizes the purpose, project scope, previous relevant wastewater planning efforts, public review process, environmental review process, planning period and organization of the report.
2. Section 2 summarizes the Town's 2011 Needs Assessment report, updates to Needs Assessment report, and projects already underway or completed since the Needs Assessment report.
3. Section 3 summarizes the evaluation of technological alternatives.

4. Section 4 summarizes the formulation and development of the Town's recommended wastewater plan.
5. Section 5 presents the Town's recommended wastewater plan on a watershed-by-watershed basis and contains the statement of consistency with the Cape Cod Commission's 208 Plan.
6. Section 6 presents the Town's proposed implementation plan and schedule.
7. Section 7 summarizes the financial considerations associated with the proposed plan.
8. Section 8 summarizes the environmental impact and benefits of the proposed plan.

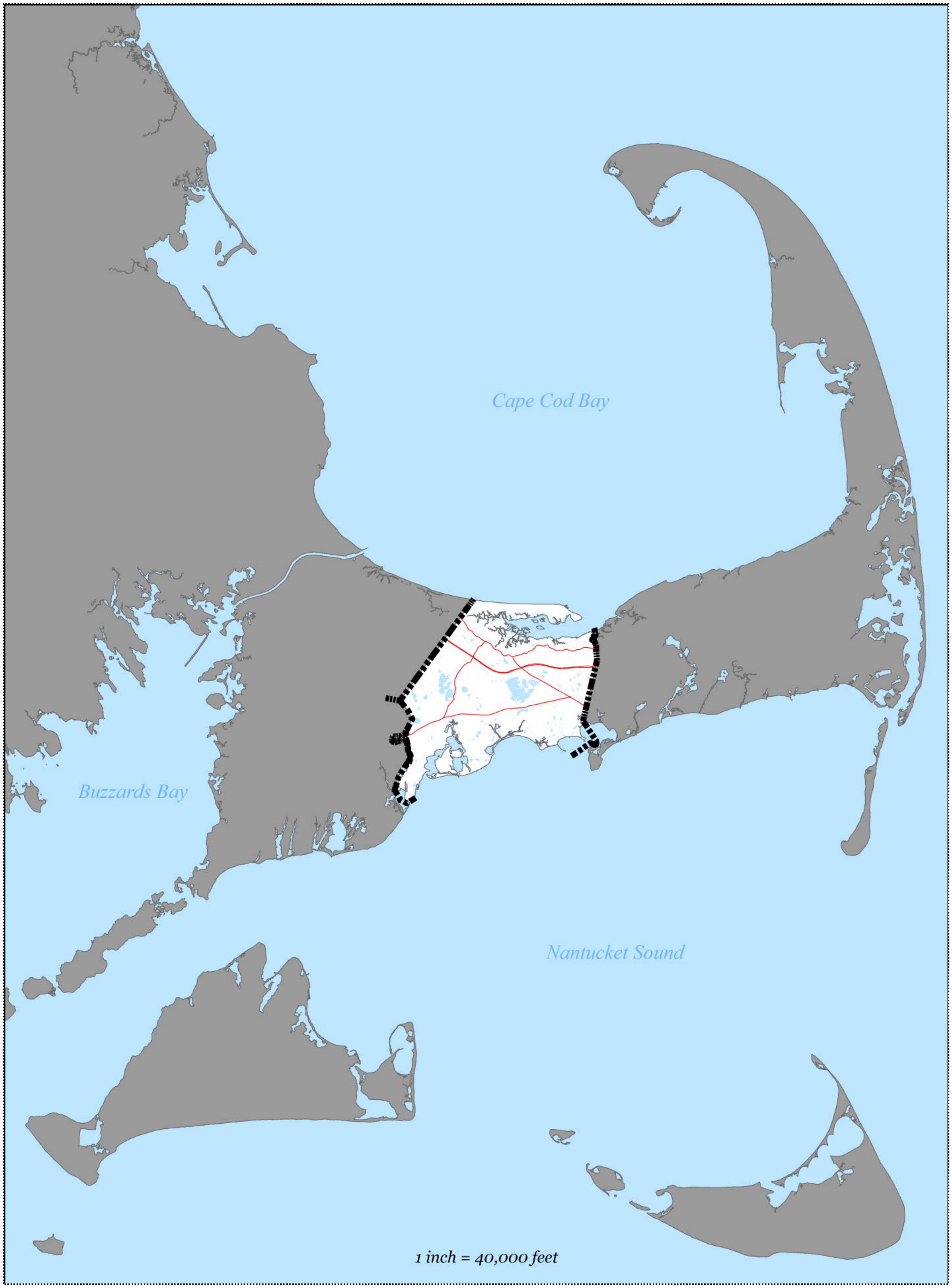

Figure 1-1: The Town of Barnstable is located in the middle portion of Cape Cod

2 NEEDS ASSESSMENT

2.1 THE 2011 NEEDS ASSESSMENT REPORT

In 2011 a Needs Assessment Report was completed by GHD to clearly define the wastewater and nutrient-related needs of the Town. The complete Needs Assessment Report is provided in Appendix R.

2.2 UPDATES TO THE 2011 NEEDS ASSESSMENT REPORT

This section provides an overview of pertinent updates since the 2011 Needs Assessment Report.

2.2.1 UPDATE OF EXISTING ENVIRONMENTAL CONDITIONS

This section provides an overview of the existing environmental conditions within the Town of Barnstable.

2.2.1.1 SURFACE WATER

Ponds

The Pond and Lake Stewardship (PALS) sampling program was already underway as of the writing of the 2011 Needs Assessment Report. That program was developed in 2000 and conducted sampling of 38 ponds in the community. With the WRAC effort, it was identified that additional ponds should be sampled. A subcommittee was formed that developed the following criteria to select the additional ponds to be sampled.

This resulted in data for 23 additional ponds. The samples were taken using the Pals methodology, and measured for the same constituents. Specifically, samples were analyzed for total nitrogen, total phosphorous, chlorophyll a and pH. Associated water quality data was collected at each site, and include dissolved oxygen, turbidity (water clarity), temperature, and depth. The results of this additional effort can be found in Table 2-1.

The completed 2017 Pond Study and results are provided in Appendix S.

Table 2-1: 2017 Ponds Water Quality Assessment

	Ultra-Shallow	Shallow 2.1 to 8.6m	Deep
Oligotrophic Total P<0-12 (ug/l)	Campground Pond		
Mesotrophic Total P<12-24 (ug/l)	Flowing Pond Israels Pond	Coleman Pond Patty's Pond	
Eutrophic Total P<24-96 (ug/l)	Mill Pond Lamson Pond Fawcett's Pond Mill (Filenes) Pond Weathervane Pond Ben's Pond Fresh Hole Pond Flax Pond	Simmons Pond Flintrock Pond Sam's Pond North Pond	
Hypereutrophic			

Coastal Embayments

The 2011 Needs Assessment Report discussed in detail why TMDLs are established for waters that are unable to meet state-established water quality standards, and that Barnstable had a number of embayments that required TMDLs for nitrogen. At that time, the Town had received the following reports (all of which are contained in the appendices) concerning these embayments:

- MEP Technical Report for Popponesset Bay; MEP, September 2004.
- MassDEP TMDL Report for Popponesset Bay; MassDEP, April 10, 2006.
- MEP Technical Report for Rushy Marsh; MEP, April 2006 (No TMDL Report expected due to its size).
- MEP Technical Report for Three Bay System; MEP, April 2006.
- MassDEP TMDL Report for Three Bay System; MassDEP, September 7, 2007.
- MEP Technical Report for Centerville River System; MEP, November 2006.
- MassDEP TMDL Report for Centerville River System; MassDEP, January 29, 2008.
- MEP Technical Report for Lewis Bay (and Halls Creek); MEP, December 2008.

However, at that time, the Town was still expecting TMDL for Lewis Bay (and Hall's Creek), and the Technical and TMDL Reports for Barnstable Harbor. Since then, the following has been released:

- MassDEP TMDL Report for Lewis Bay System and Halls Creek, March 2015 (Appendix BB)
- MEP Draft Technical Report for Barnstable Harbor, June 2017 (Appendix CC)

The Town is still waiting on a final TMDL for Barnstable Harbor.

A summary of the projected threshold concentration of nitrogen that needs to be obtained in each watershed is included in Table 2-2. A summary of the nitrogen removal requirements in each watershed as delineated by the Cape Cod Commission are included in Table 2-3.

Since the writing of the 2011 Needs Assessment, the Cape Cod Commission completed its update to the 1978 Water Quality Management Plan for Cape Cod, known as the "208 Plan" (found in Appendix A) in June 2015. The 1978 Plan had described the major water quality and wastewater management problems confronting the region at that time; and recommended land use controls, wastewater management, nonpoint source controls and institutional arrangements to improve water quality. The updated plan, in its own words, "recommends actions to streamline the regulatory process, make complex information more transparent and available to citizens, abate nitrogen-induced costs already impacting the region, provide more support to local community water quality efforts, and eliminate unnecessary costs" (*Cape Cod Area Wide Water Quality Management Plan*, June 2015, pg. S-xviii). Importantly Chapter 4 of the 208 Plan is a thorough look at technologies, both traditional and nontraditional, available to address wastewater issues. The Town used the Report to identify nitrogen removal requirements from each community that share watersheds. It also heavily utilized the 208 Plan's Chapter 4 when assessing technologies to address wastewater needs. This CWMP will leverage that chapter for its Section 3, *Evaluation of Technology Alternatives*, vs creating one from scratch.

Table 2-2: TN Concentrations in Watersheds

Watershed	Sub-embayment	Observed TN Concentration (mg/l)[1]	Threshold TN Concentration (mg/l)
Barnstable Harbor	Barnstable Harbor	0.072-0.111	0.16
Barnstable Harbor	Millway		0.21
Barnstable Harbor	**Barnstable Harbor Sentinel Station[2]**		TBD
Centerville River	Centerville River East	0.43-0.75	
Centerville River	Centerville River West	0.43-0.75	
Centerville River	East Bay	0.41	
Centerville River	Scudder Bay	0.62	
Centerville River	**Centerville River Sentinel Station[3]**		0.37
Lewis Bay	Halls Creek	0.45	
Lewis Bay	Hyannis Inner Harbor	0.43 – 0.60	
Lewis Bay	Lewis Bay	0.41	
Lewis Bay	Mill Creek	0.52-0.56	
Lewis Bay	Snows Creek	1.57	
Lewis Bay	Stewarts Creek	1.25	
Lewis Bay	**Lewis Bay Sentinel Station[4]**		0.38
Popponesset Bay	Pinquickset Cove	0.527	
Popponesset Bay	Popponesset Bay	0.485-0.422	
Popponesset Bay	Shoestring Bay	0.690-0.520	
Popponesset Bay	**Popponesset Bay Sentinel Station[5]**		0.38
Three Bays	Cotuit Bay	0.39-0.44	
Three Bays	North Bay	0.38-0.48	
Three Bays	Princes Cove	0.32	
Three Bays	Princes Cove Channel	0.50-0.52	
Three Bays	Seapuit River	0.60-0.70	
Three Bays	Warrens Cove	0.64	
Three Bays	West Bay	0.64	
Three Bays	**Three Bay Sentinel Station[6]**		0.38
Rushy Marsh	**Rushy Marsh Sentinel Station[7]**	1.107	TBD

Notes:

1. Barnstable Harbor Based on Draft MEP report
   Centerville River Based on 2001-2005 data.
   Lewis Bay Based on 2001-2006 data

Popponesset Bay Based on 1997-2003 data
Three Bays Based on 1999-2004 data
Rushy Marsh Based on MEP Report

2. TMDL not yet available
Millway and Bass Hole, as these 3 component basins are functioning somewhat independently

3. Located seaward of the mouth of the Bumps River. Additional threshold value of 0.50 mg/l applies to station BC-7 and station BC-3 for the protection of benthic habitat.

4. Located at the eastern end of Lewis Bay. The Halls Creek had its own target threshold of 1.0 mg/l

5. Located at the mouth of Shoestring Bay

6. Located between Cotuit Bay and North Bay

7. TMDL not yet available

Table 2-3: Nitrogen Removal Requirements by Watershed (Source: Cape Cod Commission, 2016)

Watershed	Total attenuated controllable watershed N nitrogen load (kg/day)	Total attenuated controllable N load (from Barnstable) (kg/day)	Target (kg/day)	Total N load reduction required (kg/day)	N Load reduction required (by Barnstable) (kg/day)
Centerville River Watershed					
Centerville River East	52.7	52.7	24.7	28.0	28.0
Centerville River West	8.2	8.2	9.5	0.0	0.0
East Bay	7.8	7.8	8.6	0.0	0.0
Scudder Bay	44.5	44.5	52.6	0.0	0.0
Halls Creek Watershed					
Halls Creek	20.0	20.0	36.3	0.0	0.0
Lewis Bay Watershed					
Hyannis Inner Harbor	18.9	15.7	7.4	11.5	11.2
Lewis Bay	39.8	9.9	9.7	30.2	7.5
Mill Creek	32.7	5.7	22.3	10.3	1.8
Snows Creek	9.7	9.7	16.2	0.0	0.0
Stewarts Creek	51.3	51.3	41.6	0.0	0.0
Popponesset Bay Watershed					
Pinquickset Cove	0.9	0.9	0.8	0.2	0.2
Popponesset Bay	1.7	0.6	1.8	0.0	0.0
Shoestring Bay	35.5	11.3	19.7	15.8	5.0
Three Bays Watershed					
Cotuit Bay	22.1	21.0	22.3	0.0	0.0
North Bay	25.0	24.8	4.5	20.6	20.4
Princes Cove	11.7	10.8	2.2	9.5	8.8
Princes Cove Channel	5.7	5.7	0.8	5.0	5.0
Seapuit River	2.7	2.7	3.8	0.0	0.0
Warrens Cove	29.3	23.7	20.8	8.5	6.9
West Bay	15.0	15.0	16.0	0.0	0.0
Rushy Marsh Watershed					
Rushy Marsh Pond	0.2	0.2	0.1	0.1	0.1
Barnstable Harbor Watershed					
Barnstable Harbor*	100.2	82.1	75.1*	25.0*	20.5*

* Draft Barnstable Harbor MEP was not developed at the time of development of this table. This assumed a 25% reduction target as a placeholder. As discussed in Section 5, removal requirements per MEP are less.

2.2.1.2 STORMWATER

The Town has been implementing stormwater management solutions to help address nutrients, bacteria, and/or sediments impacting town waterways. Since the 2011 Needs Assessment Report, the Town, working with other organizations, has conducted the following projects, see Table 2-4.

Table 2-4: Special Stormwater Drainage Systems

Site Location	Village	Date Installed	Unit Type	Projected Removal Rates
Cotuit Library	Cotuit	2020 (Projected)	Rain garden with sediment forebay and educational section	
South County Road	Osterville	2020 (Projected)	Planted swales with sediment forebay	55% Nitrogen 70% Bacteria
Putnam Ave. at Little River crossing	Cotuit	2020 (Projected)	Bioretention with sediment forebay	55% Nitrogen 70% Bacteria
Cordwood Landing Phase 2	Cotuit	2020 (Projected)	Bioretention with sediment forebay	55% Nitrogen 70% Bacteria
Old Shore Road at Ropes Beach Phase 2	Cotuit	2019	Bioretention with sediment forebay	55% Nitrogen 70% Bacteria
Town Parking Lot Boat Ramp Prince Ave.	Marstons Mills	2019	Sand filter with rain garden and sediment forebay	55% Nitrogen 70% Bacteria
Cordwood Landing Phase 1	Cotuit	2009, upgraded 2019	Bioretention with sediment forebay	55% Nitrogen 70% Bacteria
Putnam Ave. at Old Shore Road/Ropes Beach & Boat Ramp	Cotuit	1999, upgraded 2019	Vortecnics/Wetland Pockets	55% Nitrogen 70% Bacteria
Osterville Library	Osterville	2018	Rain garden & educational section	
Oyster Place Road/Town Dock	Cotuit	2017	Rain garden	
Gateway Park	Hyannis	2015	gravel wetland	47% Nitrogen
Bay Street/ Boat Ramp	Osterville	2015	PERC CRETE Settling/Infiltrators	

Within the 208 Plan Update, the Three Bays area was identified as a watershed where stormwater has a significant impact, with approximately 23% of controllable nitrogen coming from stormwater runoff. The Town partnered with the Association to Preserve Cape Cod, the Barnstable Clean Water Coalition, the Horsley Witten Group and the Barnstable Land Trust on a five-year $1.2 million project for improving water quality through stormwater management. The project utilizes green infrastructure stormwater systems, which incorporate plants and soil media to remove nitrogen, bacteria and other pollutants before the stormwater passes into the bays.

This approach accounts for BMP vulnerabilities and incorporates projected impacts of climate change when considering siting, selection, and materials of practices. Design plans consider options for redundancy and flexibility to adapt to these impacts and emphasize the use of green infrastructure and low impact design. To ensure long-term effectiveness of the installed systems, O&M plans and training for town staff is provided and a permanent training video to support training of new staff in the future.

The overall nitrogen removal rate of green infrastructure, with normal maintenance, should be on the order of 55% for system(s) placed in service or upgraded after 2017 in the Three Bays watershed.

2.2.1.3 SOILS

Soil data remains unchanged. Refer to Section 5-8 of the 2011 Needs Assessment.

2.2.1.4 DEPTH TO GROUNDWATER

The groundwater in Barnstable provides drinking water supplies and recharges the ponds, wetlands, and coastal estuaries. All groundwater in Barnstable is supplied by the Sagamore Lens which is shared by the towns of Bourne, Sandwich, Falmouth, Mashpee, and Yarmouth; the groundwater resources on Cape Cod as a whole are classified as a sole-source aquifer by USEPA. Groundwater contours in the Town of Barnstable are shown in Figure 2-2.

2.2.1.5 FLOOD ZONES AND VELOCITY AREAS

The FEMA flood zone maps were updated in July of 2014. The updated mapping added a substantial number of new properties to the various flood hazard zones. Figure 2-3 shows the updated FEMA flood zones.

2.2.1.6 GROUNDWATER AND DRINKING WATER PROTECTION AREAS

The Town draws its public water from the Sagamore Lens. Current discharges from individual septic systems and from wastewater treatment facilities have the potential to impact this drinking water supply. MassDEP has established regulations that must be met to protect this resource. Nitrogen discharges from septic systems previously were the main concern to the water supply, now concerns have been raised about a new category of water contaminant called Contaminants of Emerging Concern (CECs). This general category includes three subgroups – endocrine disrupting compounds, pharmaceuticals, and personal care products. These compounds and potential contaminants are not currently regulated by the federal government because their toxicity is not well understood.

Protection zones are put in place to protect the recharge area from contaminants around public water supply groundwater sources. DEP divides the wellhead protection recharge area into two zones called Zones I and II.

A Zone I is the protective 400 foot radius required around public water supply wells or well-fields that yield 100,000 gpd or greater. For wells of less than 100,000 gpd or greater than 10,000 gpd a 250-foot protective radius is used.

A Zone II is the area of the aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated. This is traditionally modeled as 180 days of pumping at approved yield, with no recharge from precipitation. The Zone II must include the entire Zone I area. The existing state designated wellhead protection areas (Zone I and Zone II) are shown in Figure 2-7.

2.2.1.7 GROUNDWATER PROTECTION OVERLAY DISTRICTS

The Town's zoning has established three Groundwater Protection Overlay Districts to protect the public health, safety, and welfare by encouraging nonhazardous compatible land uses within groundwater recharge areas. The three overlay districts are shown in Figure 2-8. The overlay districts are defined as follows:

- The Groundwater Protection Overlay District (GP) is based on Zone II delineations to existing, proven future and proposed public water supply wells.
- The Well Protection Overlay District (WP) is based on a five-year time of travel zone to existing, proven future and potential future public supply wells.
- The Aquifer Protection Overlay District (AP) consists of all other areas of Town, except those located in the aforementioned GP or WP Overlay Districts.

The GP and WP districts restrict certain uses which could cause groundwater contamination, limit impervious coverage, site clearing, and sewage disposal. Refer to Appendix DD for the portion of the Zoning Code that establishes the Overlay District (Section 240-35 of the Town Code).

2.2.1.8 INTERIM SALTWATER ESTUARY REGULATION

In response to establishment of nitrogen TMDLs in a number of the Town's embayments, in March 2008 the Board of Health established an interim regulation (Section 360-45 of the Town Code) focused on limiting septic load within these watersheds. Septic loads within the watersheds of Popponesset Bay, Three Bays and Centerville River are restricted by this regulation as follows:

"The maximum allowable discharge of sanitary sewage, based on the sewage design flow criteria listed in 310 CMR 15.203, Title 5, of the State Environmental Code, shall not exceed 440 gallons per 40,000 square feet of lot area, with the following exceptions:

(a) For approved building lots on which no building currently exists and that are less than 30,000 square feet in area, the maximum allowable sewage discharge shall be 330 gallons.

(b) For parcels with existing buildings, the maximum allowable flow shall be either 440 gallons per 40,000 square feet, except as described in Subsection B(1)(a) above or whatever is currently permitted, whichever is greater."

Refer to Appendix EE for the portion of the Town Code that establishes the Regulation.

2.2.1.9 SENSITIVE HABITATS

There are several regions within the Town of Barnstable that have been identified as combined habitats of rare species and wildlife by the Massachusetts Division of Fisheries, Natural Heritage and Endangered Species Program (NHESP). These are shown in Figure 2-4, and were updated in August 2017. NHESP has also identified vernal pools and potential vernal pools in the Town of Barnstable, which were updated in December of 2018 and are shown in Figure 2-5.

2.2.2 UPDATES TO EXISTING WASTEWATER INFRASTRUCTURE

This section provides an overview of the existing wastewater infrastructure in the Town of Barnstable.

2.2.2.1 BARNSTABLE WATER POLLUTION CONTROL FACILITY (BWPCF)

The Barnstable Water Pollution Control Facility is comprised of septage handling, pretreatment, primary treatment, secondary treatment, and disinfection facilities. Treated effluent is disposed of on-site via rapid sand infiltration beds. The facility currently treats an average daily flow of 1.67 MGD, and has a maximum-month average daily flow of 1.97 MGD. The facility processes between 10 to 12 million gallons of septic and grease waste each year. The following sections outline the improvements that have been made to the BWPCF and sewer collection system since the completion of the 2011 Needs Assessment Report.

2.2.2.1.1 Underground Storage Tank Removal

A contract was completed in 2011 to remove two underground chemical storage tanks and replace them with pad mounted above-ground storage tanks. The existing 4,000 gallon fiberglass underground diesel storage tank feeding the emergency standby generator was removed and replaced with a 3,000 gallon double-walled steel storage tank and a new fuel delivery system. The existing 8,000 fiberglass underground sodium hypochlorite storage tank was removed and replaced with a new 6,650 gallon double-walled polyethylene storage tank with a new chemical delivery system.

2.2.2.1.2 Renewable Energy Facilities Construction

A construction contract was completed in 2012 for the installation of two 100 kW wind turbines and an 819 kW solar array. The $5,800,000 project cost was 100% grant funded through the American Recovery and Reinvestment Act (ARRA). The power produced from these facilities is fed into the electrical grid and the BWPCF is credited for the energy produced. This project, coupled with other energy efficiency improvements at the facility, has resulted in a nearly 75% reduction in net electrical usage at the WPCF.

2.2.2.1.3 Effluent Disposal Modeling

The BWPFC has continued to discharge 100% of its effluent on site. While several alternative disposal sites were located, the Town elected not to pursue those options for a variety of reasons, most notably due to their proximity to drinking water wells. The ultimate effluent disposal capacity of the rapid infiltration beds at the BWPCF remains uncertain. This is due to many site specific considerations that are independent of the BWPCF recharge such as seasonal and multi-year variations in the elevation of the groundwater table. In order to better understand the dynamics of the groundwater table in the area downgradient of the rapid infiltration beds, in 2014 the Town contracted the services of Watershed Hydrogeologic through its consultant GHD to develop a localized groundwater model for the area surrounding the BWPCF. The model, referred to as the Barnstable Groundwater Model (BGM), was utilized to delineate the fate and transport of the BWPCF effluent recharge.

Follow-up groundwater simulations were conducted in 2017 in order to provide the Town with a planning level analysis of the effects of various effluent discharge scenarios. While the inputs and assumptions used during these simulations were conservative, the analysis determined that the permitted discharge volume of 4.2 MGD for the BWPCF could potentially create groundwater mounding issues in the vicinity of the BWPCF rapid infiltration beds, and that a more detailed analysis should be carried out. As a result, the Town and Massachusetts DEP determined that the disposal capacity of the BWPCF should be lowered to 2.7 MGD with the issuance of the 2018 groundwater discharge permit, but that follow up studies would be necessary to determine the actual disposal capacity for the facility. In early 2019, a consultant was hired to precisely and definitively quantify the effluent discharge capacity of the BWPCF.

2.2.2.1.4 Solids Handling Evaluation

In 2015, the Town initiated a solids handling evaluation and design in order to address the condition and capacity of the BWPCF solids handling facilities and to evaluate future sludge dewatering and disposal practices. The evaluation was put on hold until 2018 while wastewater planning efforts were completed. This allowed the consultant to gather design data for the volume of septic waste expected to be received and the amount of sludge expected to be produced at the BWPCF over the next 20 years. The design of these improvements is expected to be completed by the fall of 2020. It is expected that improvements will be constructed to the septage receiving station, grit removal system, sludge pumping equipment and pipework, odor control system, chemical delivery systems, and sludge thickening equipment.

2.2.2.1.5 Biowin Modeling

In 2017, in conjunction with the solids handling evaluation, the Town began the development of a Biowin computerized simulation model for the BWPCF. The model was used to establish future sludge production totals for the design of the BWPCF solids handling upgrades. The model can also act as a predictive tool to analyze the impact of varying flows and loads on the wastewater treatment process. While the data generated from the Biowin model will be used as a predictive tool for process control and assessing scenarios, it is not intended to be used as the basis for design or permitting.

2.2.2.1.6 Clarifier Rehabilitation

A construction contract completed in 2018 rehabilitated the BWPCF's two primary and three secondary clarifiers. The existing Primary Clarifiers Nos. 1 and 2 and Secondary Clarifiers Nos. 1 and 2 were built in 1980 and improvements were needed in order to address the condition of the process equipment and to improve the sludge removal efficiency of the clarifiers. Process equipment within Primary Clarifiers Nos. 1 and 2 and Secondary Clarifiers Nos. 1 and 2 was demolished and retrofitted with new spiral blade rake arms, baffles, algae sweeps, clarifier drives, catwalks and sludge withdrawal mechanisms. Secondary Clarifier No. 3, constructed in 1996, was rehabilitated by sandblasting and recoating steel process equipment and installing a new clarifier drive. The concrete tank walls on all clarifiers were spot repaired and epoxy coated. Four 20-inch valves were replaced within the primary clarifier distribution box, and seven clarifier isolation valves were replaced within the Secondary pump room.

2.2.2.1.7 Standby Generator Installation

A construction contract completed in 2019 replaced the existing standby generator with a new 750kw pad-mounted diesel generator with a sound attenuated enclosure. The automatic transfer switch, main switchgear MSA, motor control center MCC-6, and all associated wiring was replaced as part of this project. The existing turbine generator, exhaust stack, main switchgear MSA, and motor control center MCC-6 were demolished and the electrical room ceiling and walls were repaired and repainted. While the new generator provides standby power for the entire wastewater treatment facility, future plans call for a second 450 kW generator to be installed at main switchgear MSB when future loads dictate. The 450 kW generator will provide additional redundancy to the BWPCF's existing standby power system.

2.2.2.1.8 Effluent Flow Meter Installation

As required by the 2018 permit update for the BWPCF, an effluent flow meter is to be designed prior to December 31, 2019 and installed at the facility prior to December 31, 2020. This project is discussed further in the permit update section.

2.2.2.2 EXISTING COLLECTION SYSTEM STUDIES

The sewer collection system in the Town of Barnstable dates back to 1937 and consists of approximately 55 miles of gravity sewer, low pressure sewer, vacuum sewer, and force main. The Town owns, operates, and maintains a total of 27 pump stations. These range in size from very small stations serving private developments to larger stations which serve downtown areas while accepting flow from one or more smaller stations. The H-1 sewer expansion and Lincoln Road Pump Station construction projects outlined in the 2011 Needs Assessment report have been completed. The Town has assumed responsibility for the Hyannis Youth and Community Center pump station and the Settlers Landing private development pump station.

2.2.2.2.1 SewerCAD Modeling

In 2016, a contract was completed to expand the existing SewerCAD model for downtown Hyannis to incorporate the Town's entire collection system. The SewerCAD model, which is operated in-house by DPW engineers, is the most efficient way to evaluate capacity limitations as sewer extensions, new connections, or increases in flow are proposed. The updated model was loaded with existing water use data and a report was submitted outlining potential bottlenecks within the sewer system or capacity issues with pump stations under both existing and future flows. Several areas were identified as having capacity issues, and projects to address those deficiencies are discussed in detail in the localized collection system projects section of this report. See Appendix FF.

2.2.2.2.2 Infiltration and Inflow (I/I) Analysis

In 2017, as part of the Town's Capacity, Management, Operation and Maintenance (CMOM) efforts, a study was completed analyzing the amount of infiltration and inflow entering the Town's sewer system. Infiltration is the leakage of groundwater into the sewer through cracks and openings in sewer pipes and/or manholes. Inflow is the flow of surface water into the sewer through storm drains, roof leaders, and/or sump pumps in basements of buildings. Removal of infiltration and inflow from the Town's sewer system will free up pipe capacity and disposal capacity at the BWPCF. Sewer system authorities were required to submit an infiltration and inflow analysis to the DEP by December 31, 2017.

The 2017 study concluded that up to 0.44 MGD of infiltration could be entering the sewer system during high groundwater conditions. A 1988 infiltration and inflow study by Whitman and Howard estimated as much as 0.55 MGD was entering the sewer system. The study also found that there could be as much as 1.02 MGD of inflow entering the Town's collection system during a standard five-year twenty-four hour storm event. This conclusion represents a large increase of inflow over the 1988 study which found that inflow was negligible.

Based on the findings of this study, the Town has elected to follow up with Sewer System Evaluation Survey (SSES) work in order to locate the exact sources of infiltration and inflow noted in the 2017 Infiltration and Inflow Analysis. Sewers in the area of Enterprise Road and Route 132 will be evaluated for potential sources of infiltration and inflow while 8 other subsections of sewer will be evaluated for sources of inflow.

2.2.2.2.3 Pump Station Evaluation

In 2018, the Town hired a consultant to conduct evaluations for all of the 27 sewage pump stations it owns and maintains. The purpose of this project was to evaluate each of the pump stations with respect to the structural, architectural, electrical, mechanical and process components and to make recommendations for improvements. Special consideration was given to coastal resiliency with shoreline pump stations. The consultant provided a twenty year capital improvement plan for improvements deemed necessary by this evaluation.

2.2.2.3 EXISTING COLLECTION SYSTEM IMPROVEMENTS

2.2.2.3.1 South Street Sewer Improvements

A consultant was hired in 2018 to complete an evaluation and design of sewer improvements in South Street in Hyannis. The purpose of the evaluation was to assess the condition and capacity of the sewers in South Street in order to support future buildout flows. The evaluation noted areas of capacity restrictions with both current and future flow scenarios. The consultant has recommended breaking this project into three construction phases. The first recommended phase is to replace the existing 12- and 15-inch clay sewers between High School Road and Old Colony Pump station with a new 18-inch PVC sewer in order to address the capacity constraints that currently exist. Phase 2, would replace the existing 12- and 15-inch clay sewers between Old Colony Road and Lewis Bay Road with a new 18-inch PVC sewer line. By phasing this portion of the project, the Town has the benefit of waiting to see if future flows proposed in this area materialize, or if the sewers can simply be relined. Phase 3 of the project would replace the existing 10-inch clay sewers between Sea Street and High School Road if future buildout requires increased capacity in this area.

2.2.2.3.2 Barnstable Road Evaluation

A consultant was hired in 2018 to complete an evaluation of the sewers in Barnstable Road in Hyannis. The purpose of this evaluation is to identify any conditional defects or capacity constraints within the Barnstable Road sewers so that these repairs can be made in conjunction with the Hyannis Water System's pipe rehabilitation program. This will allow the Town to save money on construction costs while minimizing disruption to residents and area businesses.

2.2.2.3.3 Pleasant Street Sewer Relining

In order to address capacity constraints identified in the 2016 SewerCAD report, in 2019 the Town hired a contractor to re-line the sewers on Pleasant Street in Hyannis. This project increased the capacity of the sewers by approximately 10% by reducing friction of the pipe and will improve the condition of the 1935 clay sewers within Pleasant Street. In addition to this project, the Town is in the preliminary planning phase for the construction of a new sewer running between Main Street and South Street on Old Colony Road, which will shed flow off of Pleasant Street and alleviate any remaining capacity constraints in the area.

2.2.3 UPDATES TO WASTEWATER TREATMENT FACILITY GROUNDWATER DISCHARGE PERMITS

2.2.3.1 BARNSTABLE WPCF

The Barnstable Water Pollution Control Facility was issued an updated Groundwater Discharge Permit (GPD) in November 2018. The permit expires in November 2023. The updated discharge permit limits the Town of Barnstable to 2.7 MGD maximum daily flow and requires the Town to submit an engineering report demonstrating adequate discharge capacity prior to accepting any flows in excess of 2.7 MGD. Table 2-5 summarizes the effluent limitations outlined in the 2018 discharge permit.

In addition to the discharge limitations, there are several new supplemental conditions required in the updated Groundwater Discharge Permit. The Town is required to submit a Comprehensive Wastewater Management Plan (CWMP) or equivalent to the Department for review and approval by December 31, 2021. By December 31, 2019, the Town must submit an engineering report and plans for DEP review for the installation of an effluent flow meter and have the meter installed by Dec 31, 2020. As part of the permit renewal in 2023, the Town must submit an engineering report outlining what modifications, if any, are required to insure that the facility can remain in compliance through the next 5 year permit term (year 2028) and beyond. See Appendix GG.

Table 2-5: BWPCF EFFLUENT DISCHARGE LIMITATIONS

Effluent Characteristics	Current Discharge Limitations	Expanded Discharge Limitations
Flow	2.7 MGD (maximum)	4.2 MGD (maximum)
Biochemical Oxygen Demand	30 mg/L	30 mg/L
Total Suspended Solids	30 mg/L	30 mg/L
Total Dissolved Solids	1000 mg/L	1000 mg/L
Nitrate Nitrogen	10 mg/L	10 mg/L
Total Nitrogen	10 mg/L and not to exceed 49,315 pounds per calendar year*	10 mg/L
Oil and Grease	15 mg/L	15 mg/L
Fecal Coliform	200 colonies/100 ml	200 colonies/100 ml
Total Chlorine	1 mg/L	1 mg/L

*49,315 pounds per year represents the mass load at a maximum daily flow of 2.7 MGD and an annual average Total Nitrogen concentration of 6 mg/L.

2.2.3.2 Marstons Mills Wastewater Treatment Plant (MWWTP)

In February of 2019 the Marstons Mills Wastewater Treatment Plant (MMWWTP) was issued an updated Groundwater Discharge Permit. The permit expires in February 2024, see Appendix HH. Table 2-6 summarizes the effluent limitations outlined in the discharge permit.

Table 2-6: MMWWTP Effluent Discharge Limitations

Effluent Characteristics	Discharge Limitations
Flow	42,900 GPD
Biochemical Oxygen Demand	30 mg/L
Total Suspended Solids	10 mg/L
Nitrate- Nitrogen	10 mg/L
Total Nitrogen	10 mg/L
Oil and Grease	15 mg/L
Fecal Coliform	200 colonies/100ml
Turbidity	5 NTU

Note: As part of the permit renewal in 2023, the Town must submit an engineering report outlining what modifications are required to insure that the facility can remain in compliance through the next 5 year permit term (year 2028) and beyond.

2.2.4 EXISTING WASTEWATER GENERATION

The GIS-based tool compiles all water data and nitrogen removal requirements by watershed into one centralized location. The tool compiles water data from 2010 to 2016 and calculates the average daily water usage of each parcel in the Town. The tool then calculates wastewater generation of each lot as 90% of the calculated water usage. Nitrogen is calculated assuming a typical Title 5 septic system concentration of 26.25 mg/L. A summary of the water use, wastewater generation and associated nitrogen generation by watershed is provided in Table 2-7.

Table 2-7: Existing Wastewater Generation by Watershed

Watershed	Water Use (gpd)	Wastewater Generation (gpd)	Nitrogen Generation (kg/day)
Lewis Bay	1,698,200	1,528,380	42.6
Halls Creek	280,910	252,820	14.4
Centerville River	1,529,540	1,376,590	132.3
Three Bays	1,361,000	1,224,900	121.4
Rushy Marsh	4,200	3,780	0.4
Popponesset Bay	181,720	163,550	16.2
Barnstable Harbor	879,200	791,280	65.5
Total	5,934,770	5,341,300	245.7

2.2.5 UPDATE ECONOMIC DEVELOPMENT REQUIREMENTS

Aligning housing and economic development objectives with infrastructure planning is critical to the Town's economic future and environmental health, as well as the long-term fiscal stability of the municipality. The availability of infrastructure, specifically municipal wastewater, is a fundamental factor in business and housing development decisions. Available connections to municipal wastewater treatment allow for development at higher densities, therefore bringing down development costs and allowing for the most productive use of land.

Encouraging the development and redevelopment of land in areas appropriately supported by multi-modal transportation infrastructure, away from sensitive environmental or historic resource areas, and in proximity to community activity centers will support the growth of this community, while supporting community character and fiscal sustainability. The availability of sewer infrastructure in areas designated for growth is critical to their economic success.

The WRAC process identified a number of areas in Town as priority areas for sewer expansion based on economic and housing development objectives. Priority areas identified here are further refined based on existing development patterns and review of Local Comprehensive Plan and Regional Policy Plan objectives.

2.2.5.1 ECONOMIC/HOUSING DEVELOPMENT PRIORITY AREAS

- Attucks/Independence: This area is zoned for commercial and industrial development and is well served by transportation infrastructure. The area contains a number of existing businesses and housing developments, and possesses the strong potential for future growth. Limited sewer expansion in this area has been funded by private developers in connection with new development projects and with the 2017 MassWorks Infrastructure Grant.
- Yarmouth Road Triangle: This built-out area contains many existing small businesses and several large auto dealerships. The immediate area contains limited development potential, but potential future connections to the Barnstable Municipal Airport property could result in economic growth in connection with aviation purposes. The area also hosts several drinking water wells belonging to the Hyannis Water Division. Connecting the businesses in the area to municipal wastewater treatment would allow potential future economic expansion, as well as have long-term water quality benefits.
- The un-sewered portions of Route 28 corridor from Centerville to Marstons Mills include the auto-oriented commercial center in Centerville, as well as a number of commercial and multi-family residential uses outside of designated commercial zoning districts. The potential to intensify existing economic centers or infill/redevelop property along the corridor would be created with the addition of sewer infrastructure.
- There are a number of specific areas where the existing zoning does not reflect future development potential if there was expanded infrastructure availability. On account of current infrastructure constraints, as well as other factors, these areas are not designated economic or growth centers; however, with availability of wastewater infrastructure, these areas could support additional development. Such decisions would require regulatory changes, and thus appropriate community support. Further, policy decisions about infrastructure cost-sharing between the Town and potential developers where necessary may also have an influence.

  The areas are presented here for the purposes of identifying where this capacity for economic and housing growth could occur in the future.
    - Undeveloped parcels around the Route 132 & Attucks intersection
    - Cape Cod Regional Transit Authority’s Hyannis Transportation Center
    - Hyannis Resort & Conference Center and Golf Course
    - Bell Tower Mall, Centerville
    - Town of Barnstable, Marstons Mills School

2.2.5.2 GROWTH INCENTIVE ZONE

The Growth Incentive Zone is an area encompassing downtown Hyannis Main Street, Hyannis Harbor, and commercial areas south of the Airport Rotary is designated as an area to support additional economic and housing growth and development. This designation was based on the availability of public wastewater infrastructure, along with historic and existing development patterns that could accept compact, walkable development. The area is the focus of planning efforts and development incentives to encourage new investment. The Growth Incentive Zone is currently zoned to encourage multi-family development and is the focus of regulatory efforts to further increase development potential.

Buildout of sewer infrastructure in Downtown Hyannis began in 1935. The system has been maintained and expanded over time; there are very few developed parcels within the Growth Incentive Zone that are not connected to public sewer. Planned infill development and redevelopment will rely on continued investment in improvement of the system. Further, policy decisions about infrastructure cost-sharing, where necessary and appropriate, may impact development.

Analysis of wastewater capacity completed at the time of the 2017 Growth Incentive Zone renewal supported that, overall, the existing infrastructure adequately supports existing development. The analysis highlighted the potential for deficiencies in the capacity of the South Street sewer main, which conveys flows from the majority of Hyannis to the South Street pump station. The sewers on South Street were installed in 1935 in three-foot sections of clay pipe and have recently shown signs of deterioration. Recent modeling efforts indicated that South Street sewers between High School Road and Old Colony Road are at full capacity under peak flow conditions, and will be over capacity under future conditions. The sewers between Old Colony Road and School Street are approaching capacity and will be over capacity under future conditions.

The Town has completed an evaluation of improvements necessary to upgrade the South Street Main and this project is in the design phase. In Fiscal Year 2020, a $4,019,000 CIP was approved under the Water Pollution Control Enterprise Fund for construction of the necessary improvements. Increasing sewer capacity on South Street will accommodate future growth and development for parcels feeding into South Street sewers.

Two other projects in the Growth Incentive Zone are also complete. One is a cleaning and lining of the sewers on Pleasant Street and surrounding areas to support additional capacity. This project was factored into the planning for the South Street sewer upgrades and funded by a Housing Choice Grant from the Commonwealth. An evaluation of the capacity of sewers on Barnstable Road is also currently underway.

2.2.6 FUTURE CONDITIONS

2.2.6.1 POPULATION PROJECTIONS

2.2.6.1.1 Trends

The region experienced decades of growth through the 20th century, but the population saw a slight decline between 2000 and 2010. Population decline in Barnstable was more pronounced than in other Cape communities during this time period. Current population estimates for Barnstable are approximately 44,000-45,000 year-round residents. The current population is equivalent to that experienced in the late 1990's.

Table 2-8: Town of Barnstable Population Trends

	1980	1990	2000	2010	2015
Barnstable	30,898	40,958	47,821	45,193	44,331

Population projections are based on both natural change (births vs. deaths) and net migration. As a retirement destination, the Cape's population and economy is far more impacted by migration than by natural growth. The aging demographic profile of the Town, and of the region, predictably results in a declining natural growth rate. Barnstable County has the oldest median age in the Commonwealth (52.5 years) and has been experiencing a natural decrease in population since 1991.[1]

Positive in-migration was the contributing factor to population growth between 1970 and 2000. As the region's labor force, employment, and economic performance began to decline, so did rates of in-migration. In the decade of the 2000s, net migration was slightly positive (approx. 900 net in-migrants) while natural decrease was the dominant contributor to population decline. Thus far in the 2010s, natural decrease and net migration have nearly equaled each other; resulting in a slight decrease in population since 2010.

Analysis of the change in share the population amongst age cohorts shows expected "bell-shaped" trends over the past few decades in all except the 65 year and older group. Younger age cohorts increased until 2000 and have since declined. In Barnstable, the percentage of residents under the age of 18 has decreased from 19.1% in 2010 to 16.9% in 2017. This trend is reflected in changes in regional school enrollment, which declined 9.1% between 2010 (31,535) and 2017 (28,650). The share of persons aged 20-44 years also declined, likely as a result of residents moving off Cape for educational and job opportunities.

[1] Cape Cod 2020 Regional Transportation Plan, Cape Cod Metropolitan Planning Organization/Cape Cod Commission; Cape Cod Commission's Regional Housing Market Analysis and 10-year Forecast of Housing Supply and Demand by Crane Associates, Inc, June 30, 2017

2.2.6.1.2 Forecasts and Projections

Data from the US Census and MassDOT Office of Transportation Planning, provided to Metropolitan Planning Organizations, both indicate a continuation in population decline over the next three decades, with the regional population dipping below 200,000 in 2030. These projections, however, do not take into account factors such as the Cape's profile as a seasonal and retirement destination. The continued attractiveness of the Cape as a retirement destination amplifies the influence of future migration, as opposed to natural growth and may result in an underestimation in population.[2]

The Cape Cod Commission's Regional Housing Market Analysis and 10-year Forecast of Housing Supply and Demand by Crane Associates, Inc, dated June 30, 2017, forecasts population growth in Barnstable through 2025. Barnstable is predicted to increase its population by an average of 215 residents per year (0.51%). The Mid-Cape, specifically the Town of Barnstable, is predicted to show stronger population growth than other areas within the region. The Crane Report cites expected future job growth as a population driver. Other factors that support this determination may be the more even distribution of age and seasonal population in Barnstable than in other towns, as well as greater potential for new development based on recent growth, adopted land use policies, and infrastructure availability.

The Commission's Market Analysis by Crane Associates estimates the Mid-Cape will add approximately 3,790 jobs (0.59% annual average growth rate) between 2015 and 2025. The predicted trend is job growth presented in the Crane report is consistent with other sources that also forecast increases in employment within the Town. According to downscaled economic data by EMSI provided by the Cape & Islands Workforce Board, the Town of Barnstable hosted 33,488 jobs in 2018. Jobs grew by 1,602 over the last five years and were projected by that source to grow by 1,073 over the next 5 years (.63% average annual growth rate).[3] The Town of Barnstable's designated role as a regional commercial center, the existing availability of infrastructure to support higher density development, and a trend toward encouraging future residential and commercial growth all support projections that residential and commercial infrastructure demands on infrastructure could increase.

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[2] Cape Cod 2020 Regional Transportation Plan, Cape Cod Metropolitan Planning Organization/Cape Cod Commission

[3] Emsi Q1 2019 Data Set for 10 Massachusetts Zip Codes within the Town of Barnstable

Table 2-9: Town of Barnstable Building Permits

	2014	2015	2016	2017	2018
RESIDENTIAL					
New Dwellings	83	94	58	60	43
Additions/Alterations	1421	1562	1796	1609	1587
Demolitions	49	48	47	71	63
Rebuilds	26	28	24	29	25
COMMERCIAL					
New Buildings	17	5	17	16	19
Remodel	288	304	217	459	570

Building permit numbers continue to show strong patterns of redevelopment and reinvestment in both the single-family and commercial sectors, which reflect the limited supply of remaining vacant developable land available. The rate of issuance of building permits for single-family residential dwellings shows a trend towards decline of new construction over the past five years. The single-family construction numbers continue to stand in contrast to high rates of new growth in preceding decades; by comparison, the Town averaged 235 new single-family residential units per year in the late nineties. The above permit numbers, however, do not fully reflect the significant recent increases in multi-family units in Hyannis and Barnstable. Within the above time-frame, a total of 390 multi-family units in five projects were completely constructed; an estimated 100 additional units have completed the development review process and are anticipated to become available within the next one to two years. In the commercial sector, Barnstable has experienced significant investment in the form of redevelopment in the regional commercial center, including projects such as the Cape Cod Five headquarters and reinvestment in the large retail centers. A number of high profile projects, including redevelopment of Cape Town Plaza and Cape Cod Healthcare's planned six-story addition, are indicative of continued strong commercial investment.

These analyses and observations are largely consistent with the demand analysis presented in the *New Sources Alternatives Evaluation Report*, prepared for the Town by Weston & Sampson in March 2019. This report anticipated increases in Hyannis Water System projected average daily demand through 2023 based on economic and other factors.

When considering impacts on growth, population projections are an important determinant, but rates of household formation are also significant. Demographic data indicates that current and future population is concentrated in the upper age cohorts, a group which has already formed independent households and is not predicted to drive new household formation in the future. Overarching trends, both regionally and nationally, are towards declining household size (or fewer people per household), primarily driven by increases in single-person households and single-parent families. This trend, combined with an expected demand for smaller units by persons in upper age cohorts, could potentially drive demand for smaller housing units.[4]

Table 2-10: Town of Barnstable Households, 1990-2015

	1990	**1995**	**2000**	**2005**	**2010**	**2015**
Households	16,593	17,984	19,647	19,729	19,225	19,503

Finally, the impacts of Cape Cod's identity as a seasonal housing market and tourist destination must be considered. The Town's housing stock has always included a share of seasonal units. This share, however, was shown to have increased significantly during the Great Recession, which resulted in low real estate values on the Cape and opportunities for acquisition by people in strong regional markets (New York and Boston). The result Cape-wide was a decline in year-round housing units between 2010 and 2015. Because of aging demographics and the Cape's continued attractiveness as a retirement destination, the demand for seasonal housing units is expected to remain strong. Seasonal housing units are expected to increase at more than twice the rate of year-round units through 2025.[5]

2.2.6.1.3 Summary

In summary, a review of recent studies indicates that Barnstable can expect modest year-round population growth (±215 residents/year) over the next ten years as a result strong economic prospects. Additionally, the attractiveness of Barnstable as a seasonal retirement community is expected to continue. These population forecasts should be paired with observed trends towards decreasing household size, diminishing single-family residential permit activity, and increases in multi-family housing production. Should these population and market demand trends continue, the Town can expect to see modest population growth, coupled with increased demand for smaller-scale housing units, and continued strong demand for seasonal housing.

2.2.6.2 BUILDOUT

Buildout studies first done for wastewater and comprehensive land use planning conducted in the late 2000's and then updated for MEP reports and the 2017 Water Resources Advisory Committee were used as a basis for this analysis. The prior buildout methodologies were reviewed and updated to reflect new development, regulatory changes, and current conditions.

[4] Cape Cod Commission's Regional Housing Market Analysis and 10-year Forecast of Housing Supply and Demand by Crane Associates, Inc, June 30, 2017

[5] Seasonal housing units are expected to increase at more than twice the rate of year-round units through 2025.

Projections were made on a parcel by parcel basis to estimate potential development that may occur at a future time of buildout. The number of residential dwelling units and non-residential building square footage were estimated for future buildout conditions.

This methodology produces a picture of the Town's "ultimate" buildout condition, with each parcel being subdivided or developed based on current zoning, or, for non-residential properties, floor-area ratio assumptions derived from current zoning. Consequently, it is important to note this buildout analysis reflects existing zoning and that future potential zoning changes would alter buildout figures. In a limited number of instances, additional buildout potential was assigned to a parcel based on the strong prospects of development potential notwithstanding current zoning.

Table 2-11: Residential Dwelling Units by Watershed

Watershed	Existing Residential Dwelling Units	Total Residential Dwelling Units at "Ultimate" Buildout	Additional Dwelling Units at "Ultimate" Buildout	Additional Flow at "Ultimate" Buildout (gpd)[1]
Centerville River	7,789	8,192	403	65,290
Three Bays	5,328	6,163	835	176,600
Rushy Marsh Pond	8	10	2	500
Popponesset Bay	858	978	120	21,280
Halls Creek	2,531	2,724	193	27,790
Lewis Bay (not including Halls Creek)	5,488	8,067	2,579	371,380
Scorton Creek	6	8	2	420
Barnstable Harbor	3,718	5,545	1,827	332,150
Uncategorized (outside all watersheds)	966	1,121	155	32,640
TOTALS:	**26,692**	**32,808**	**6,116**	**1,028,050**

1. Flows are based upon 90% of the Average Water Consumption per Dwelling Unit in each watershed as provided in Table 5-11 of the 2011 Needs Assessment Report (See Appendix R)

Table 2-12: Commercial Building Square Footage by Watershed

Watershed	Existing Commercial Building Square Footage	Total Commercial Building Square Footage at "Ultimate" Buildout	Additional Commercial Building Square Footage at "Ultimate" Buildout	Additional Flow at "Ultimate" Buildout (gpd)[1]
Centerville River	1,559,488	2,291,927	732,439	38,090
Three Bays	1,164,866	2,490,861	1,325,995	79,560
Rushy Marsh Pond	0	0	0	0
Popponesset Bay	62,764	175,648	112,884	10,720
Halls Creek	428,089	775,851	347,762	27,470
Lewis Bay (not including Halls Creek)	9,066,887	27,376,398	18,309,511	1,446,450
Scorton Harbor	0	0	0	0
Barnstable Harbor	2,239,471	6,293,017	4,053,546	283,750
Uncategorized (outside all watersheds)	148,960	524,014	375,054	52,880
TOTALS:	**14,670,525**	**39,927,715**	**25,257,190**	**1,938,920**

1. Flows are based upon 90% of the Average Water Consumption per 1,000 SF of Non-Residential Use in each watershed as provided in Table 5-12 of the 2011 Needs Assessment Report (See Appendix R)

2.2.6.2.1 Future Wastewater Generation

This plan provides an action strategy to meet established water quality goals in each of Barnstable's watersheds and sub-watersheds. To do this, this plan must mitigate the impacts of existing development, as well as fully address loads from new development.

Areas where the greatest potential for near-term growth exists, based on both population/market demand analysis and buildout projections (under current regulations), include the Route 132 commercial center, the Hyannis/Barnstable industrial areas, and the Downtown Hyannis Growth Incentive Zone, all within the Lewis Bay Watershed. These areas are, for the most part, currently served by municipal wastewater infrastructure and potential increases in wastewater flows have been anticipated, planned for, and allocated. This is a result of long-standing "smart growth" land use policies in Barnstable that have coordinated regulatory efforts with capital planning to concentrate development potential in areas that have both the wastewater and transportation infrastructure to support it. And because growth potential both relies on local zoning, regional land use regulation, as well as the availability of multiple types of infrastructure, these development patterns are largely anticipated to continue.

New single-family home construction, typically reliant on Title 5 systems, which historically consumed large expanses of land and dominate Barnstable's built environment today, are anticipated to continue only at the current modest rates. An average of 68 new single-family dwellings have been constructed annually over the past five years. The greatest potential for new single-family home construction lies within the Cape Cod Bay watershed, specifically Barnstable Village, where zoning allows one-acre minimum lot sizes.

Areas where significant potential for sewer-induced growth, and resulting additional wastewater demand exist, are called out in the Economic Development section above. These are areas where zoning permits more intensive development, but additional buildout is constrained by Title 5. Such areas include the Yarmouth Road triangle, a number of large parcels along Route 132, and non-residentially zoned parcels on the Route 28 corridor. For the most part, locations that present the potential for sewer-induced growth are contiguous to existing developed areas in the Lewis Bay and Centerville River Watersheds, represent redevelopment opportunities, and are anticipated as part of Barnstable's desired economic expansion.

The majority of the areas with significant growth potential, either those currently served by wastewater or those with the potential for increased growth resulting from being served, are previously developed, as opposed to "greenfield" development opportunities. This development pattern is beneficial from a nutrient management perspective, as future projected development is not anticipated to consume significant acreages land in a natural state, which provides natural (atmospheric) nitrogen attenuation benefits.

The buildout figures presented here are based on increases in number of dwelling units and commercial square footage. They do not represent the cumulative potential for increases in wastewater flows that could result from increases in the size of existing dwelling units no longer constrained by bedroom restrictions under Title 5 and local Board of Health regulations.

2.3 PROJECTS ALREADY UNDERWAY OR COMPLETED SINCE THE 2011 NEEDS ASSESSMENT

Since the writing of the 2011 Needs Assessment, the Town has engaged in a number of wastewater related projects that will/can affect the nutrient loads in its embayments. These range from actual infrastructure projects such as the Stewarts Creek Sewer Expansion, to evaluations of existing infrastructure to ensure capacity, to agreements regarding wastewater management with adjoining communities, to new and alternative approaches to nutrient management issues that are being pursued. This section is intended to update the reader on the most significant of those activities.

2.3.1 COOPERATIVE/INTER-MUNICIPAL INITIATIVES

This section provides an overview of the cooperative and inter-municipal initiatives to date.

2.3.1.1 POPPONESSET BAY THREE TOWN IMA

The Popponesset Bay Watershed is located in the Towns of Barnstable, Mashpee and Sandwich. As a result, all three Towns share some responsibility for addressing the watershed's Total Nitrogen (TN) TMDL. To that end, from June 2016 until April 2017 the Towns met five times to develop an Inter-municipal Agreement (IMA), and begin discussions on a potential application for a Watershed Permit. The IMA was signed by all parties by the end of 2017. A full copy of the IMA can be found in Appendix II. Key components of the IMA included:

- The Towns agreed that it was in their best interests to apply jointly for a Watershed Permit.
- That each Town would develop and implement its own MassDEP approved CWMP or Targeted Watershed Management Plan, and the capital projects undertaken by the Town as a result of those plans will be the sole responsibility of that Town.
- The Town of Mashpee would serve as the fiscal agent under the IMA and, as such, will receive, hold, and expend any funds appropriated by the Parties for joint actions required in the implementation of the IMA, as well as any grant funds awarded to the Parties for the purpose of pursuing, securing, and implementing a Permit.
- The towns would establish a Popponesset Bay Watershed Work Group, which would be comprised of three members from each Town (Town Manager, Selectman/Town Councilor, and a technical representative), and which will:
  - Administer this IMA and any amendments to it;
  - Administer the application and implementation of a Watershed Permit; but
  - The Work Group has no authority to bind one or more of the Parties.
- The towns established a nitrogen allocation formula for the purpose of assigning costs (see Table within this bullet). They further agreed that the costs should be allocated on the basis of un-attenuated and attenuated nitrogen loadings.

    - The un-attenuated loads for tracking and accounting of nitrogen reductions which result from implemented measures.
    - The attenuated loads to provide a benchmark for comparison of improvements to water quality based on implemented measures. Attenuated load is what is 'received in the estuary'. See Table 2-13.
- The towns agreed to develop a fair and practical methodology for nitrogen trading mechanism.
- The towns agreed to work together to adopt a fair and practical methodology for monitoring the water quality of the watershed, and funding said effort.

Table 2-13: Nitrogen Load Sharing by Town – Popponesset Bay Watershed IMA

	Unattenuated	Attenuated
Barnstable	12.6%	16.0%
Mashpee	65.4%	74.5%
Sandwich	22.0%	9.5%
Total	100%	100%

2.3.1.2 YARMOUTH/BARNSTABLE FEASIBILITY STUDY

The towns of Barnstable and Yarmouth share the impaired Lewis Bay Watershed. In 2018, Yarmouth was awarded an Efficiency and Regionalization Grant from the State's Community Compact Program, a portion of which was used to fund an analysis of the potential to share wastewater treatment and effluent recharge between the two towns. As noted within this CWMP, Barnstable has an existing treatment facility, but may need to find additional disposal capacity. Yarmouth has additional disposal capacity at its Buck Island Road site, but does not have treatment facilities. The initial result of this effort is summarized in a memo which included in Appendix JJ. What was found was that sharing wastewater treatment and effluent recharge between communities is feasible, but the details regarding cost apportionment between the communities for the effort still needs to be negotiated and will ultimately dictate whether the effort moves forward.

In anticipation of this effort the Town has appropriated 1.3 million dollars to install piping under the railroad tracks and along the length of Route 28 during the MassDOT project.

2.3.1.3 JOINT BASE CAPE COD

Joint Base Cape Cod (JBCC) has a wastewater treatment and disposal system on its property that may be suited to serve as a potential regional wastewater system. The system provides service for on-base facilities, and was designed for 70,000 users, though currently only serves approximately 3,500 users. It is owned by the United States Air Force (USAF) and operated and maintained by the Massachusetts Air National Guard 102nd Intelligence Wing (ANG). The treatment plant (here after referred to as the WWTF) is an extended aeration activated sludge facility (biological nitrogen removal) that was constructed in 1995. The WWTF has a design capacity of 360,000 gpd (annual average) and a maximum day flow of 840,000 gpd. Treated effluent from the facility is piped via a 12-inch diameter ductile iron force main approximately 10.5 miles from the WWTF, through the Reserve, to a set of four Rapid Infiltration Basins (RIBs) that are located at the northwest edge of the JBCC near the Cape Cod Canal. The effluent force main has a design capacity of 1,400,000 gpd (peak hour) and could potentially be increased to 1,750,000 gpd on a peak hour basis with some modifications. The RIBs have a total surface area of 259,160 square feet, and are permitted for disposal of up to 360,000 gpd of effluent on a 12-month rolling average basis and up to a maximum of 840,000 gpd on any given day.

One of the concerns of using the JBCC system as a regional wastewater system is the condition of both the existing water and wastewater infrastructure. The Air Force has been clear that whatever entity takes over the wastewater system, will also have to take over the water system. These systems are extensive, and have not been maintained or had capital investments made to them to the same level as expected by municipalities. The wastewater collection system and water system are described below.

Wastewater Collection System

- Approximately 36 miles of sewer piping (161,000 LF) and 595 sewer manholes (SMHs).
    - 15% AC Pipe constructed in the 1960s (within 15 years of being at the end of design life)
    - 80% VC Pipe constructed in the 1940s and 1950s (at the end of design life)
    - 5% PVC Pipe constructed in the 1990s
- 11 pump stations

Water System

- Two primary water supplies:
    - The interconnection with the Upper Cape Regional Water Supply Cooperative (UCRWSC).
    - The J-Well located on the JBCC, which is much more costly to treat and pump to the distribution system than wholesale purchase of bulk water from the UCRWSC
- Two, 400,000-gallon elevated water storage tanks.
    - The tanks were constructed in 1942, dating back to the origin of the water system. Both tanks were refurbished in the early 1990s
    - Both tanks are approaching 75 years old and both are constructed using an older, high maintenance technology for water storage.
- Serves approximately 380 customers
- Does not use water meters to determine billing, rather water bills are generated based on a usage algorithm.

- Contains approximately 270 fire hydrants, many date back the original distribution system or were added with the expansion in the 1950's.
- The total length of water mains in the JBCC water distribution system is approximately 259,000 feet or 49 miles.
  - 144,000 LF of unlined cast iron water main ranging in size from 2-inch to 12-inch in diameter was installed in 1940 and 1941
  - 112,000 LF of cement lined cast iron pipe installed between 1955 and 1960
  - 32,900 feet of asbestos cement (transite) mains, also installed between 1955 and 1960, that are reported to be brittle and increasingly a problem.
  - 13,275 LF of copper pipe installed in the 1950s
  - 3,020 LF of ductile iron pipe installed in the 1980s

The costs of bringing these systems up to modern standards and operating them are significant.

Massachusetts Development, and/or the four surrounding towns (Bourne, Falmouth, Mashpee, and Sandwich) have been investigating the possibility of making the WWTF a regional facility in one form or another for over a decade. During the winter of 2018/2019 Barnstable was approached by members of the afore mentioned team and invited to join the four towns in their pursuit of the JBCC. Massachusetts Development was no longer a primary player, and the other towns felt Barnstable participation would be beneficial. Barnstable agreed to join, and immediately contracted with a consultant to help come up to speed on the issues, opportunities, and challenges associated with a facility, and to "catch-up" with the other towns. The results of the consultant's efforts can be found in Appendices KK to NN.

2.3.2 NON-TRADITIONAL PROJECTS

This section provides an overview of non-traditional projects that the Town (and its various partners) are pursuing or have perused since the 2011 Needs Assessment Report. The Town's main effort relative to non-traditional projects is focused on the Three Bays Watershed, specifically the Marstons Mills River. A team of experts from science and government fields were formed to look at opportunities for nontraditional, in situ, approaches to nutrient reduction in the Marstons Mills River. The team was comprised of the following members: James Crocker, Town Councilor, Precinct 5; Dr. Brian Howes, Chancellor Professor, School of Marine Science and Technology, UMass Dartmouth; Zenas Crocker, Executive Director, Barnstable Clean Water Coalition; Scott Horsley, Water Resources Consultant; Dan Santos, Director, Barnstable DPW; Rob Steen, Assistant Director, Barnstable DPW. The Team initially was focused on Mill Pond, and specifically the dredging of Mill Pond, which had been suggested as a nitrogen reduction effort in previous planning. However, it became apparent that a better approach would be to look at the Marstons Mills River, from its origins in cranberry bogs at its upper end to where it exists into North Bay, as a complete treatment system. To organize this approach, the nutrient removal from the river system was categorized into four efforts:

1. Utilization of the cranberry bogs at the upper end of the river
2. Mill Pond dredging
3. Innovative nutrient removing septic systems, and farming practices along its reaches
4. Warren's Cove dredging and aquaculture

It became apparent that items 1 and 3 were best pursued by the Barnstable Clean Water Coalition (BCWC) a 501 (c) (3) non-profit organization, while items 2 and 4 by the Town of Barnstable. In doing so the basis of a strong public-private partnership was formed between the Town and BCWC.

2.3.2.1 UPPER-END CRANBERRY BOGS

The headwaters of the Marstons Mills River contain approximately 150 acres of cranberry bogs. The BCWC has been collecting water quality data at the bogs, and found that more than 8,000kg of nitrogen flows out from them into the Marstons Mills River each year, or about 40% of the watershed's excess nitrogen load. Most of this nitrogen originates from septic systems that discharge to groundwater that then flows into the bogs as they are a collection area for the groundwater from much of the surrounding residential developments. The bogs contain wetlands and on old maps, the entire site was marked "ponds and wetlands". Interestingly, the farmers have stated that while they used to apply fertilizer, little is now needed since the crops do well without additional nitrogen. As a result, BCWC and the Town believe that the bogs could play a vital role in reducing the nitrogen load in our watershed. As of the writing of this report, BCWC is working closely with the farmers to examine a series of pilot programs that would allow for significant nitrogen attenuation to occur without negatively impacting their farming of the bogs.

2.3.2.2 MILL POND DREDGING

Mill Pond is a manmade pond at the mid-point of the river system, at the intersection of Routes 149 and 28. The pond has been progressively filling with silt and debris since its creation, to the point that it is less than 1-foot deep in many locations. Recent work by Dr. Brian L. Howes, Dr. David Schlezinger, and Dr. Roland Samimy of the University of Massachusetts – Dartmouth, School of Marine Science and Technology, documented in a technical memorandum dated October 25, 2017 titled *Fresh Pond Restoration and Management, Benthic Nutrient Flux of Mill Pond, Town of Barnstable, Quantifying the Rates of Nutrient Release/Uptake from Sediments in Mill Pond and Comparison to Historic Rates;* see Appendix OO concluded the following:

1. Sediment has been gradually filling Mill Pond over the past four centuries. This has resulted in very short hydraulic residence time (~1 day) in the pond, which likely results in a reduction in the retention of nitrogen by the pond, thus passing most of it down the Marstons Mills River to the Three Bays System.

2. Removal of watershed derived total nitrogen by Mill Pond appears to be approximately 25% annually, but only 7%-11% in the June – August period.
3. Nitrate entering Mill Pond is either removed (likely through denitrification - about 25% of the total nitrogen removed by Mill Pond in summer, a much lower fraction than other Cape Cod fresh ponds) or transformed to organic nitrogen forms (25% - 35%), although most is discharged to the downgradient estuary. The high level of nitrate discharged from Mill Pond (0.5 mg/L even in summer) indicates there is strong potential for additional nitrogen removal within this basin.
4. Enhancement of denitrification within Mill Pond should be possible in light of higher denitrification rates measured in other Cape Cod Ponds, the high nitrate remaining after passage through the pond and the low residence time."

The Group hypothesized that assuming that the nitrogen attenuation capacity of Mill Pond could be restored to 50% removal, then approximately 2,200 kg/year of additional nitrogen could be removed from the downstream system, or about 10% of the total nitrogen that needs to be removed from the Three Bays system. Additionally, the group identified other ecological benefits to restoring the pond to its original form. As an example, the sediments that had accumulated over the years in the pond are suspected to be acting as a source for nitrogen within the system. The pond is in a herring run, and it is believed that restoring the pond would be beneficial to the herring's passage. Finally, anecdotally it has been noted that the sediments within the pond pose a significant safety concern. Though they appear solid enough to wade on, they are reportedly too fluid to support human weight and would almost act as "quick sand". Given how shallow this pond has become, and the temptation to wade in it, this is a dangerous situation for the public at large.

2.3.2.3 SEPTIC SYSTEMS AND FARMING ALONG THE RIVERS REACHES

While in situ treatment of nitrogen is an important technique to achieving the Town goals, source reduction of nitrogen, whether it be residential or commercial wastewater treatment, is still the primary focus. There are new, and emerging septic system technologies that are being tested and which seem to be more effectively removing nitrogen. The Massachusetts Alternative Septic System Test Center (MASSTC) is a leading test site for innovative septic systems in the U.S. and is located on Cape Cod. MASSTC is currently testing individual alternative systems that perform as well as many municipal systems. BCWC is working closely with MASSTC, Mass Department of Environmental Protection (DEP), U.S. EPA and the Town to create a pilot program where they can monitor and track I/A systems in a real-world environment in the Town's watersheds. In addition, they are working with The Nature Conservancy to develop a financing plan to create a roadmap for widespread replacement of Title 5 septic systems with these alternative technologies.

BCWC's water quality monitoring has also discovered several "hot spots" along the river. The most troubling is a horse farm with 8-10 horses. It is believed that a horse's liquid waste produces as much nitrogen as 20 to 40 people. During a heavy rain event, the monitoring just downstream from this farm revealed a nitrogen level six times the normal level recorded at this site, while the river flow was only three times higher than normal. Essentially, this one location may be contributing approximately one month's amount of nitrogen within hours. BCWC has been working with scientists and engineers from the U.S. EPA, UMass, and Horsley Witten Group to develop and install a simple, easily constructed, wood chip-based bioreactor (effectively a PRB) that is designed to significantly reduce the nitrogen flow from storm water on these types of farms.

2.3.2.4 WARREN'S COVE DREDGING

Warren's Cove is located at the exit of the river system as it empties into Prince Cove. Over time the cove has silted in due to poor tidal flushing and macro algae blooms. This has resulted in the cove becoming a "dead zone" full of silt and decaying matter. It was hypothesized that if the cove was dredged back to its sandy bottom, it would eliminate the nitrogen being contributed from the decaying silt and matter in its benthic layers, and could create an environment that could serve as a nursery for the local aquaculture farms, which would help further remove algae and nitrogen from the waterbody.

2.3.2.5 SAMPSON'S ISLAND DREDGING

Sampson's Island is a barrier beach on the south side of the Three Bays embayment. To the west of Sampson's Island, between the mainland of Cotuit, is a navigational channel which connects Cotuit Bay to Nantucket Sound. The eastern end of the island (known as Dead Neck) experiences significant erosion due to net littoral drift moving from east-to-west along this stretch of shoreline, which has resulted in an 800-foot sand spit forming on the western end of Sampson's Island. This spit has reduced the channel width which has reduced tidal flushing within Cotuit Bay. The Sampson's Island Dredging project is a three-phase, three-year project which will widen the channel width by approximately 400 feet in an effort to improve flushing in Cotuit Bay and improve navigation. The dredged material will be beneficially reused on-site for beach nourishment and bird habitat enhancement. The project is scheduled to be completed in the winter of 2020.

2.3.3 TRADITIONAL APPROACH

This section provides an overview of traditional (sewer collection, treatment and disposal) projects that the Town has completed or has underway.

2.3.3.1 STEWARTS CREEK SEWER EXPANSION

The Stewarts Creek Sewer Expansion was located in the southeast section of the Town of Barnstable in the Village of Hyannis. The sewer area is divided in two sections, east and west, by Stewarts Creek. The area was listed in the "Wastewater Facilities Plan Phase 1, Needs Assessment Report" dated December 1993, as an "Area of Concern". The area is plagued by high groundwater conditions, with wastewater discharged at groundwater level, near resource areas, with poor soils and small lots. The sewer extension was completed in 2012. Significant points of the project are:

- The Project also included updated stormwater structures and road improvements as needed.
- The sewer design included system resilience by removing a vulnerable sewer line crossing at the mouth of Stewarts Creek which opens to Hyannis Harbor/Nantucket Sound.
- Gravity and low pressure systems were combined to decrease the area of disturbance and cost.
- Policy: "Deadlines for Connections to Public Sewer Stewart's Creek Area Project" was adopted on February 12, 2013 by Barnstable Board of Health.
- First connection to the sewer was in October 2012.
- Total dwelling units to be connected is listed as 288, with one unit taken for taxes by the Town. Total number of parcels is 241 and the breakdown of unit types shown on Table C.i

Table 2-14: Stewarts Creek Sewer Extension

Unit Type	Parcels Total	Dwelling Units
Single Fam MDL-01*	178	178
Two Family	34	68
Multi Houses/Rooming MDL-01	3	3
Municipal MDL-00	6	NA
Undevable MDL-00	7	NA
Vac Land MDL-00	3	3
Pot. Dev Ld	1	1
Condo MDL-05	3	29
bed & Brkf	1	1
Accessory	1	1
Auto Repairs*	2	2
Charity Org MDL-01	1	1
Housing Auth MDL-01	1	1
Total	241	288

2.3.3.2 ROUTE 28 EAST SEWER EXPANSION PROJECT

The Route 28 East Sewer Expansion Project will install sewer infrastructure, including gravity sewer within Route 28 from Strawberry Hill Road to Phinney's Lane, a large pump station located at the intersection of Route 28 and Phinneys Lane, and sewer force mains which will convey flow from the proposed pump station to the BWPCF. The proposed pump station is anticipated to be utilized as a "booster" pump station for the sewer expansion into the Three Bays Watershed and the westerly portions of the Centerville River Watershed. As of the writing of this document, Town Council has appropriated $800,000 for preliminary and final design for this project and $283,900 to purchase a property located at the intersection of Route 28 and Phinneys Lane which is anticipated to be used to site the required pump station.

2.3.3.3 ATTUCKS LANE SEWER EXPANSION PROJECT

The Attucks Lane Sewer Expansion Project will enable approximately 5,500 LF of sewer piping on portions of Attucks Lane, Iyannough Road (Route 132) and Old Strawberry Hill Road which will feed the new Attucks Lane Pump Station. This project will provide businesses and residences in the area a municipal solution to their wastewater needs. By doing so, the project will remove an estimated 500 kg/year of nitrogen from the Barnstable Harbor Watershed by removal of the existing septic systems. As of the writing of this document, Town Council has appropriated $100,000 for design and construction for this project.

Cape Cod Five Bank approached the Town about its desire to build a new state of the art headquarters at a 1500 Iyannough Road, which is a piece of property located between Attucks Lane and Iyannough Road (Route 132). Cape Cod Five offered to build a pump station on the site that would connect via a force main to the nearest point of the sewer collection system, approximately 250 feet east of the intersection of Phinneys Lane and Attucks Lane. As part of this work, Cape Cod Five installed necessary gravity sewer piping on-site for future tie-ins to the pump station. An agreement was reached between Cape Cod Five and the Town, where Cape Cod Five would construct the pump station and would gift it to the Town. The Town will then operate and maintain the pump station. Construction of the Attucks Lane Pump Station and associated gravity sewer and force main are scheduled to be completed in 2019.

2.3.3.4 PHINNEY'S LANE SEWER EXPANSION PROJECT

The Phinney's Lane Sewer Expansion Project will expand sewer to north of Route 28 along Phinney's Lane and the Wequaquet Lane area in Centerville to approximately Old Strawberry Hill Road. It will include gravity sewer and some low-pressure sewer. Residences in this area are completely dependent on on-site solutions to address their wastewater, which has had a negative effect on Lake Wequaquet, and to a lesser extent the Centerville River. As of the writing of this document, Town Council has appropriated $1,050,000 for preliminary and final design for this project.

Table 2-15: Phinney's Lane Sewer Expansion Project Summary

Number of Parcels Connected	WW Captured (gpd)	N Removed (kg/day)
653	94,200	9.4

2.3.3.5 LONG POND SEWER EXPANSION PROJECT

The Long Pond Project will expand sewer to south of Route 28 around Long Pond in Centerville. This will provide municipal wastewater collection to over 600 homes. It will include gravity sewer, low pressure sewer, one pump station on Main Street, Centerville, and one pump station at the south side of Long Pond. As of the writing of this document, Town Council has appropriated $1,340,000 for preliminary and final design for this project and $549,000 to purchase a property on Main Street, Centerville which may be used to site the required pump station.

Table 2-16: Long Pond Sewer Expansion Project Summary

Number of Parcels Connected	WW Captured (gpd)	N Removed (kg/day)
606	114,600	11.4

2.3.3.6 STRAWBERRY HILL ROAD SEWER EXPANSION PROJECT

Vineyard Wind reached an agreement with the Town to land submarine cables on the shore of Covell's Beach, and will use Town roads to lay the upland cables to the substation. While Vineyard Wind installs duct bank vaults up to the substation, the town will be installing approximately 19,000 LF gravity sewer from Route 132 to Covell's Beach, approximately 9,300 LF of sewer force main, and one new sewer pump station. This provides a backbone for the eventual sewering of ±1,640 parcels which will remove 25.5 kg/day of total nitrogen. The Town will be saving an estimated $3,000,000 due to Vineyard Wind completing the paving, surveying, designing, etc.

Table 2-17: Strawberry Hill Sewer Expansion Project Summary

Number of Parcels Connected	WW Captured (gpd)	N Removed (kg/day)
240	47,070	4.7

2.3.3.7 OLD YARMOUTH ROAD SEWER EXPANSION

The Old Yarmouth Road project is a conceptual plan and is currently not funded. The plan includes installing gravity sewer in the Old Yarmouth Road "triangle" area. Just south of Old Yarmouth Road is the location of the Hyannis Water District's Maher Wellfield. Sewering is needed to accommodate future economic development in the area and the protection of the Maher Wellfield from potential contaminants. MassDOT will be working on intersection improvements at Iyanough Road (Route 28) and Yarmouth Road which will consist of intersection reconstruction and traffic signal upgrades. During the improvements the Town will be installing sewer pipe within the project limits, taking advantage of the opened road. The Town is also working with property owners and developers in the area to establish a public/private partnership to install sewer infrastructure. As of the writing of this document, Town Council has appropriated $750,000 for the installation of the sewer infrastructure as part of the MassDOT Project.

Table 2-18: Old Yarmouth Road Sewer Expansion Project Summary

Number of Parcels Connected	WW Captured (gpd)	N Removed (kg/day)
130	22,600	2.2

2.3.3.8 ROUTE 28 CENTERVILLE (MARSTONS MILLS WWTF TRANSITION)

The proposed project would utilize an existing footprint of the Marstons Mills Wastewater Treatment Plant (MMWWTP) and convert it to a municipal wastewater pump station. This station would be designed to sewer the nearby properties and accommodate future sewering needs in the area. An intermediate pump station would also be included along Route 28 to convey the wastewater along Route 28 from this converted pump station to the aforementioned pump station at the intersection of Route 28 and Phinney's Lane which will convey flows to WPCF.

2.3.3.9 MERCHANT'S WAY SEWER EXPANSION

Kidd's Hill Sewer Expansion was developed after the receiving of a $3,753,000 MassWorks grant. The Grant funded sidewalks on Independence Drive and Kidds Hill Road, multiple intersection upgrades, drainage improvements and public utility extensions (sewer and water). The sewer improvements include installation of sewer on portions of Kidd's Hill Road, Merchant's Lane and Business Drive which would serve future developments (properties in this area are currently undeveloped). This project is anticipated to be completed in the Fall of 2019.

2.3.3.10 COTUIT SEWER EXPANSION EVALUATION

With the possibility of an interconnection with JBCC, there is discussion of installing sewer in Cotuit, and bringing it the JBCC plant. The JBCC would allow the Town to address nitrogen removal in the western part of the town, and could provide solutions to other sections of the Town as well. As of the writing of this document, Town Council has appropriated $250,000 for evaluation and preliminary design of sewer into Cotuit. The potential sewer extension into Cotuit has been shown as the three "stages" on the Town's phasing plan.

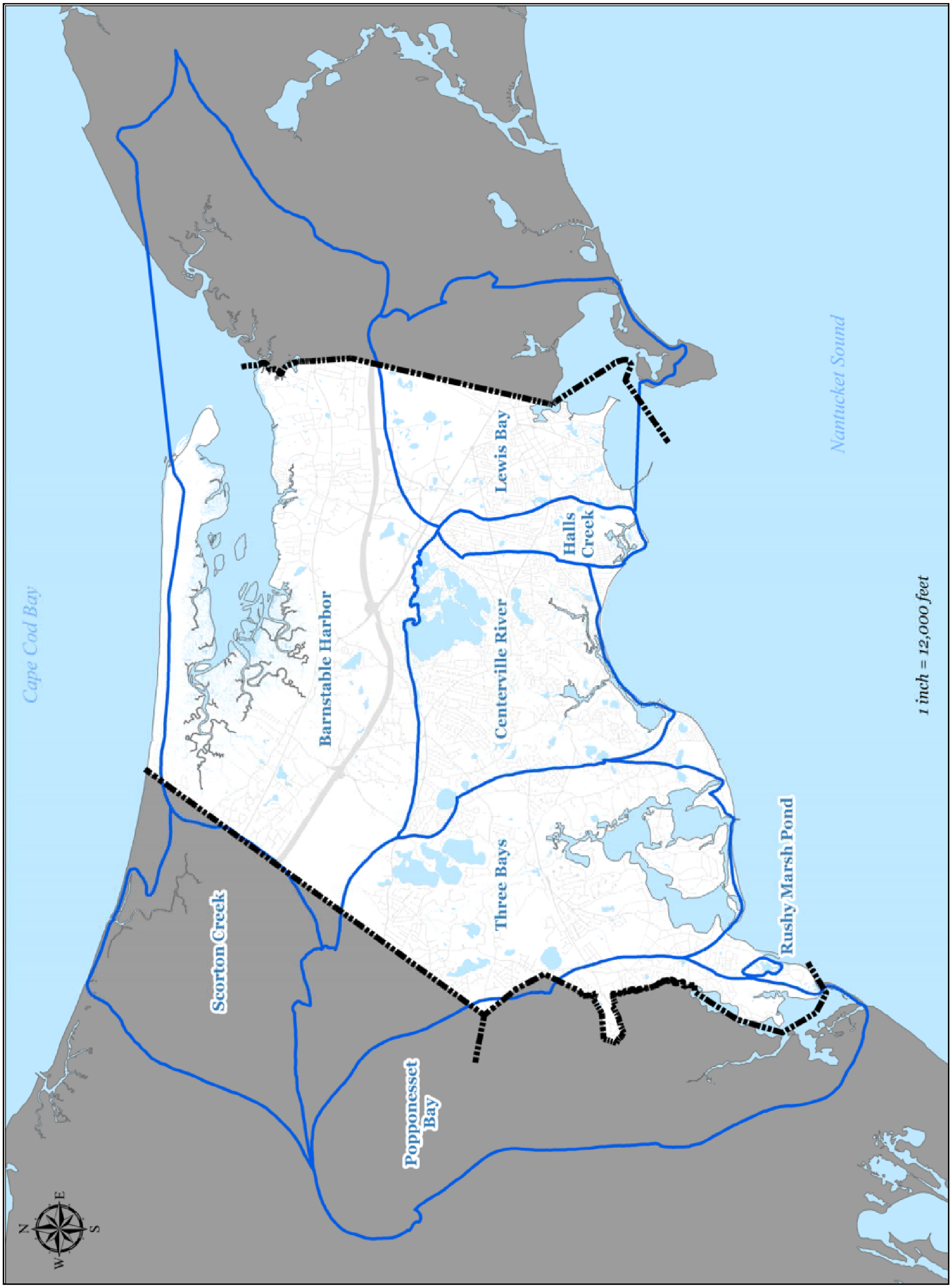

Figure 2-1: Watershed Boundaries

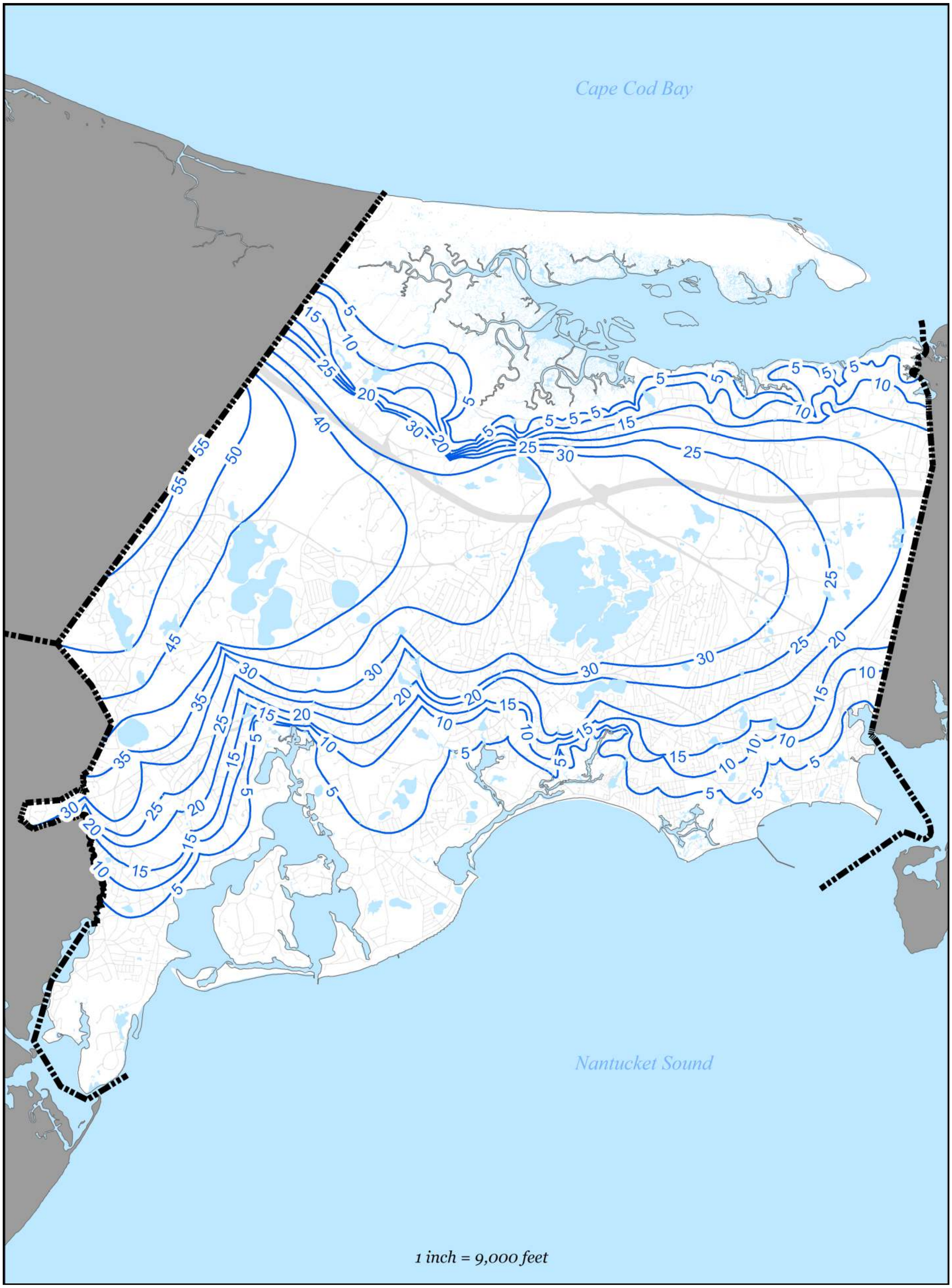

Figure 2-2: Groundwater Contours

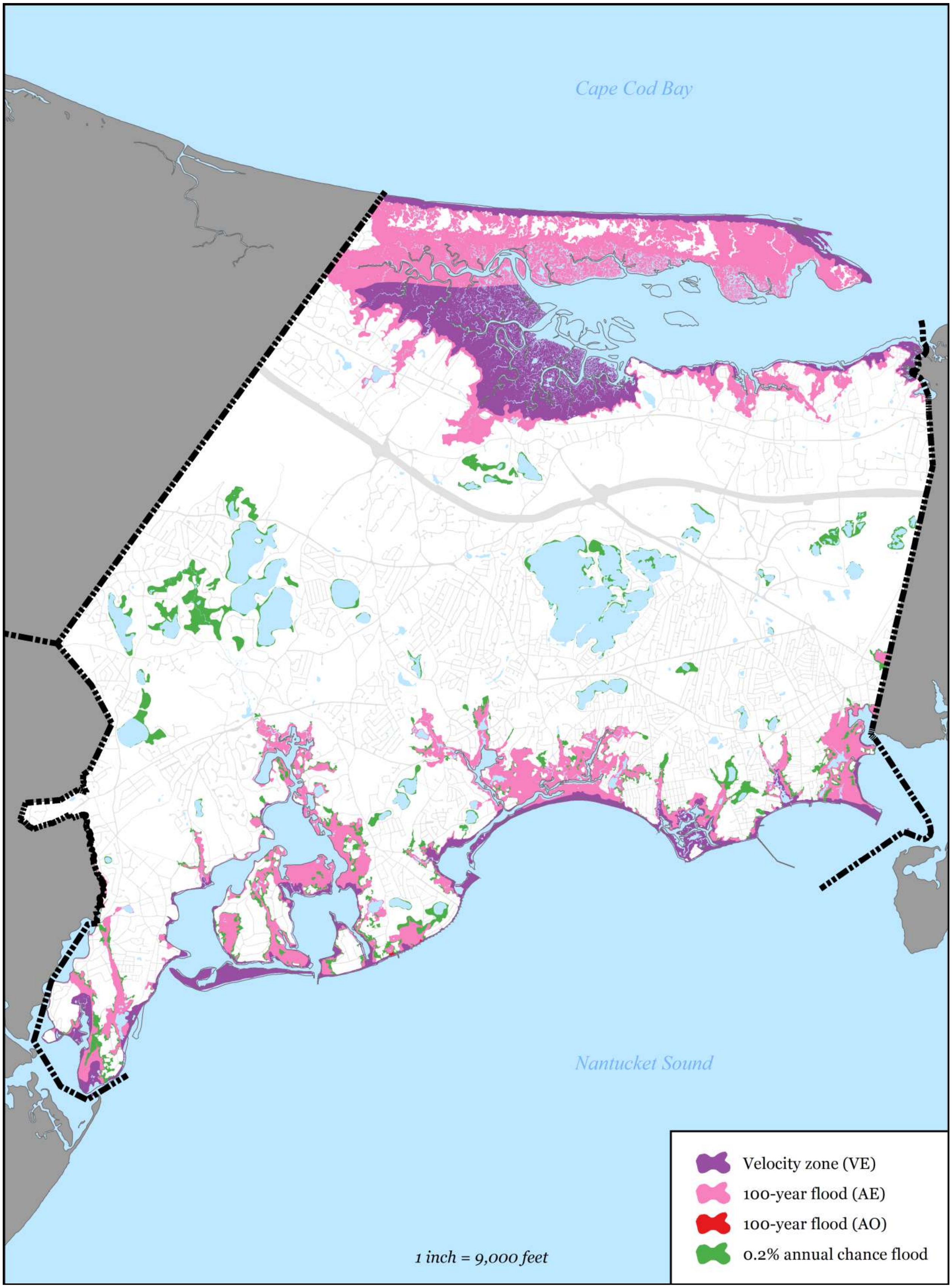

Figure 2-3: FEMA Flood Zones (2014)

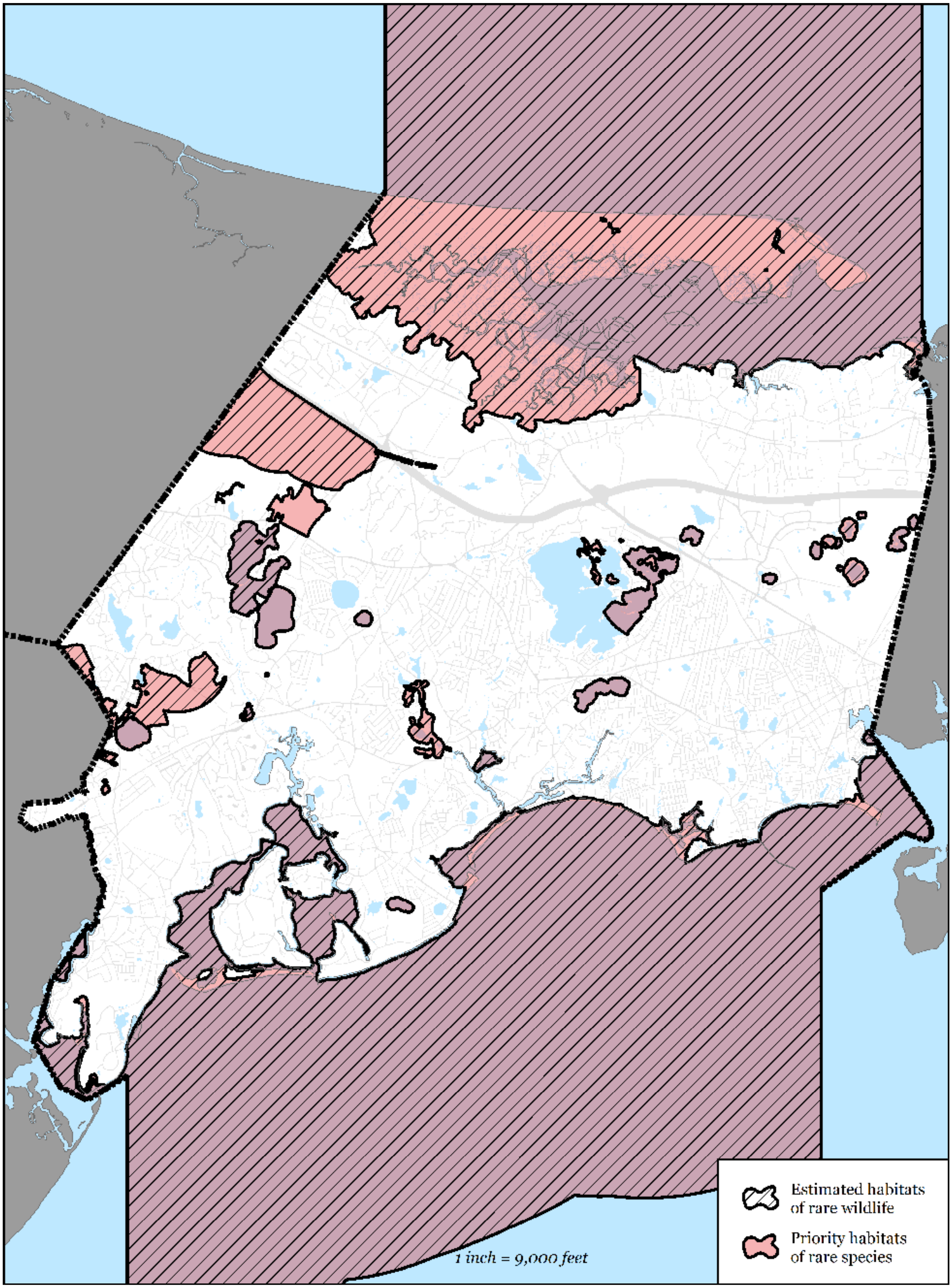

Figure 2-4: NHESP Priority Habitats and Estimated Habitats

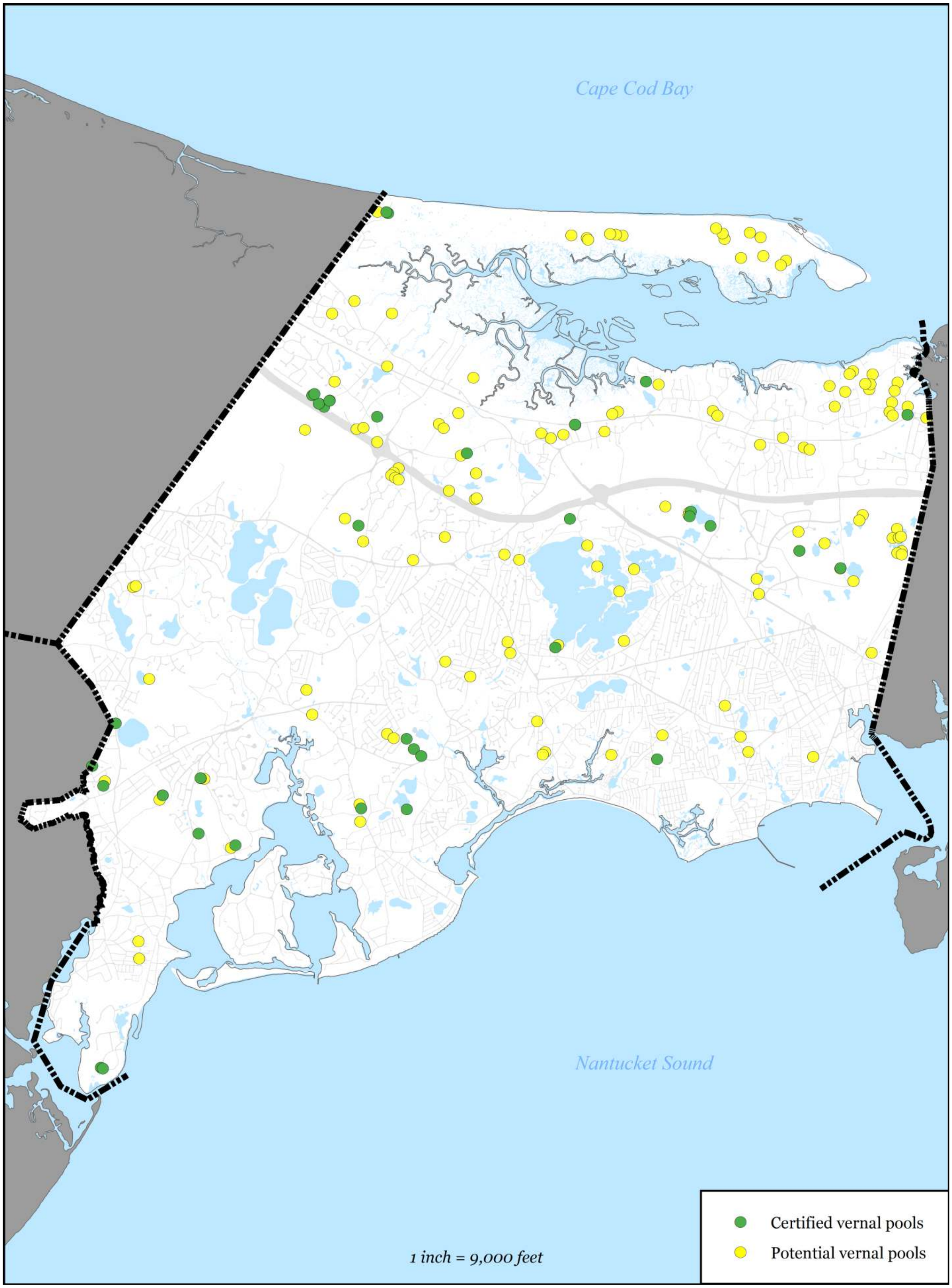

Figure 2-5: NHESP Certified Vernal Pools and Potential Vernal Pools

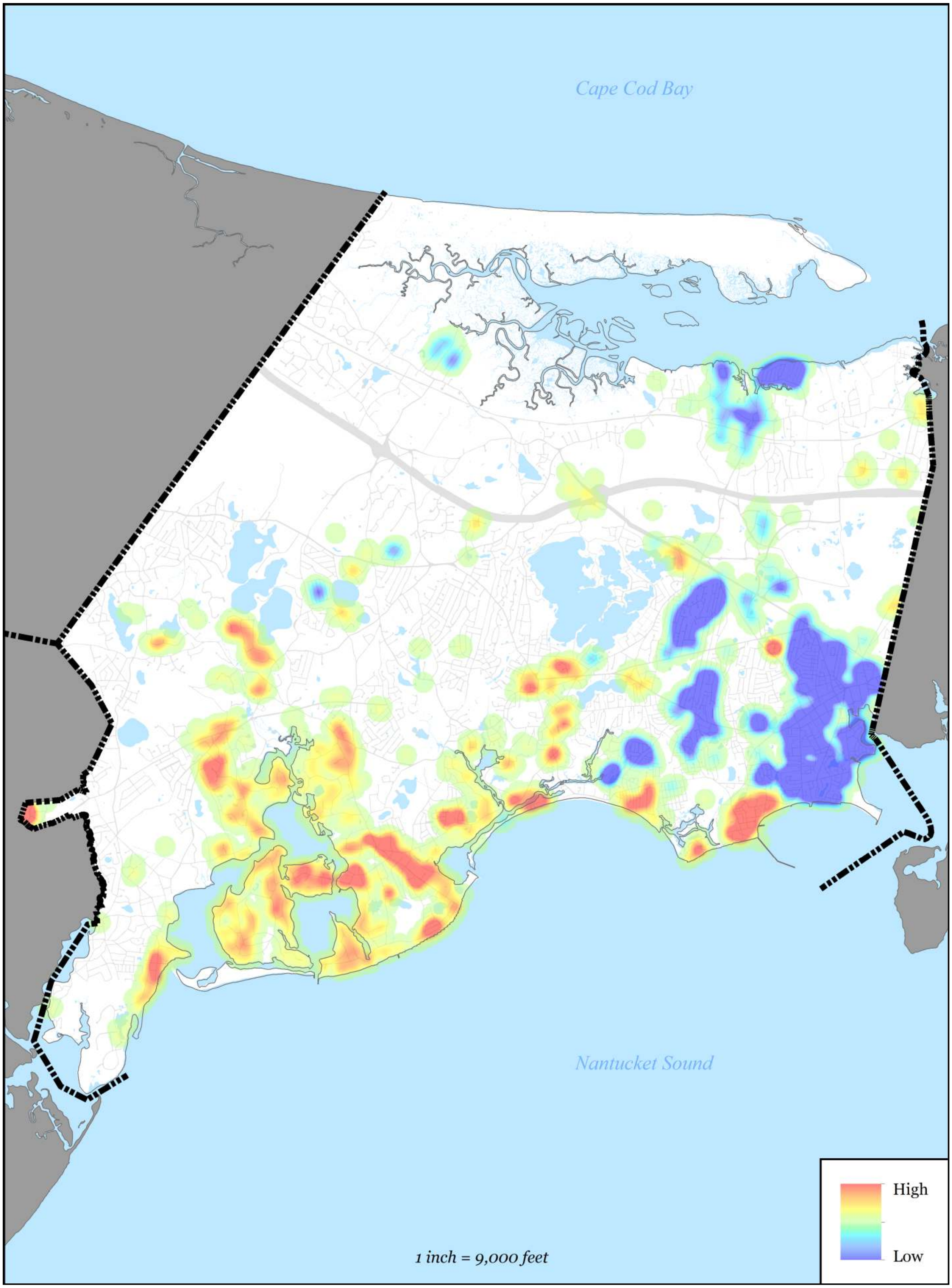

Figure 2-6: Nitrogen Loading Hotspots

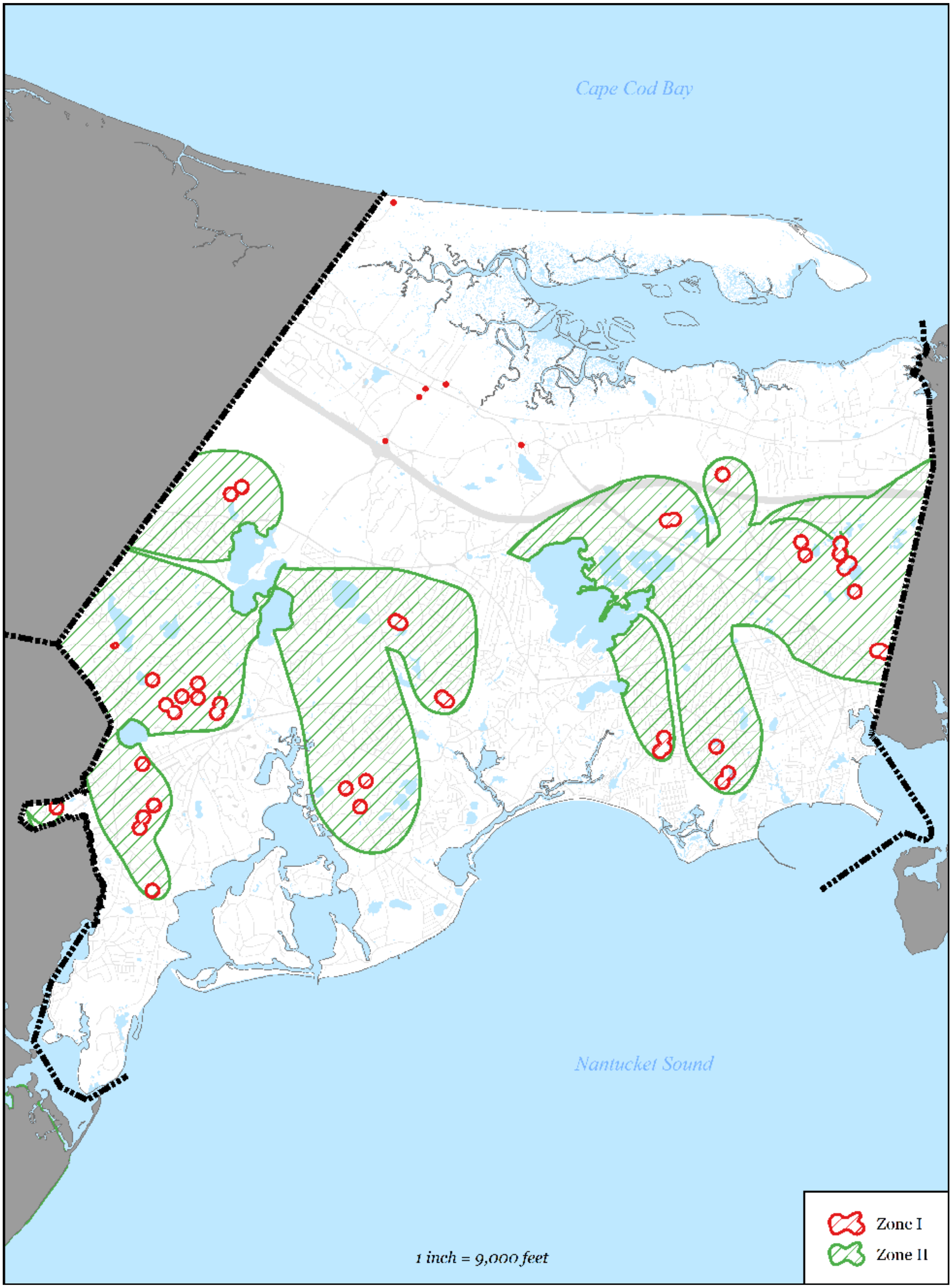

Figure 2-7: State-designated Wellhead Protection Areas

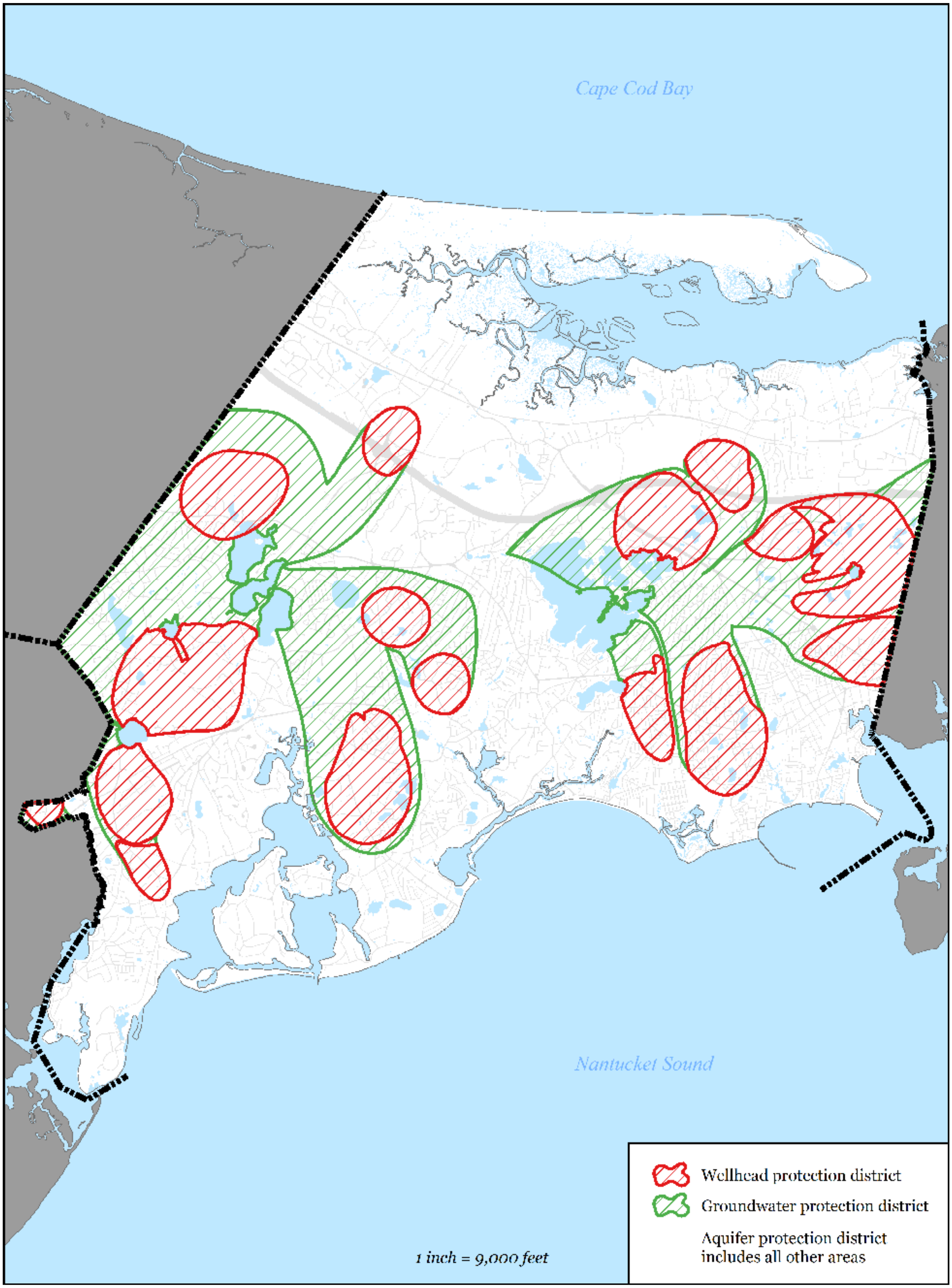

Figure 2-8: Town of Barnstable Groundwater Protection Overlay Districts

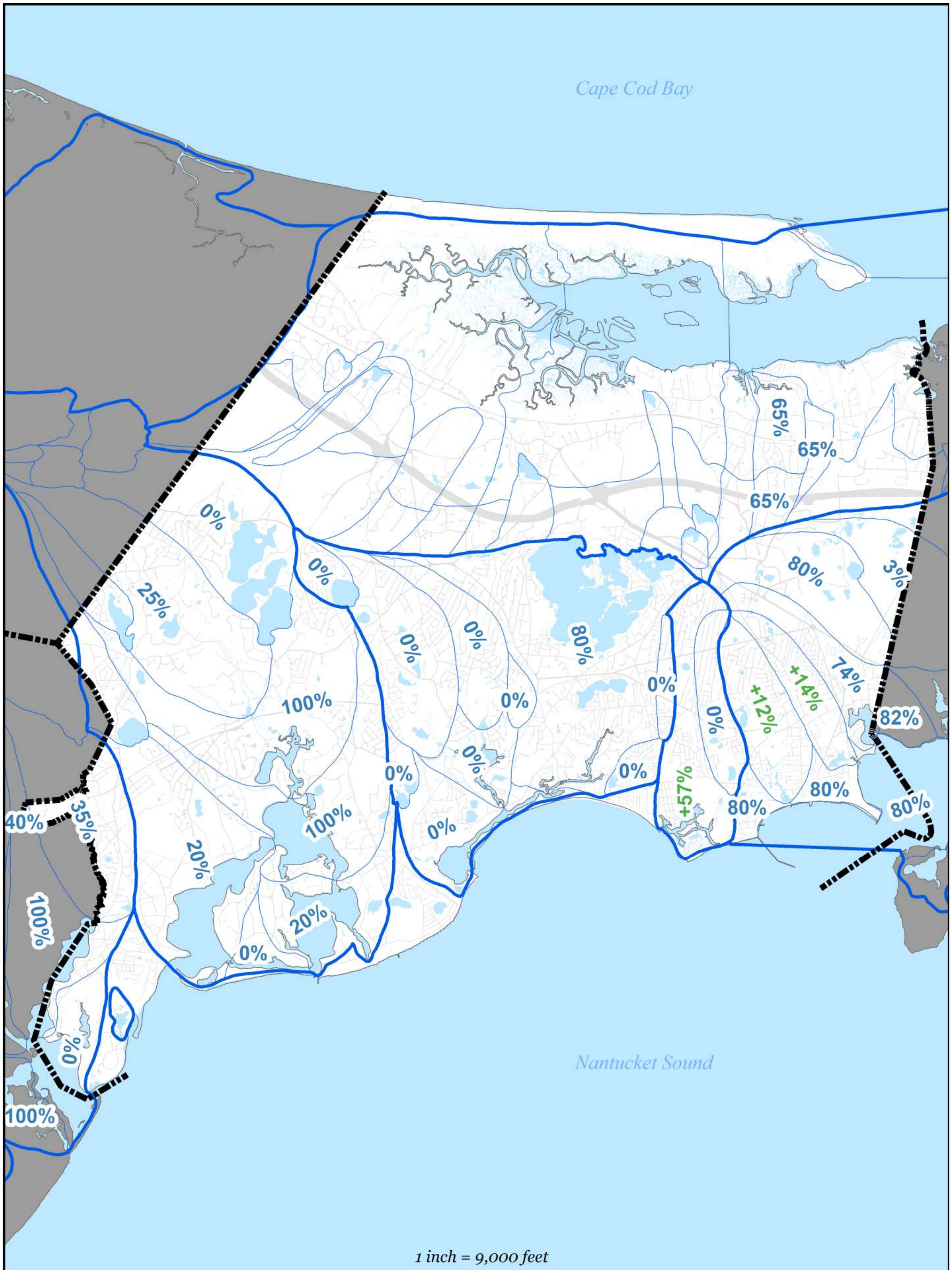

Figure 2-9: MEP Modeled Existing Target Septic Load Removal

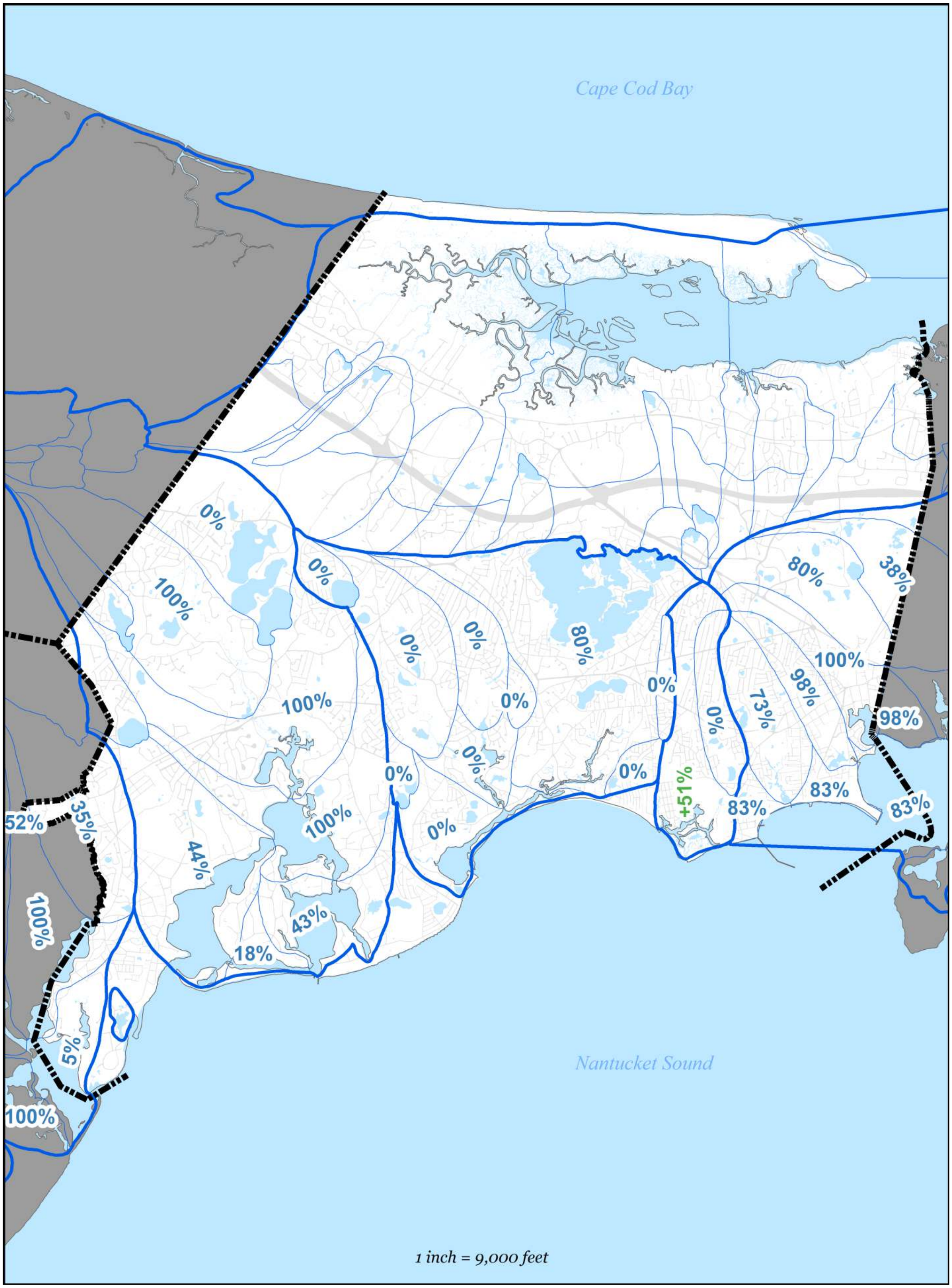

Figure 2-10: MEP Modeled Future Target Septic Load Removal

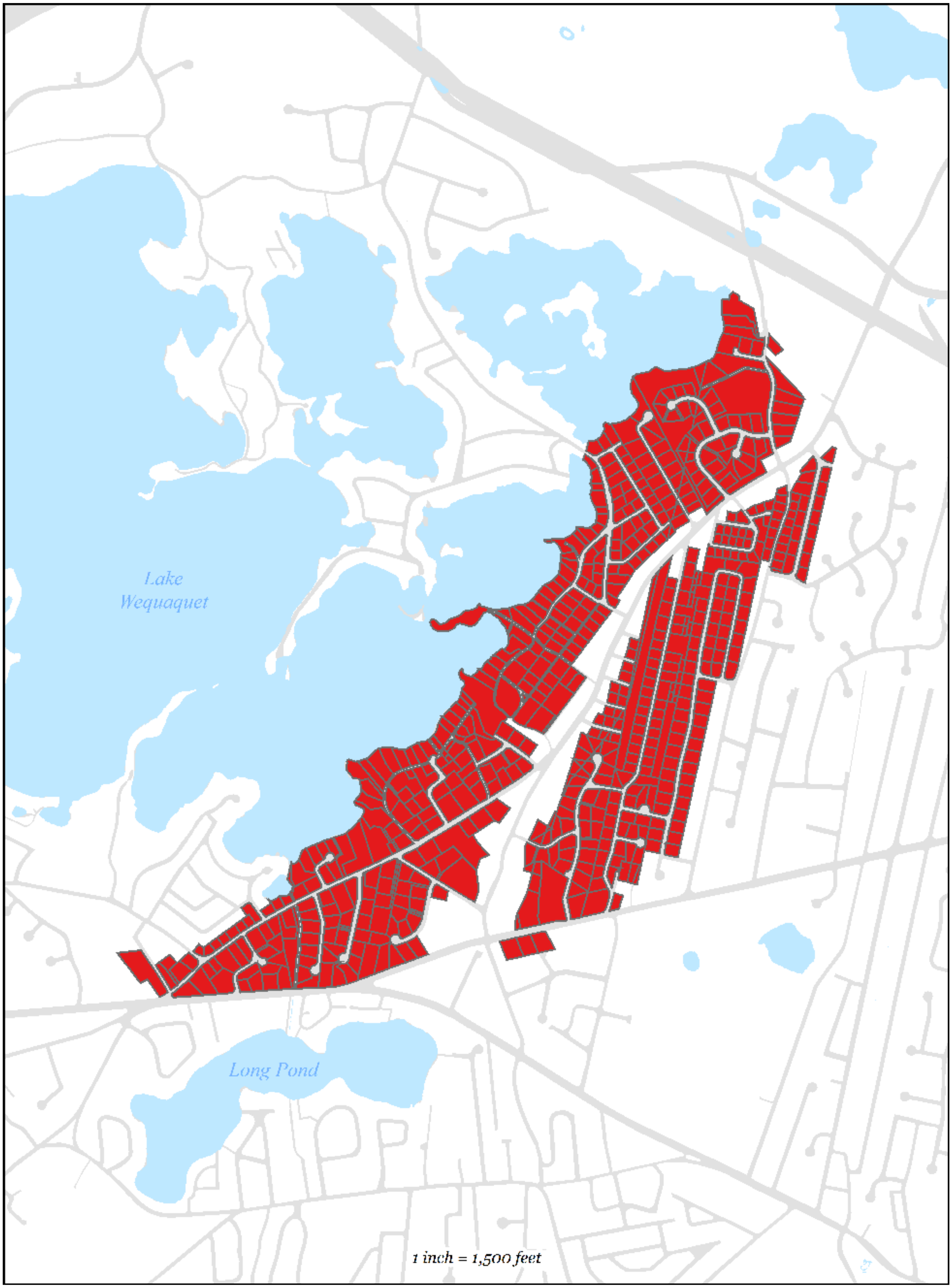

Figure 2-11: Phinney's Lane Sewer Expansion Project

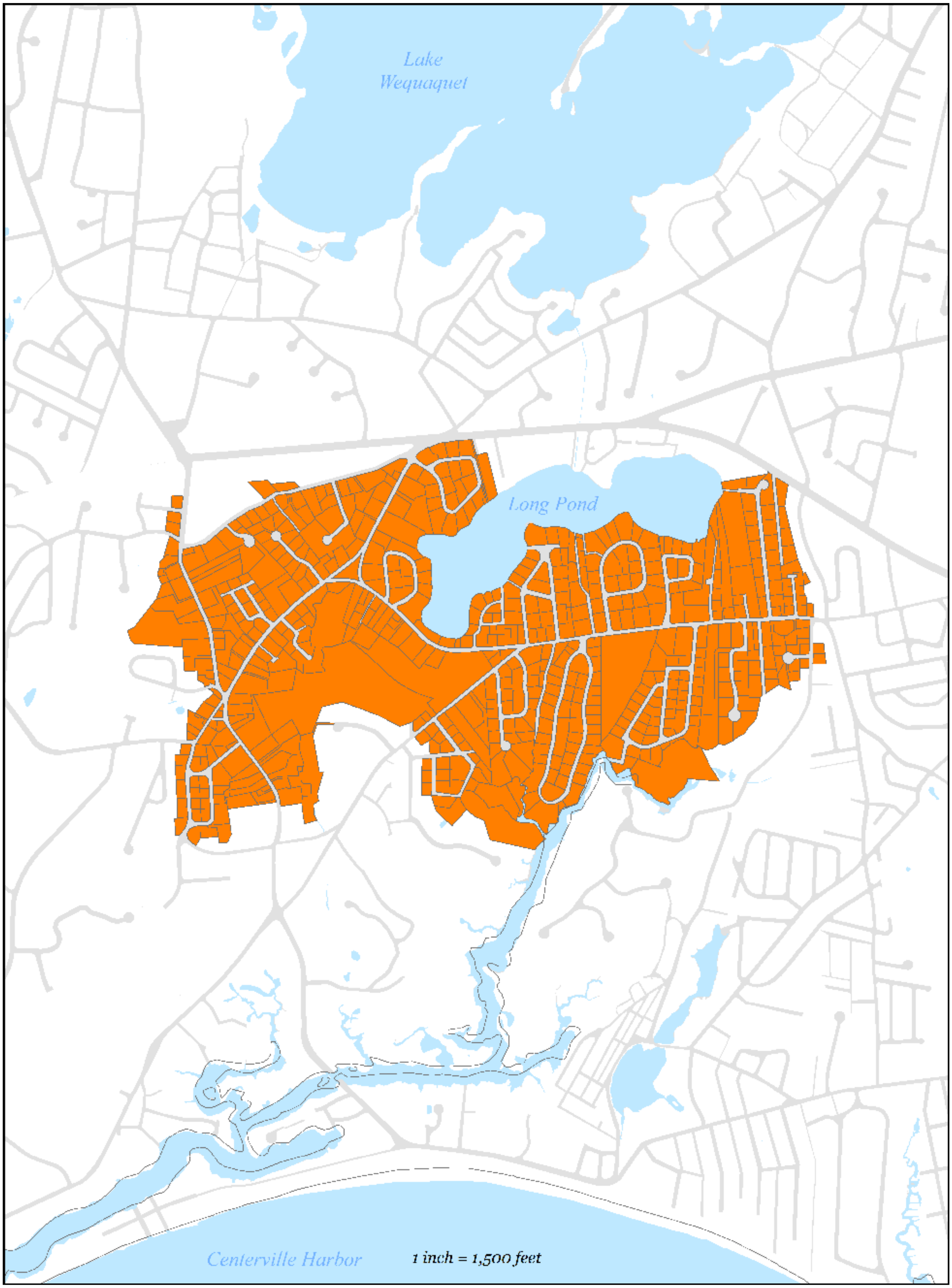

Figure 2-12: Long Pond Sewer Expansion Project

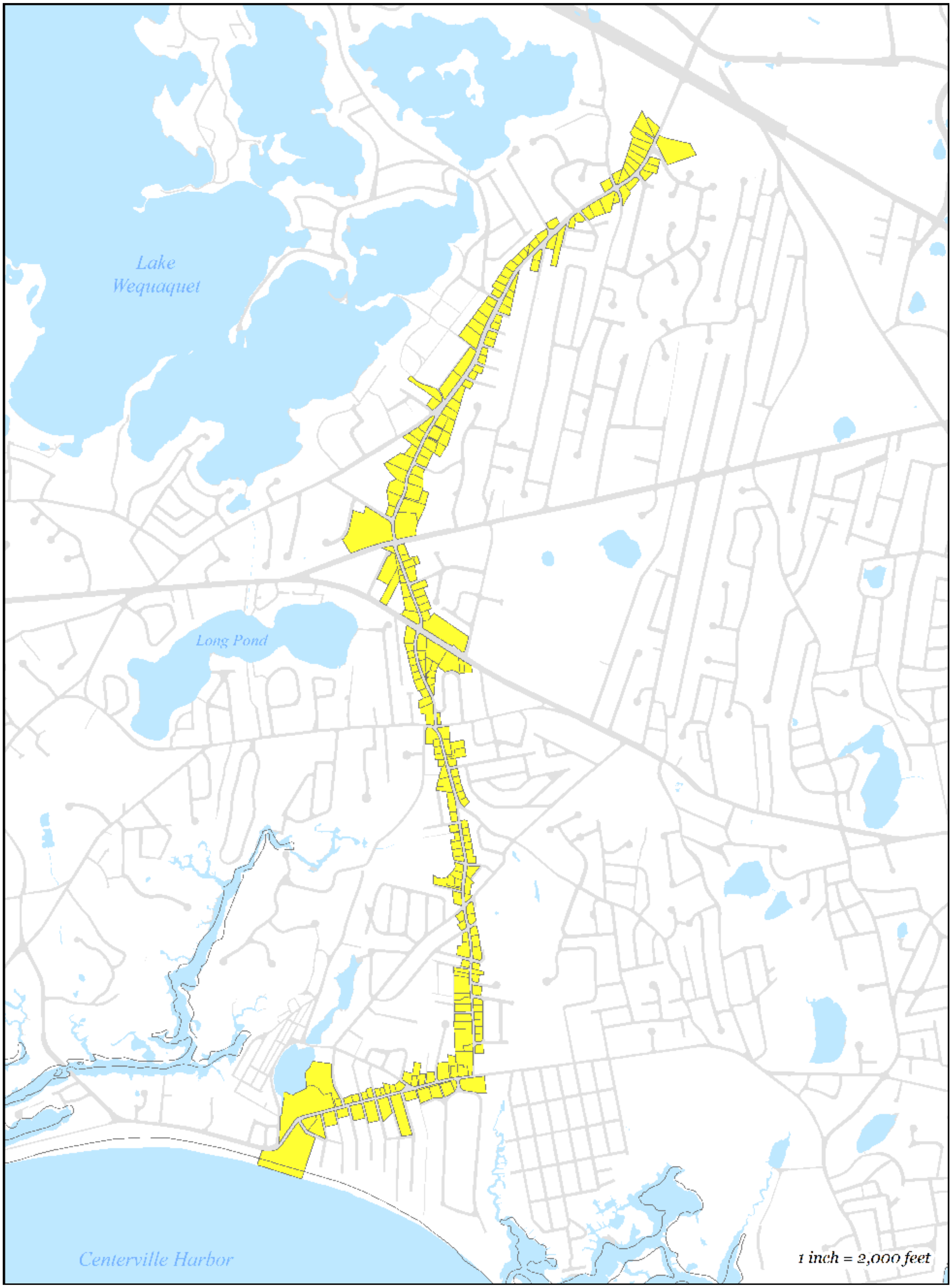

Figure 2-13: Strawberry Hill Road Sewer Expansion Project

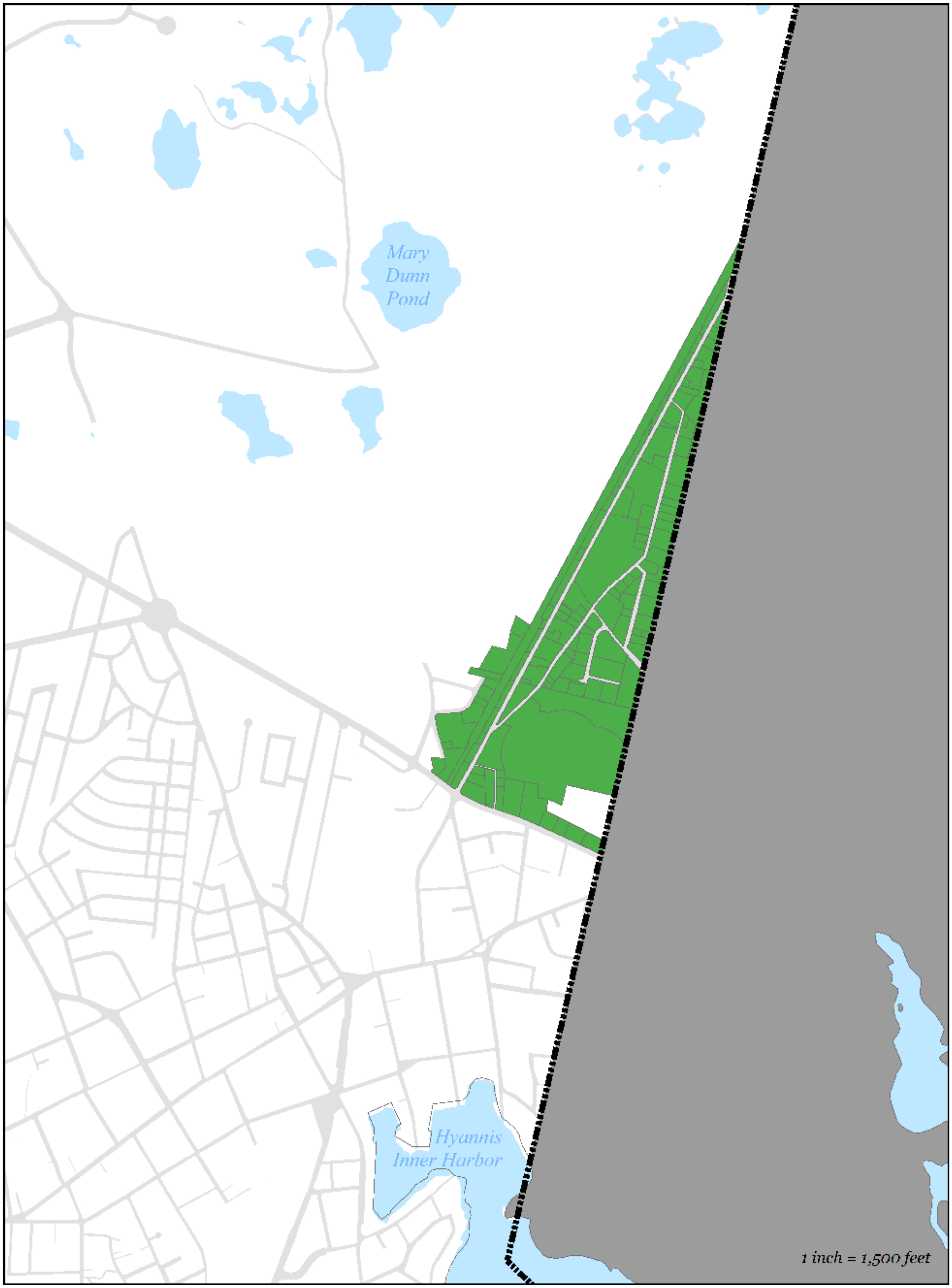

Figure 2-14: Old Yarmouth Road Sewer Expansion Project

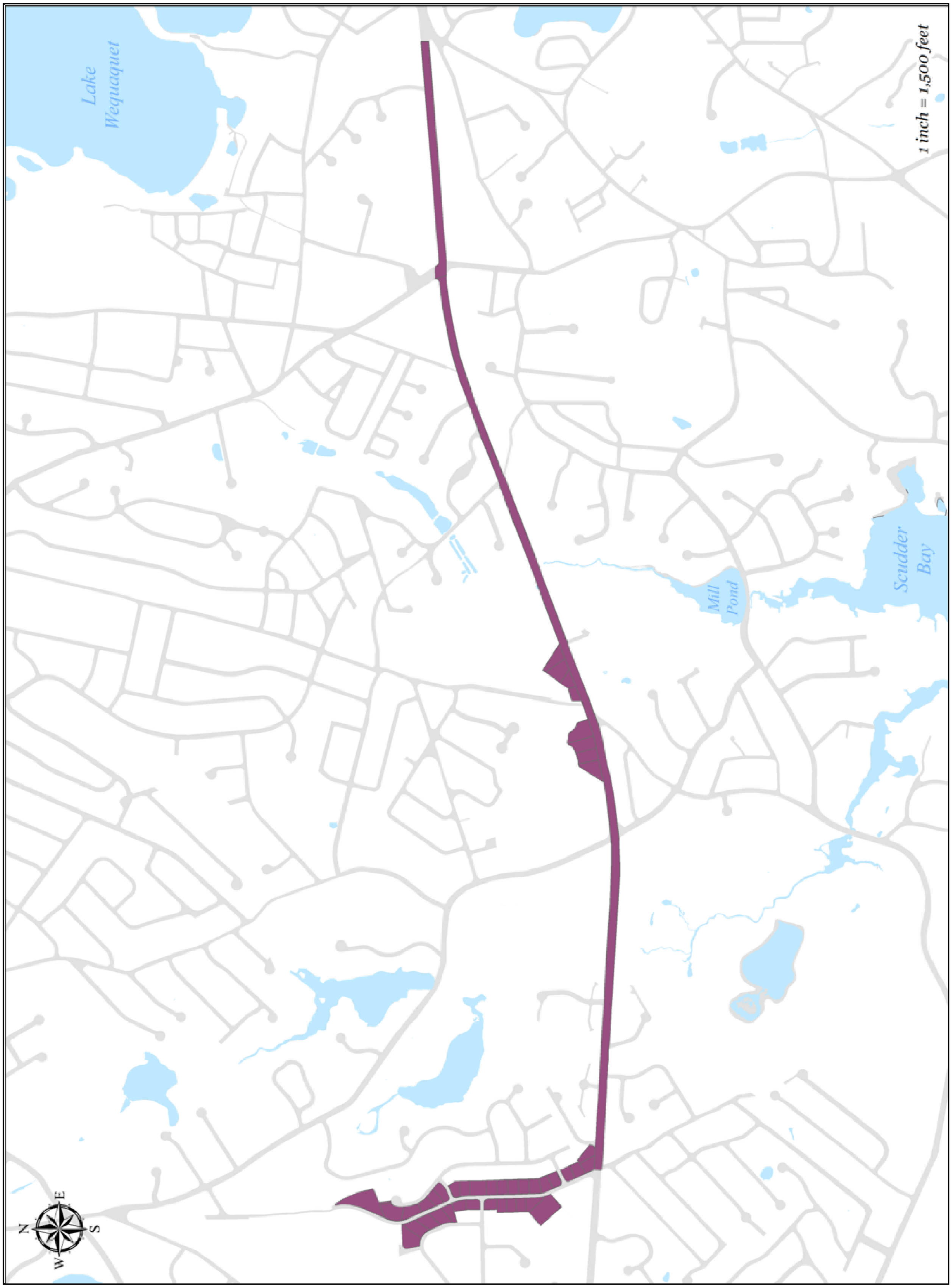

Figure 2-15: Route 28 Centerville (MMWWTF Transition) Project

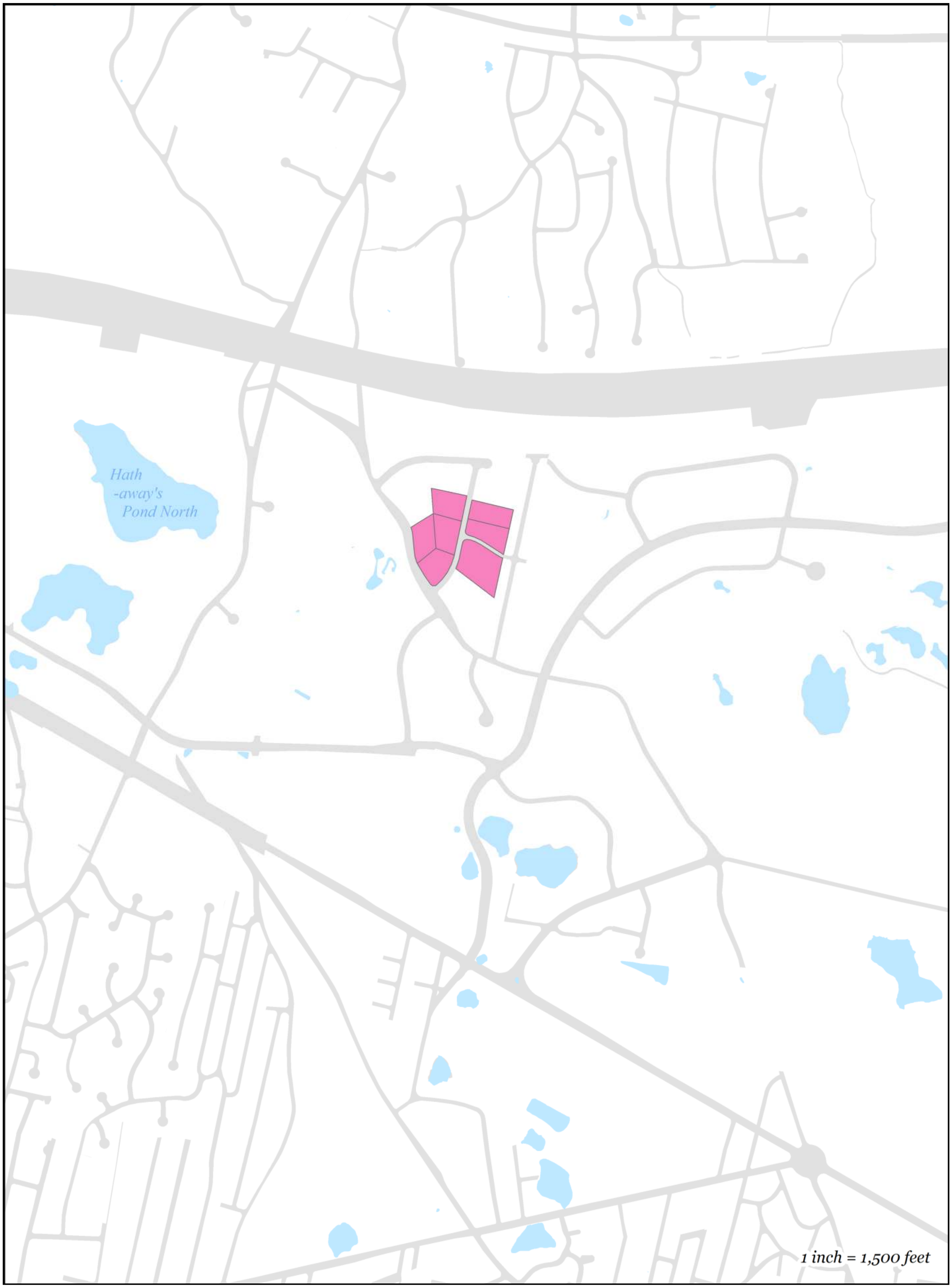

Figure 2-16: Merchant's Lane Sewer Expansion Project

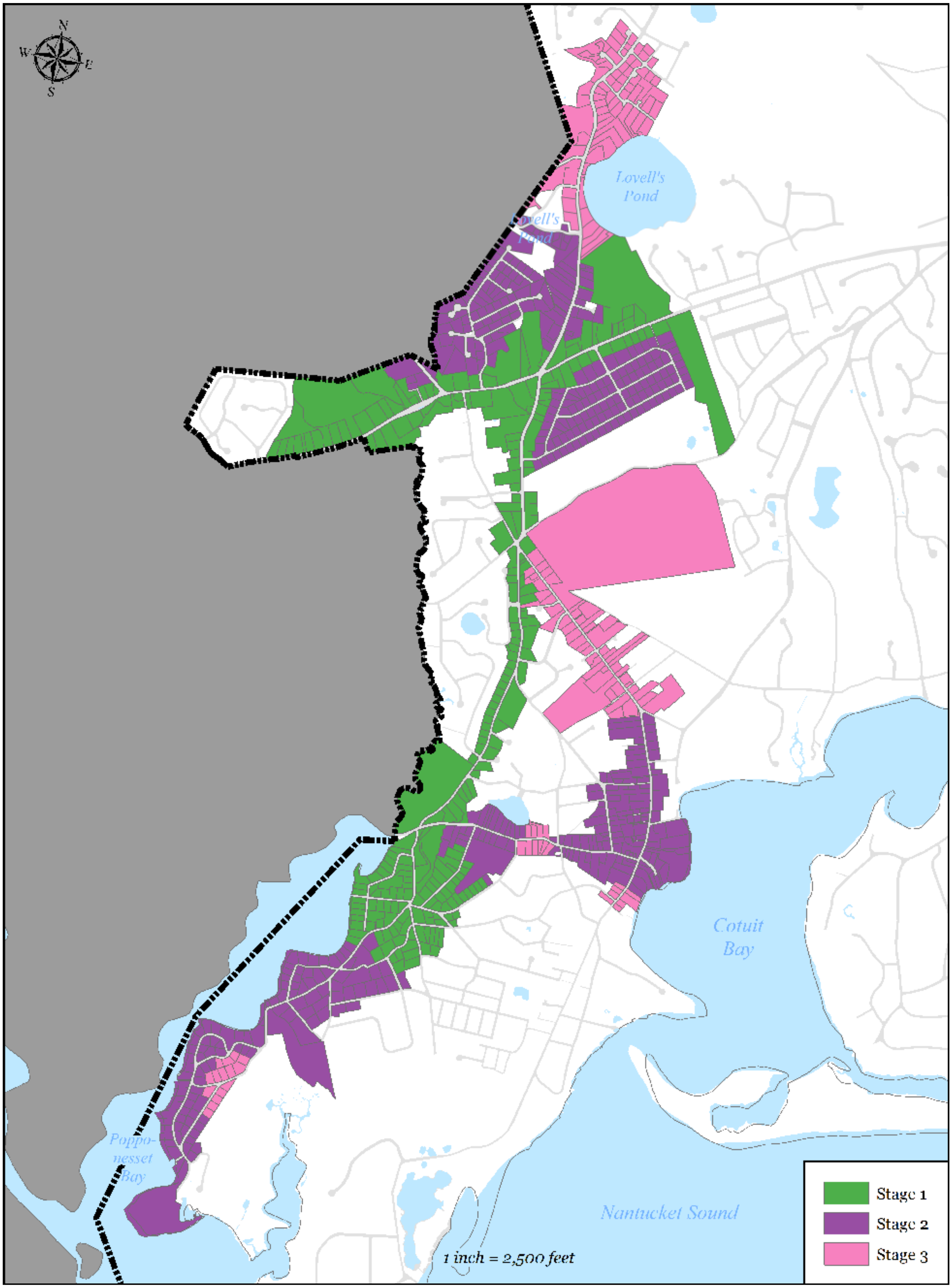

Figure 2-17: Cotuit Sewer Evaluation / Cotuit "Staging" Plan

3 EVALUATION OF TECHNOLOGY ALTERNATIVES

This section addresses the Identification, Screening and Evaluation of Alternatives Phase of the CWMP process. As previously noted the Chapter 4 of the Cape Cod Commission's 208 Plan did a complete examination of the potential technologies, relevant to Cape Cod, that address wastewater needs. The chapter outlines expected nitrogen removals of the identified technology, their related costs, installation considerations, advantages and disadvantages. The Town used that information during its planning to make decisions on its plan. As a result, rather than creating a new document on the subject, this section will refer to the 208 Plan (see Appendix A) and highlight some of the technologies that are incorporated in to the plan.

3.1 SUMMARY OF CAPE COD COMMISSION 208 PLAN CHAPTER 4

The 208 Plan is a watershed-based approach that deploys regulatory reforms, innovative strategies, and community-wide processes to mitigate nitrogen pollution. "Chapter 4: Nutrient Mitigation Technologies and Policies" of the 208 Plan, explains the different technologies, tools, policies and approaches that can help restore water quality. The following sections describe the technologies that have been considered in the development of the plan.

3.1.1 TRADITIONAL TECHNOLOGIES

Traditional wastewater technology includes the following components:

- Collection of the wastewater from more than one property
- Conveying that wastewater to a facility(s) that can treat it
- Treating the wastewater to eliminate the aspects of it that will have negative effects on public health or the environment
- Disposing of that wastewater in an appropriate manner

These components apply whether one is considering a multi-property septic system or the largest wastewater treatment facility. A quick discussion of each follows.

3.1.1.1 COLLECTION OF WASTEWATER

A wastewater collection system consists of a series of pipes which collect wastewater from individual properties. Wastewater flows from the home/business to the street via a sewer service connection. Usually these are the homeowner's responsibility at least to the edge of their right-of-way, but sometimes all the way to the sewer mains that are located in the street. The sewer mains are owned by the municipality, and are installed so the wastewater will be moved along by either gravity, under pressure (low pressure sewer which requires a small pump at every property), or via a vacuum. The Town of Barnstable has all three types of sewer main piping within its existing collection system, and as a result has formed a strong preference for gravity collection systems whenever possible. The Town experience is that the vacuum sewer is not reliable, and is limited in terms of expansion. Low pressure sewers are problematic as they too are limited in terms of expansion, and they require each property owner to have a small grinder pump on site. The responsibility for maintaining those pumps, particularly during power outages, has been the source of friction in the past. Gravity systems have the capability to be expanded, are relatively problem free, and do not require property owners to own mechanical equipment that could be argued are part of the collection system.

With a gravity system, when the collected wastewater reaches a low point in the neighborhood, it will need to be pumped up to where it can freely flow by gravity again. This is accomplished with pump stations. Pump stations range in size, but include an underground tank for the wastewater to collect in and pumps and controls that will push that wastewater uphill through pressurized pipes (force mains) to the next gravity section. There are multiple types of pump stations; each with its own niche, through there is some overlap between them. All will have multiple pumps (to ensure redundancy), control systems, and in Barnstable, backup power on station.

3.1.1.2 CONVEYING WASTEWATER

Once in the sewer mains, the wastewater must be transported from the neighborhood to the treatment facility. In the case of a communal septic system that may be within the same neighborhood, conveyance is effectively part of the collection process. However, in other situations – such as is planned for the neighborhoods in the Three Bays Watershed - treatment can be multiple miles away (over five in Three Bays case) from the neighborhood. Conveyance is generally accomplished using a series of pump stations and gravity mains which take up multiple neighborhoods collection system's flows and transport them to the wastewater treatment facility.

It is often believed that the largest expense in installing a wastewater system is in treatment, however typically collection and conveyance represents up to 75% of the total capital construction costs for the system.

3.1.1.3 TREATING WASTEWATER

Traditional wastewater treatment is used to eliminate the aspects of the wastewater that will have negative effects on public health or the environment. There are lots of options regarding wastewater treatment, with choices being informed based on the required size and scale and what one is trying to eliminate from the wastewater.

In Barnstable's case, the community already has a wastewater treatment facility, and it is the Town's intention to use that facility, expanding it as necessary, to treat as much of its wastewater as makes practical sense.

3.1.1.4 DISPOSING OF TREATED WASTEWATER (EFFLUENT DISPOSAL)

Once the wastewater is collected, conveyed to the wastewater treatment plant, and treated, it must then be disposed of or put to productive use (reuse). The Town's existing wastewater plant disposes of the wastewater via sand beds that are located on the same grounds as the plant.

Though the plant is permitted to treat up to 4.2 MGD, it is currently limited in what is can dispose of to 2.7 MGD (max day) pending the outcome of the effluent disposal study discussed in Sections 2.2.2.1.3. Ultimately it is expected that mitigating measures will be found to allow the Town to dispose of all of its treated wastewater either at the wastewater treatment plant site or others.

3.1.2 NON-TRADITIONAL TECHNOLOGIES

The following sections describe non-traditional technologies that have been considered in the development of the plan. As discussed in Section 2.3.2, the focus area for the implementation of non-traditional technologies is the Three Bays Watershed.

3.1.2.1 AQUACULTURE

The growing and removal of mature shellfish can help remove nitrogen from an estuary. Shellfish do not absorb nitrogen directly from their environment; rather they feed on naturally-occurring phytoplankton, which use dissolved inorganic nitrogen to grow. Thus, shellfish incorporate nitrogen from their food into their tissues and shells. When shellfish is harvested, the accumulated nitrogen is removed from the water.

Shellfish also play an important role in the cycling of nutrients, including nitrogen. They release nitrogenous waste that can be used by phytoplankton as a source of nitrogen. In addition, some of the nitrogen filtered from the water by shellfish is deposited to the sediment as feces and pseudofeces (rejected food particles). These bio-deposits are decomposed by bacteria, which transform the nitrogen to a variety of other forms, including ammonium (NH4+), nitrate (NO3-), and nitrogen gas (N2).

In addition to contributing to water quality improvements, additional aquaculture could provide economic benefits to Cape Cod. The Town of Barnstable has 61.66 of shellfish grant acreage within Three Bays and Cotuit Bay. The Town is currently looking at Warrens Cove as a prospective aquaculture nursery. Warrens Cove currently is not appropriate for aquaculture due to silt. Dredging Warrens Cove back to a sandy bottom may allow the Town to establish aquaculture nurseries. The Cape Cod Commission estimates that aquaculture beds/floating racks can remove 8- 15% of the nitrogen they encounter.

3.1.2.2 FERTIGATION

Fertigation consists of captivating nitrogen enriched ground water with wells and using it to irrigate plants. Fertigation wells can capture nutrient enriched groundwater and recycle it back to irrigate and fertilize turf grass areas such as golf courses and athletic fields. Fertigation can reduce nutrient loads to down gradient surface waters while reducing fertilizer cots to irrigated areas.

3.1.2.3 CONVERSATION OF CRANBERRY BOGS

The headwaters of the Marstons Mills River contain approximately 150 acres of cranberry bogs. The Town believes that the abandoned bogs could play a vital role in reducing the nitrogen load in Three Bays watershed. The following treatments of the bogs could help reduce the amount of nitrogen flowing into the Marstons Mills River:

- Conversion to ponds (Approx. 50%)
- Conversion to wetlands (TBD)
- Installation of floating wetlands (Approx. 8-15%)

3.1.2.4 ALTERNATIVE TOILETS

In any wastewater plan one of the hardest items to quantify and address are the potential future flows from either new development, or redevelopment of existing parcels. An approach to that issue is code changes that require alternative toilets (or I/A septic systems) for structures that are located in nitrogen sensitive areas that are not served by a sewer collection system. Alternative toilets (such as urine diverting (UD) toilets and composting toilets) are potential means of reducing both wastewater flows and pollutant loads. It has been hypothesized that human urine typically contributes about 80% of the nitrogen and 50% of the phosphorus in household wastewater, yet only around 1% of its volume. UD toilets are designed to capture these nutrients via urine, and segregate it from the remaining waste stream (which could facilitate resource recovery). Composting toilets collect all the waste (not just urine) rely on aerobic bacteria and fungi to naturally degrade and convert the wastes into compost. This generally happens in sealed units that are usually located in a structures basement. While there are some significant benefits from these technologies, they have traditionally not gained enough public acceptability to be widely used. One of the significant stumbling issues has been that in existing properties they generally require significant re-plumbing, which can be expensive and disruptive. However, this issue is avoided on new construction where the systems are installed as the structure is being constructed.

3.1.2.5 ALTERNATIVE SEPTIC SYSTEMS

Innovative/alternative (I/A) septic systems may be used in areas where sewers are not anticipated, but where nitrogen reduction is warranted. Prior to being permitted for use, each type of system undergoes a three-phase approval process (Piloting Use, Provisional Use, General Use) to ensure performance at levels at least consistent with Title 5. During the approval process, limited numbers of each type of system may be installed under strict siting and flow conditions and extensive monitoring. Title 5 regulations include special requirements for installation, monitoring, and maintenance of these systems. Systems achieving Remedial Use approval are allowed solely to replace a failed system where a conventional system could not be sited and where there will be no increase in design flow.

3.1.2.6 DREDGING

Ponds and lakes naturally play an important role when it comes to decreasing the levels of nutrients in water. Freshwater and estuaries store nutrients within their sediments. As ponds age, they accumulate years of organic material, nutrients can be released into the overlying water column and can become a major source of nitrogen and phosphorus. Dredging and removing these sediments and nutrients, helps reduce these nutrients from the water body and the watershed.

The Town is currently utilizing techniques like dredging for the rehabilitation of Mill Pond. Mill Pond is located between Route 28 and 149. Sediment has been gradually filling the pond over the past four centuries, and currently has up to 9 feet of silt and sand. Dredging the pond back to its original depth will give back its capacity to reduce the nitrogen concentrations.

Dredging of marine areas ensures safe access for navigators, as well as assisting in maintaining adequate tidal flushing. Tidal flushing maintains salinity levels, dissolved oxygen levels, and provides adequate nutrient exchange between embayments and the ocean. The Town is currently utilizing dredging to improve tidal flushing in the Three Bays (Sampson's Island Dredging Project) and has previously experienced modest improvements in water quality within the Centerville River after maintenance dredging.

3.1.2.7 PERMEABLE REACTIVE BARRIERS (PRBS)

An alternative to treating nitrogen on site or at an off-site treatment facility is to intercept nitrate in groundwater at the coastline before it enters an embayment. A permeable reactive barrier (PRB) is an in-situ (installed within the aquifer) treatment zone designed to intercept nitrogen enriched groundwater. Through a carbon source, microbes in the groundwater uptake the nitrogen, denitrifying the groundwater. As groundwater flows through the medium, microbes naturally occurring in the groundwater consume the carbon source, as well as oxygen, developing an anoxic environment. This process releases nitrogen gas to the atmosphere, reducing the groundwater nitrogen load before reaching the estuary.

3.1.3 MANAGEMENT SOLUTIONS

There is no one solution that addresses all the wastewater issues being experienced by Barnstable. Rather it will take a mix of solutions to achieve the Town's goals including traditional solutions, nontraditional solutions, and "management solutions". This last category, management solutions, includes a variety of approaches, all of which are related in their attempt to reduce the quantity and strength of the wastewater reaching the environment either by rules (zoning, ordinances, regulation, etc.) or by education and changing public behavior (flow and load reduction, storm water practices on private property, septic system improvements). In this section a number of those approaches will be introduced and discussed. Many of these are also discussed in Section 4 of the Cape Cod Commission's 208 Plan (see Appendix A).

3.1.3.1 REDUCTION OF FLOWS AND LOADS

One of the easiest and probably most cost effective ways to address wastewater is via reduction of the flows and loads that come from each of our homes, businesses, and municipal facilities. However, this also is a difficult approach to verify and enforce. Wastewater flows are the volumes of wastewater generated from our usage of toilets, sinks, showers, dishwashers, laundry units, etc. within our properties. It is generally measured as flow over a given time period, and usually expressed in units such as gallons per day (gpd). Wastewater loads are the quantities of pollutants (food waste, soaps, hormones, organic carbon, grease, human waste, etc.) contained in the wastewater. It usually is measured in mass-per-time units such as pounds per day. A brief summary of flow and load reduction strategies is provided below.

Flow Reduction - Reduction in water use can be implemented by requiring low-flow plumbing fixtures and/or progressive water pricing. While flow reduction does not reduce the nutrient load (or other constituents of concern) within the wastewater, it does equate to less water that needs to be pumped, piped and treated; or that has to be addressed by a septic system. Additionally, it saves on source water having to be withdrawn from the ground in the first place. Low-flow plumbing fixtures (sinks, showers, toilets, and appliances) are available and can reduce water consumption without having to radically change behavior. Progressive water pricing charges fees based on the size of the service and quantity of water used - the larger the service connection, the higher the quarterly fee and the higher the water use, the higher incremental cost. This should be an incentive for property owner to reduce their water consumption, and its resulting wastewater flow. An additional progressive water pricing strategy would be to adjust rates seasonally, based on historic demand. As an example, during summer season when demand is highest, raise the rates which would provide economic incentives to reduce water consumption (and the associated wastewater generation).

Load Reduction – Reduction in the strength of the wastewater, or the load associated with it, is more difficult to achieve. However, one of the easiest ways is with the handling of food wastes. Disposing of waste food down the sink, and particularly through garbage grinders is a significant source of load in the waste stream (grease, organic carbon that translates to BOD, nutrients, etc.). Many communities ban the use of garbage grinders in homes served by sewers and/or on-site systems. A preferred way to address this waste product is through either composting (either residential or municipal), or at a minimum disposing of it in the trash.

3.1.3.2 LAND MANAGEMENT AND ZONING

Land use management and zoning is important as it can dictate the quantity of future flows that needs to be addressed by the wastewater plan. This is important as the proposed nitrogen removal percentages required in the watershed is the percentage of <u>existing flows</u> that needs to be removed. It is assumed that, 100% of all future flows must also be removed as well, which can be significant. Additionally, many communities have used the on-site wastewater restriction and rules as default zoning and growth regulations/restrictions; however, these are no longer applicable if sewers are provided to an area. Massachusetts State Sanitary Code, Title 5 (310 CMR 15.00) establishes maximum onsite flows based on residential bedroom count (110 gpd/bedroom), and different kinds of commercial uses. Title 5 also sets flow criteria for nitrogen-sensitive areas, limiting flow to 440 gallons per day per acre or four bedrooms on a one-acre lot. So, land use management and zoning needs to be considered in wastewater planning from two perspectives. Those two perspectives are:

1. Areas that are already developed, and which will now have sewers, will no longer have the check on growth that was provided by on-site system, and Title 5 regulations.
2. Areas that are not yet developed, where the Town does not want growth and wants to limit nutrient impact, can be zoned in such a way as to discourage that growth from occurring in the first place. This will prevent the need to provide future wastewater solutions and reduce total scope and cost of the Town's plan.

As such, the community may wish to install a variety of regulatory and land use planning tools to manage growth in the absence of Title 5. These include building regulations, zoning changes that direct growth to specific areas, and providing improved wastewater treatment methods when dealing with non-conformities. They also can include regulations that stipulate the amount of nutrients and flow allowed by on-site septic systems. Prudent use of these tools can help ensure that TMDLs can be met now and in the future, that sewer capacity is efficiently directed to those areas where greater intensity of land use is desirable, and that natural resource areas are protected.

3.1.3.3 FERTILIZER MANAGEMENT

By many accords, the second largest controllable nitrogen source impacting our environment is from the fertilizer used on lawns, golf courses, and recreational areas. The Massachusetts Estuaries Project estimated about 10% of the nitrogen harming our estuaries comes from fertilizer. To address this issue the Town of Barnstable implemented its own fertilizer control regulations. Chapter 78, of the Town Code, is titled *Fertilizer Nitrogen and Phosphorus Control*, outlines those regulations (see Appendix PP). The enforcement responsibility for this falls to the Town's Board of Health, through its Director of Public Health, with the exception of § 78-5B(4) and (8), which will be enforced by the Town's Conservation Commission.

3.1.3.4 SEPTIC SYSTEM MAINTENANCE

The Town should continue to encourage proper septic system maintenance with regard to septage pumping. While proper septage management will not reduce the nitrogen or phosphorus load to the watershed, it will preserve the life of an existing Title 5 system. This measure should be encouraged for all properties which continue to utilize on-site systems.

4 FORMULATION AND DEVELOPMENT OF THE RECOMMENDED PLAN

As discussed in the Department of Environmental Protection's (DEP), GUIDE TO COMPREHENSIVE WASTEWATER MANAGEMENT PLANNING, released in January 1996, "The comprehensive wastewater management planning process is the process whereby current and future wastewater needs are evaluated, wastewater management alternatives are developed which will meet these needs, and a final plan is chosen through careful comparison and evaluation of the alternatives. The process must include the necessary steps in ensuring that the planning effort results in the most cost effective, environmentally sound wastewater management plan." This section will describe how the Town of Barnstable developed its plan.

4.1 WATER RESOURCES ADVISORY COMMITTEE (WRAC), AND THE PLANNING PROCESS

As was previously discussed, the plan, which is documented in this report, was created by the Town's appointed Water Resources Advisory Committee (WRAC), the Department of Public Works (DPW), and other Town staff members. WRAC members included:

- Councilor Frederick Chirigotis
- Councilor John Norman
- Councilor John Flores
- Lindsey Counsell (served as the Committee Chair)
- Michael Moynihan (served as the Committee Vice Chair)
- Phillip Boudreau
- Casey Dannhauser
- Fred Dempsey
- Ed Eichner
- Farley Lewis
- George Zoto

The WRAC's work, and the subsequent planning efforts, was supported by a number of DPW and Town staff members. Those included:

- Mark Ells, Town Manager
- Andrew Clyburn, P.E., Assistant Town Manager
- Daniel Santos, P.E., DPW Director
- Mark Milne, Finance Director

- Elizabeth Jenkins, Planning and Development Director
- Rob Steen, P.E., DPW Assistant Director
- Griffin Beaudoin, P.E., Town Engineer
- Amanda Ruggiero, P.E., Assistant Town Engineer
- Andrew Boule, Water Pollution Control Supervisor
- Matthew Sumner, Engineering Records and Asset Manager
- Miroslav Jakubicka, Engineering Designer
- Dale Saad, Ph.D., Senior Project Manager – Special Projects
- Casey Scrima, Engineering Aide I
- Cynthia Lovell, Administrator to the Town Council
- Jim Benoit, GIS Manager

A number of guiding principles were utilized to steer the planning process. They included the following.

- The plan should be Town-wide and address all the categories of wastewater needs that are listed below. However, regulatory requirements (TMDLs) for nitrogen removal took priority.
    - Sanitary Needs
    - Convenience and Aesthetics
    - Protecting Groundwater and Water Supplies
    - Protecting Surface Waters
    - Enabling Sustainable Economic Growth
- Previous wastewater planning efforts, where applicable, should be used to inform the plan.
- The Cape Cod Commission 208 plan was a valuable resource for planning. It identified the portion of a watershed's nitrogen removal that was the Town's responsibility; and Section 4 (of the 208 Plan) identified potential treatment technologies and their associated removal percentages.
- The existing Water Pollution Control Facility, and collection system technologies, should be leveraged to the fullest extent possible.
- Regional solutions and potentially "nitrogen trading" could have benefits and should be fully explored and considered.
- New effluent disposal should not occur in Zone IIs; and where possible, it should occur outside of nitrogen sensitive watersheds.
- Appropriate phasing of the plan should facilitate adaptive management, sound fiscal policy, and allow for future technology/regulatory changes to be incorporated into the plan as they are encountered
- The plan should consider all types of solutions: Traditional (sewers, etc.), Nontraditional (UD toilets, fertilizer plans, aquaculture, dredging, etc.), and Management (Zoning, etc.).

- All regulatory requirements would be initially addressed via traditional technologies. However, nontraditional solutions should be incorporated into the initial phase of the plan, monitored, and if effective, used to remove traditional approaches in the associated watershed in later phases of the plan.
- Management approached (zoning, etc.) would be considered for future growth/buildout for residential properties.

The WRAC met at least monthly, and at times more often, from January of 2016 until August 2017 when it presented its findings to the Town Council. During that time the committee:

- Assembled the data from previous planning efforts (wastewater and otherwise), and other viable sources.
- Identified "holes" in this data, and then set about addressing those data gaps.
- Created a GIS-based tool, that allowed the WRAC and DPW to evaluate on a lot-by-lot basis
    - Poor sanitary conditions and public health issues, such as
        - bad soils/high groundwater
        - effluent surfacing over leaching field
        - inadequate set-back from private wells/property lines
        - direct discharge of sanitary wastewater to a water body
    - Water Supply Protection issues, and identify impaired or endangered wells and the sources of that impairment.
    - Properties/areas that were causing nutrient enrichment in surface waters (both marine estuaries and freshwater ponds)
    - Convenience and aesthetic issues including needing mounded septic systems, septic systems located in the flood mapping velocity zones, systems that require excessive pumping, or are in areas that where it is very expensive to install on-site wastewater solutions
    - Areas where economic development was desired, yet difficult due to the lack of good, viable, wastewater options.
- Utilized the GIS-based tool to understand the various wastewater needs and requirements, and devise solutions for those needs.
- Reviewed the CCC 208 Plan
- Met with regulators from both the Department of Environmental Protection (DEP) and Cape Cod Commission.
- Facilitated the meeting of Town staff with adjoining towns' staffs to find efficiencies and areas where common solutions could be used to address regional wastewater needs.
- Conducted public meetings, had staff create public outreach programs utilizing the Town's local access television station, and did public outreach meetings with the village associations that requested them.

- Complied with the Cape Cod Commission's 208 Plan process, including the submission of "Bookends" Plan and a "Hybrid" Plan.
- Presented its recommended plan to the Town Council at which point the WRAC was disbanded.

After the presentation to Town Council in August of 2017, the plan continued to evolve. Three major events affected this evolution:

1. Town Council wanted to proceed with plan execution in areas that made sense and that could be considered traditional sewer expansion (that were adjacent to the existing collection system), but that also would start to address the nitrogen issues in our embayments. As a result three projects were submitted to Town Council as Capital Improvement Projects (CIPs). Town Council approved those projects for design. They are currently on-going. These are discussed in Section 2.3.3.
2. Vineyard Wind came to an agreement with the Town to land its power cables in Barnstable, and convey them through Barnstable roads. This presented an opportunity to leverage their road work and have sewer installed at the same time at a lower cost than would occur otherwise. As a result, some potential projects were pulled forward on the timeline.
3. Treatment and Effluent disposal at Joint Base Cape Cod (JBCC) WWTF. This was an opportunity that needed to be explored (see Section 2.3.1.3 and Appendices KK to NN). During the winter of 2018/2019 Barnstable joined the four upper Cape towns in their pursuit of the wastewater assets on the JBCC. Utilizing JBCC would allow the Town to address more thoroughly the wastewater challenges in its western portion and possibly provide needed effluent disposal for other portions of the Town as well.

The plan is discussed in detail in Section 5, however, as is described above, it is continuing to evolve as more information comes available, and lessons are learned from earlier planning efforts.

4.2 APPROACH TO NON-TRADITIONAL SOLUTIONS

Using non-traditional approaches in wastewater planning has been difficult due to problems with quantifying their effect on nitrogen, gaining DEP approval for credit of the amount of nitrogen removal, and then documenting the effect once the approach has been installed (some items like fertilizer control are difficult to directly measure). To avoid all these issues, the Town made the decision to approach non-traditional solutions slightly differently. Rather than predicating the plan on them and having to ask for credit for these approaches up front, the Town instead decided to create a three 10-year phased plan that would address nitrogen requirements with traditional solutions. However, it would also in the first phase of the plan install non-traditional solutions "at risk" (see Marstons Mills River discussion). The Town would then monitor the performance/results of those solutions over a 5-10 year period, thus establishing their benefit. With that benefit firmly established, the Town would ask DEP for relief from that amount of traditional nitrogen removal (sewers) contained in the later phases of the plan.

4.3 PUBLIC CONSULTATION

Public consultation for this plan is a continuing activity. The development of the CWMP was a public process. The WRAC was formed from representatives of the community, the meetings were posted and open to the public, and the meetings were broadcast on the Town's CATV station. The Town Manager and DPW Director also presented progress on the plan, and then the plan itself, to the Town Council (also broadcast on the Town's CATV station) regularly. Toward the end of the planning process those updates became monthly. The Town's CATV station also conducted interviews for broadcast from participants in the wastewater planning process, and is developing a standalone documentary broadcast on the plan.

The plan also was, and continues to be, presented to Village Associations, boards, and civic groups that request the presentation. As of the writing of this document, Cotuit Village Association, Marstons Mills Village Association, Hyannis Village Association, Barnstable Clean Water Coalition, Lake Wequaquet Association, the DPW Commissioners, and the Board of Health have all had presentations made to them. Additional groups that will have the plan presented to them include: Senior Manager's Meeting (comprised of Town Department Heads), the Conservation Commission, the Planning Board, the School Board, the Economic Development Committee, and any other organization that requests it.

Additionally, the Town of Barnstable is unique in that three of its four public water purveyors are private entities that are not Town departments (the fourth one is a Town Department). To ensure appropriate communication with these organizations, the DPW initiated monthly meetings with the leaders of those organizations, where the plan was presented and discussed.

Finally, a website will be developed that will contain not only the plan, but links to the WRAC meetings and various televised presentations of the plan.

4.4 SHARED WATERSHEDS WITH ADJOINING COMMUNITIES

All but one of the impaired watersheds that Barnstable is responsible for is shared with at least one neighboring communities. Consequently, the Town needed to work with Mashpee, Sandwich, and Yarmouth in addressing the needs in these watersheds. As previously mentioned, one of the great benefits of the 208 plan was it apportioned the nitrogen removal requirements for a watershed between the communities that shared said watershed. This gave each community a clear understanding of their responsibility in the matter. What remained to be discussed between the communities was if there were collaborative approaches to the problem that would be more efficient than each community addressing it alone.

The Barnstable DPW met with each of the aforementioned community's wastewater planning teams multiple times. The solutions discussed with each were unique to that relationship, but the acknowledgement of a common problem was universal. Each is briefly synopsized below.

4.4.1 SANDWICH

Barnstable shares the watersheds of Three Bays, Popponesset Bay and a small sliver of Barnstable Harbor with Sandwich. Joint items that were pursued included:

- Popponesset Bay IMA - The Town engaged with the towns of Sandwich and Mashpee in developing an inter-municipal agreement (IMA) regarding nutrient management in Popponesset Bay. As discussed in Section 2.3.1.1, the IMA provides a framework for collaboration by establishing a working group to develop an application for a Watershed Permit for Popponesset Bay, a formula for allocation of responsibility, establishing a "lead municipality" to serve as fiscal agent for common and agreed upon expenses (in this case, Mashpee) and the mutual assurance that each town will take affirmative steps toward water quality improvement.
- Three Bays Watershed – Coordination meetings and discussions were held with Sandwich. Each community is addressing its respective need for this watershed via their own CWMP. However, collaboration via the JBCC work may modify this approach.
- JBCC - The four upper cape towns (Bourne, Falmouth, Mashpee, and Sandwich) had been investigating the possibility of making the WWTF on JBCC a regional facility for over a decade. During the winter of 2018/2019 Barnstable was invited to join the four towns in that effort. Barnstable agreed to join, and immediately contracted with a consultant to help understand the issues, opportunities, and challenges associated with managing and operating the JBCC facility. The results of the consultant's efforts can be found in Appendices KK to LL.

4.4.2 MASHPEE

Barnstable shares the Popponesset Bay watershed with Mashpee

- Popponesset Bay IMA - The Town engaged with the towns of Sandwich and Mashpee in developing an inter-municipal agreement (IMA) regarding nutrient management in Popponesset Bay. As discussed in Section 2.3.1.1, the IMA provides a framework for collaboration by establishing a working group to develop an application for a Watershed Permit for Popponesset Bay, a formula for allocation of responsibility, establishing a "lead municipality" to serve as fiscal agent for common and agreed upon expenses (in this case, Mashpee) and the mutual assurance that each town will take affirmative steps toward water quality improvement.

- JBCC - The four upper cape towns (Bourne, Falmouth, Mashpee, and Sandwich) had been investigating the possibility of making the WWTF on JBCC a regional facility for over a decade. During the winter of 2018/2019 Barnstable was invited to join the four towns in that effort. Barnstable agreed to join, and immediately contracted with a consultant to help understand the issues, opportunities, and challenges associated with managing and operating the JBCC facility. The results of the consultant's efforts can be found in Appendices KK to LL.

4.4.3 YARMOUTH

Barnstable shares the Lewis Bay and Barnstable Harbor watersheds with Yarmouth

- Treatment and disposal exchange – The towns share the Lewis Bay watershed and have begun discussions to see if shared wastewater treatment and effluent recharge between the towns was a viable and efficient solution. Talks were initiated and a study was conducted to better understand the opportunities related to having an exchange with Yarmouth. The basis of that exchange would be that Yarmouth would send its collected sewage to Barnstable for treatment, and Barnstable would send that effluent, plus additional effluent back to Yarmouth for disposal. The results of the study can be found in Appendix JJ. Those talks were still underway as of the writing of this plan.

4.5 MAPPING TOOLS

As discussed earlier, to help visualize wastewater needs, the Town created a GIS-based tool, which allowed the WRAC and DPW to evaluate the needs on a lot-by-lot basis. The tools captured issues such as:

- Poor sanitary conditions and public health issues, such as
    - Poor soils/high groundwater
    - Effluent surfacing over leaching field
    - Non-conforming lots, and septic systems with variances
    - Inadequate setback from private wells/property lines
    - Direct discharge of sanitary wastewater to a water body
- Water Supply Protection issues, and identify impaired or endangered wells and the sources of that impairment that are likely impacting them
- Properties/areas that were causing nutrient enrichment in surface waters (both marine estuaries and freshwater ponds)
- Convenience and aesthetic issues including needing mounded septic systems, septic systems located in the FEMA mapping velocity zones, systems that require excessive pumping, or are in areas where it is very expensive to install on-site wastewater solutions

- Areas where economic development was desired, yet difficult due to the lack of viable wastewater options.

The tool proved to be extremely useful, and allowed team members to understand visualize the various wastewater needs and requirements, and devise smart and efficient solutions for those needs.

5 RECOMMENDED PLAN

5.1 PHASING

The key component of the Town of Barnstable's Comprehensive Wastewater Management Plan is an aggressive 30-year plan focused on traditional solutions that will be performed in three 10-year phases. The plan has been designed to address multiple wastewater needs of the community, specifically: nutrient removal, pond protection, drinking water protection, economic development and other wastewater concerns. In addition to the traditional solutions, the Town simultaneously will be pursuing non-traditional approaches to nutrient reduction, which was discussed in Section 2.3.2 and Section 3.1.2.

The phases of the plan were developed to accomplish the following goals:

5.1.1 PHASE 1

- Construction of sewer infrastructure along Route 28 to address nutrient related issues within the Three Bays watershed. The Route 28 sewer infrastructure will be the major infrastructure to convey flow from westerly portions of the Town to the BWPCF.
- Sewer expansion adjacent to Wequaquet Lake, Bearses Pond, Shallow Pond, Long Pond, Red Lily Pond, Lake Elizabeth, Filends Pond to address deteriorating water quality.
- Sewer expansion to accommodate identified economic development areas including along the Route 28, Old Yarmouth Road, Attuck's Lane/Route 132, Kidd's Hill, Independence Park and Hyannis Harbor.
- Sewer expansion within the flood zones in the Craigville and Long Beach region to address septic system issues in the area.
- Sewer expansion adjacent to Prince Cove and Warren's Cove (most impaired waterbodies in the Three Bays Watershed) and the Marston's Mills River.
- Modifications at BWPCF including upgraded/expanded aeration, denitrification upgrades, and upgrades to solids handling.
- Identification, permitting and construction of new effluent disposal site(s).
- Continuing to take the lead in pursuit of a regional sewer option at JBCC.
- Completion of Cotuit Cut/Sampson's Island dredging project to improve the flushing of Cotuit Bay.
- Continued pursuit, construction and monitoring of non-traditional approaches along the Marston's Mills River System (Mill Pond Dredging, green stormwater projects, etc.).
- Continued embayment monitoring.

5.1.2 PHASE 2

- Continued westerly sewer expansion along Route 28.
- Continued sewer expansion within the Centerville River Watershed, specifically the Centerville River East sub-watershed and expansion adjacent to Bumps River.
- Sewer expansion into the Nye's Neck region to complete sewer expansion surrounding all of Wequaquet Lake.
- Sewer Expansion to areas south of Craigville Beach Road east of Covell's Beach.
- Sewer expansion into the Millway sub-watershed (the one sub-watershed within the Barnstable Harbor Watershed requiring septic load removal per the MEP report).
- Sewer expansion within the Lewis Bay Watershed in the General Patton area and northern Hyannis Port.
- Continued sewer expansion within the Three Bays Watershed, directly adjacent to sub-embayments requiring septic load removal (Prince Cove and North Bay) to address areas with shortest groundwater travel times.
- Continued monitoring and analysis of non-traditional projects, in the Three Bays Watershed.
    - During this phase, it is the Town's intention to present the monitoring and analysis of the non-traditional approaches to the regulatory agencies.
    - If, as anticipated, the analysis of the monitoring program determines that the non-traditional approaches have improved conditions within the Three Bays Watershed, the Town would then enter discussions with regulatory agencies to pursue non-traditional "credits" in an effort to minimize the required sewer expansion proposed in Phase 3.
        - The Town is not proposing any non-traditional "credits" at this time and has designed the sewer expansion plan to achieve the required septic load removals by traditional approaches only.
- Continued embayment monitoring.

5.1.3 PHASE 3

- Continued sewer expansion into the northerly portion of the Three Bays Watershed.
- Continued sewer expansion within the Lewis Bay/Halls Creek Watershed.
- Continued monitoring and analysis of non-traditional projects and follow-up with regulatory agencies.
- Continued embayment monitoring.

Table 5-1: Sewer Expansion Plan - Phasing Statistics

	Phase 1 (0-10 Years)	Phase 2 (10-20 Years)	Phase 3 (20-30 Years)	Total
WW Captured (gpd)	782,000	653,000	335,000	**1,770,000**
Load N Removed (kg/day)	78	65	33	**176**
Number of Parcels Affected	4,610	3,130	2,100	**9,870**
Approximate Road Miles	90	60	40	**190**
% of N Removed by Plan	44%	37%	19%	**100%**

In addition to the three phases, the sewer expansion plan also includes three separate "stages" of sewer expansion. The three stages are located in the Village of Cotuit and are focused on the Popponesset Bay Watershed and the Cotuit Bay Sub-watershed of the Three Bays Watershed. The term "stages" was used for these sewer expansion areas because they do not have a determined schedule as these areas require an undetermined western treatment and disposal solution to accommodate the sewer expansion. The original plan developed by the WRAC recommended approaching these areas via an inter-municipal agreement (IMA) with Mashpee and Sandwich, which was then executed between the communities. However, in order to address water quality concerns in Shoestring Bay and Cotuit Bay that would not be addressed via nitrogen sharing in an IMA, there is a desire for traditional wastewater solution in these areas. If a westerly solution becomes a reality, the Town intends to pursue sewer expansion the areas identified in the stages.

Table 5-2: Sewer Expansion Plan - Staging Statistics

	Stage 1	Stage 2	Stage 3	Total
WW Captured (gpd)	37,200	84,500	22,800	**144,500**
Load N Removed (kg/day)	4	8	2	**14**
Number of Parcels Affected	250	480	160	**890**
Approximate Road Miles	6	9	3	**18**

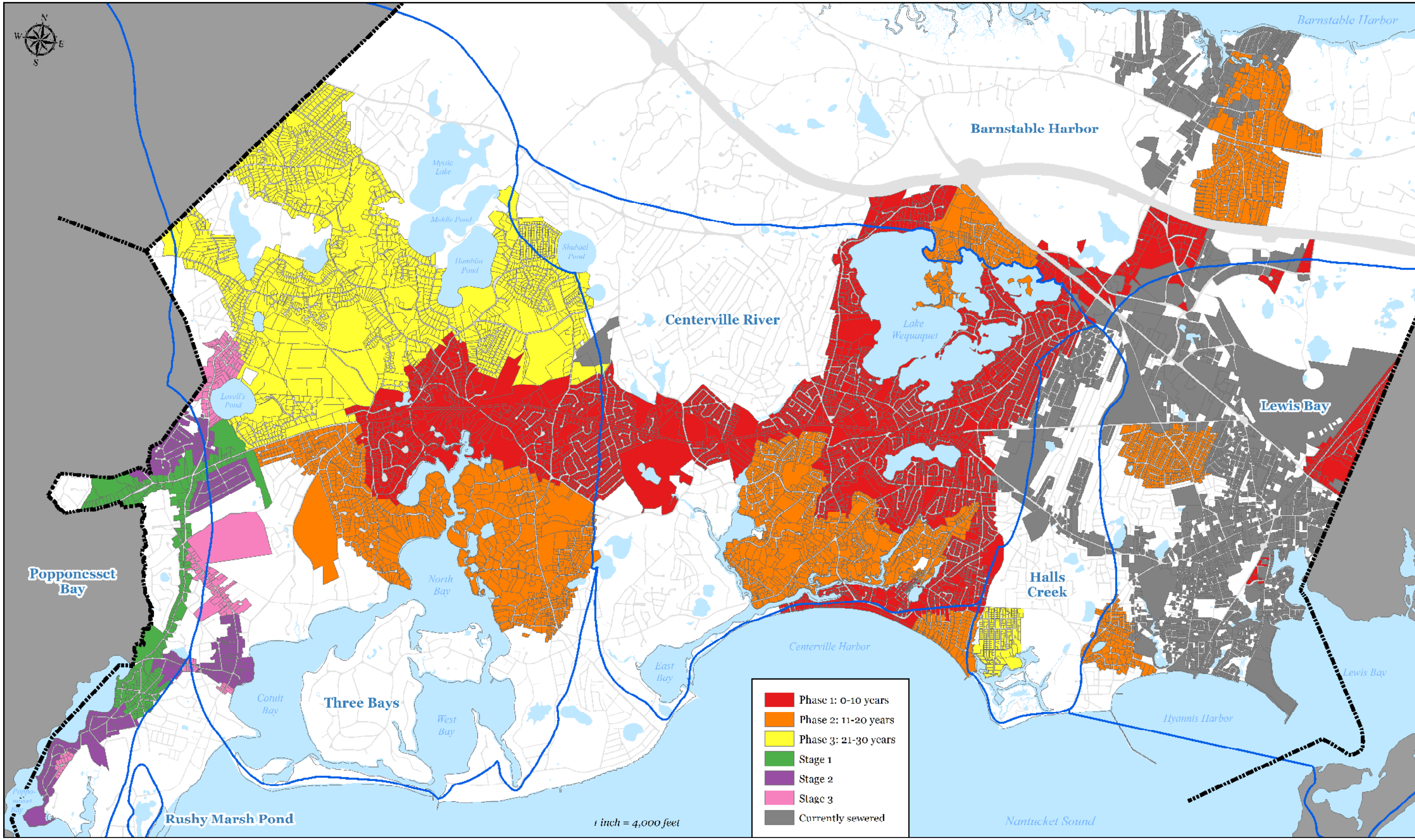

Figure 5-1: Sewer Expansion Phasing Plan

5.2 APPROACH BY WATERSHED

The plan has been developed utilizing a watershed-by-watershed approach to ensure the regulatory requirements of each watershed are met. The following sections will describe the needs and proposed solutions of each of the watershed located in the Town of Barnstable.

5.2.1 LEWIS BAY WATERSHED

The Lewis Bay Embayment System is a complex estuary located in the Towns of Barnstable and Yarmouth with a southern shored bounded by Nantucket Sound. It is comprised of several primary segments that include Hyannis Inner Harbor, Mill Creek, Snows Creek and Stewarts Creek. For a detailed description of the embayment system, refer to the 2006 MEP Report for the Lewis Bay Embayment (Appendix AA).

The Lewis Bay Watershed is the contributing area for the Lewis Bay Embayment System. The Lewis Bay Watershed is also located between the Towns of Barnstable and Yarmouth (see Figure 5-2). Within the watershed there are 71 identified surface waters including 8 named freshwater ponds and 6 significant freshwater stream outlets (Halls Creek, Stewarts Creek, Snow's Creek, Hospital Bog, Mill Pond and Chase Brook). Halls Creek Watershed is discussed separately in Section 5.2.2. There are 22 public drinking water wells located within the watershed, 10 of which are located in Barnstable (8 operated by Hyannis Water District, 2 operated by Barnstable Water District. The Town of Barnstable Water Pollution Control Facility (BWPCF) is located within the watershed. Additionally, the BWPCF treats and discharges wastewater from portions of Hyannis Village and Barnstable Village. The BWPCF is permitted for maximum daily flow treatment of 4.2 MGD and disposal of 2.7 MGD and an annual mass nitrogen load limit of 49,315 pounds per year.

5.2.1.1 SUMMARY OF NEEDS

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Lewis Bay Watershed, including nutrient removal, pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the Lewis Bay Watershed.

5.2.1.1.1 Nutrient Removal

The 2008 MEP technical report for Lewis Bay indicates that the Lewis Bay system exceeds its critical threshold for nitrogen, resulting in impaired water quality. Based upon the findings of the MEP technical report, a TMDL for nitrogen has been developed and approved.

Barnstable has already taken significant action to address nitrogen removal within the watershed via the Stewart's Creek Sewer Expansion project (refer to Section 2.3.3.1) which connected 288 of residences to municipal sewer, resulting in approximately 1.4 kg/day of net nitrogen reduction.

The Town's wastewater plan has been designed to exceed the existing septic load removals suggested in the 2008 MEP Report's threshold loading scenarios using traditional sewers. The Town also intends to pursue the feasibility in reducing nitrogen concentrations in the effluent of BWPCF by constructing denitrification filters.

The Town retained SMAST to re-model the watershed under a scenario that combines the proposed Town of Barnstable and Town of Yarmouth's wastewater plans to confirm that the TMDL will be met by the implementation of the two community's plans. The updated SMAST model which indicates that the TMDL will be met under this scenario (refer to Appendix OO). The Town of Barnstable anticipates that the two communities will pursue a watershed permit for the Lewis Bay Watershed.

5.2.1.1.2 Wastewater Needs (Other Needs)

Title 5 Issues

Integral to the planning process was the Town's development a wastewater planning GIS tool which allowed Town staff to spatially map traditional Title 5 concerns such as small lot size, depth to groundwater, existing septic variances, existing known failed septic systems, and systems within Zone IIs. Parcels with area less than 0.25 acres were flagged because they were considered difficult to site a traditional septic system, likely to need septic variances, and increased density leading to increased nutrient loading. Parcels with an average depth of groundwater of less than four feet were flagged as likely to require raised systems which are costly and less desirable for community aesthetics. Existing septic variances and existing known failed septic systems were also mapped.

The tool allows the Town to overlay these layers to identify the "hot-spots" for traditional Title 5 concerns. These areas were then incorporated into the plan where practical. Many of these "hot-spots" overlaid other needs such as nutrients and pond protection. The Plan for the Lewis Bay Watershed significantly address traditional Title 5 concerns as shown in the data presented below which was calculated using the Town's wastewater planning GIS tool:

- Total parcels within the Town of Barnstable within the Lewis Bay Watershed = 5,220
- Total parcels connected to existing municipal sewer = 2,256 (43%)

- Parcels with total area less than 0.25 acres = 2,315 (44%)
    - 1,119 (48%) already served by municipal sewer
    - 329 (14%) additional to be addressed with a traditional solution in the Plan
    - Total = 1,448 (62%)
- Parcels with average depth to groundwater less than four feet = 158 (3%)
    - 59 (37%) already served by municipal sewer
    - 20 (13%) additional to be addressed with a traditional solution in the Plan
    - Total = 79 (50%)
- Parcels with septic system variances = 27 (0.5%)
    - 3 (11%) will be addressed with a traditional solution in the Plan
- Parcels with known failed septic systems = 4 (0.08%)
    - 1 (25%) will be addressed with a traditional solution in the Plan
- Parcels located within a Zone II = 2,498 (48%)
    - 842 (34%) already served by municipal sewer
    - 265 (11%) additional to be addressed with a traditional solution in the Plan
    - Total = 1,107 (44%)

Please note that Hall's Creek Watershed is not included in this data. Refer to Section 5.2.2 for Hall's Creek Watershed data.

Flood Zones

The majority of the parcels within flood zones in the Lewis Bay Watershed in the Town of Barnstable are already served by municipal sewer.

- Total parcels within the Lewis Bay Watershed = 5,220
- Parcels within FEMA mapped 100-year flood zone (AE/AO) or velocity zone (VE) = 601
    - 430 (71%) already served by municipal sewer
    - 23 (4%) that will be addressed with a traditional solution in the Plan
    - Total = 453 (75%)

5.2.1.1.3 Drinking Water Supply Protection and Contaminants of Emerging Concern (CEC's)

The Hyannis Water System (HWS) supplies drinking water to the majority of the parcels within the Lewis Bay Watershed. In recent years, the HWS has had significant issues with CEC's, specifically PFOS and 1,4-dioxane. The Town has been proactive in addressing this issue by investing significant capital to update treatment facilities for the HWS, specifically at the Mary

Dunn Wells (activated carbon filters) and the Maher Wells (construction of $12 million treatment plant to treat for PFOS, 1,4 dioxane, iron and manganese).

The Plan continues the effort of protection of the drinking waters source. The sewer expansion will connect 265 properties that are located within delineated Zone IIs to municipal sewer. Of particular concern is the "Old Yarmouth Road" project area which is directly adjacent to and up-gradient from the Maher wellfield. The existing land use within this area is predominantly commercial. The majority of the commercial uses are motor vehicle dealerships and repair facilities which are land uses susceptible to hazard material release. The proposed Old Yarmouth Road Sewer Expansion project will connect the 131 properties within the project area to municipal sewer, thus reducing the risk of contamination from the commercial uses existing in this area.

5.2.1.1.4 Pond Protection

The Town's wastewater planning has included detailed studies of ponds 3 acres or larger throughout the Town. Through those studies, there is extensive water data for 9 ponds in the Lewis Bay Watershed. Pond classification of these ponds is shown in Table 5-3.

Table 5-3: Lewis Bay Watershed Pond Classification

	Ultra-Shallow 0 to 2.1m	Shallow 2.1 to 8.6m	Deep >8.6
Oligotrophic Total P<0-12 (ug/l)	Mary Dunn Pond Lamson Pond Campground Pond		
Mesotrophic Total P<12-24 (ug/l)	Aunt Betty's Pond Fawcett's Pond Isreal's Pond		
Eutrophic Total P<24-96 (ug/l)	Fresh Hole Pond	Flintrock Pond	
Hypereutrophic		Schoolhouse Pond	

Five ponds within the watershed have been identified as impaired; Fawcett's Pond, Isreals Pond, Fresh Pond, Flintrock Pond, and Schoolhouse Pond. Sewer expansion adjacent to the following ponds for protection from nutrients from septic systems has been proposed.

5.2.1.1.5 Economic Development

The Town's Planning and Development Department (P&D) identified a number of areas within the Lewis Bay Watershed as needs areas for sewer expansion to promote economic development. These areas include:

- The "Old Yarmouth Road Sewer Expansion" project area located north of Route 28, east of Yarmouth Road and west of the Town Line.
- Parcels not served by municipal sewer in the area of Hyannis Harbor.
- Properties in the "Independence Park" area that have not been connected to municipal sewer to date or have not been developed to date.

5.2.1.2 PROPOSED SOLUTIONS

The plan addresses the needs areas using the following techniques:

- Sewer Expansion
  - 2,256 of the 5,220 parcels (43%) in the watershed within the Town of Barnstable are already connected to municipal sewer
  - 241 parcels (5%) in the watershed within the Town of Barnstable were included in the Stewart's Creek Sewer Expansion Project (1.4 kg/day–N)
  - 840 parcels (16%) in the watershed are included in the proposed sewer expansion plan (14.4 kg/day-N)
  - Total proposed removal of (15.8 kg/day-N from watershed within the Town of Barnstable from proposed sewer expansion (including Stewart's Creek Sewer Expansion Project)

- BWPCF Upgrades
  - Evaluate, design and construct denitrification upgrades to decrease BWPCF total nitrogen (TN) from an existing average of 6 mg/L to a proposed average of 3 mg/L or lower.
    - At the BWPCF existing annual average daily flow of 1.67 MGD, 37.9 kg/day-N is discharge to the watershed.
    - A 50% reduction in the average effluent discharge TN concentration would remove 18.9 kg/day-N of existing nitrogen load from the watershed (approximately 35% of the total attenuated load to be removed per the Cape Cod Commission 208 Watershed Report).
  - Seek effluent discharge sites to accommodate additional flow being generated by the sewer expansion connections being treated at BWPCF.

- Stormwater upgrades
    - The Town's MS4 program will identify and provide solutions to existing stormwater outfalls.
        - 59 of the Town's 207 identified stormwater outfalls are located in the Lewis Bay Watershed.
    - The Town's Public Road program invests on average $750,000 a year in stormwater improvements in the Town's public roads. These improvements generally include replacement of failed catch basins and leaching structures.

- Fertilizer Regulation
    - In 2014 the Town adopted a Fertilizer Nitrogen and Phosphorus Control Regulation (see Appendix PP). The regulations includes the following:
        - Provides Best Management Practices and performance standards for noncertified fertilizer applicators.
        - Outlines education, certification, enforcement and penalties.

- Watershed Permit
    - Work with the Town of Yarmouth to seek a Watershed Permit for the Lewis Bay Watershed

5.2.1.3 FUTURE CONDITIONS

The plan accommodates future growth conditions as follows:

- Watershed is already densely developed.
- Hyannis Village is the main commercial center for Cape Cod. A Growth Incentive Zone (GIZ) has been established within Downtown Hyannis to promote re-development within the area.
    - The GIZ has existing sewer infrastructure, much of which dates back to the 1930s.
        - Studies are on-going (South Street, Barnstable Road, SewerCAD, etc.) to study the existing sewer collection system and determine where upgrades may be necessary to accommodate projected development within the GIZ.
        - Projects such as the Infiltration and Inflow Evaluation, Sewer System Evaluation Survey, and Pleasant Street Re-Lining project have addressed the aging infrastructure.
- Projected growth within the watershed is anticipated in areas that are either already served by municipal sewer or are included in the sewer expansion plan.
    - The sewer expansion plan has been designed to remove septic load than above and beyond what modeling required for existing conditions in order to accommodate projected growth within the watershed.

- Sewer expansion projects will be designed to accommodate growth within the expansion areas (increased pipe sizes, appropriate pump station sizing, etc.).
- Adaptive management and monitoring
    - The Town will continue to monitor the embayment, review the Plan and provide formal updates as required.
    - Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.

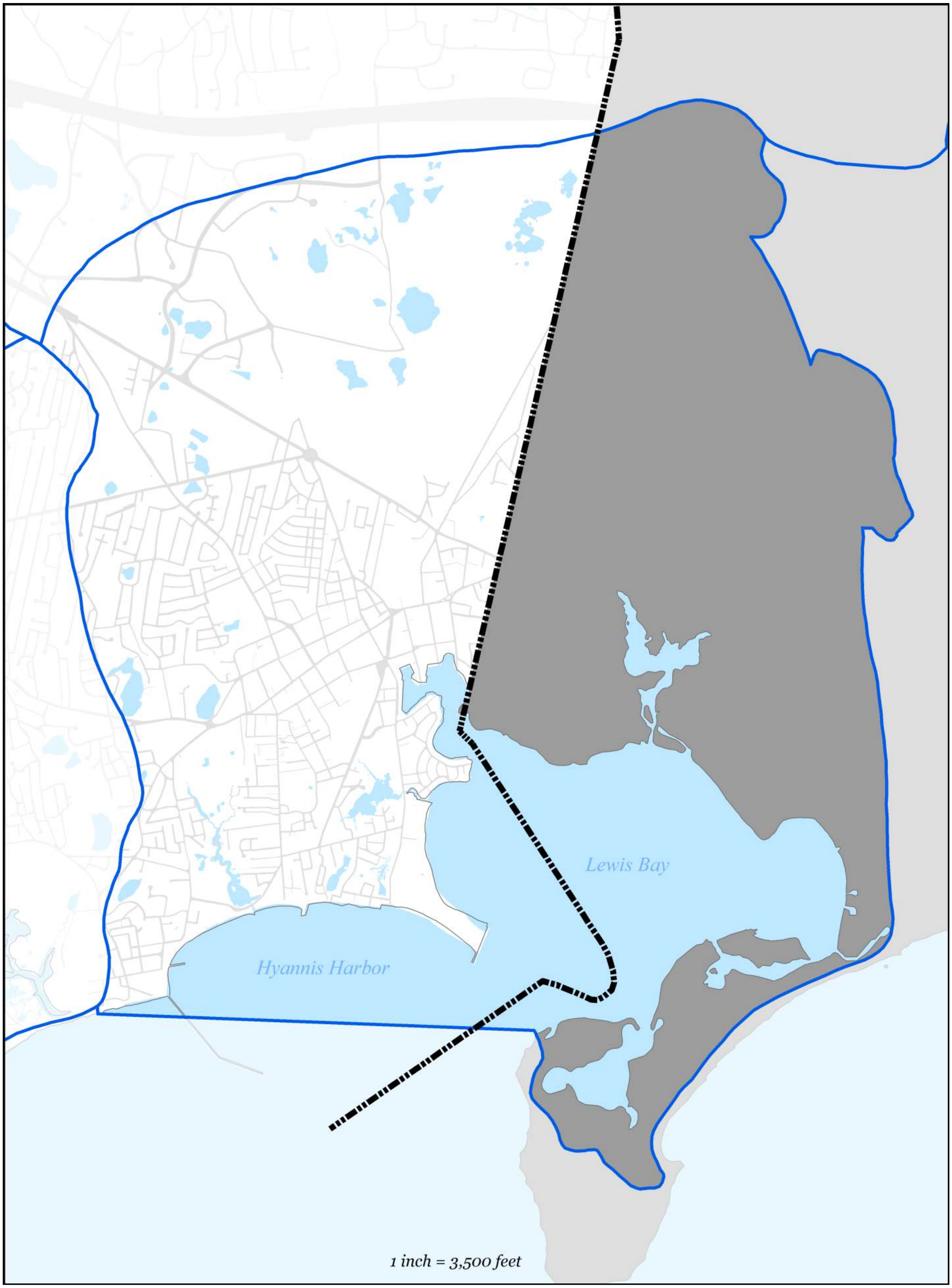

Figure 5-2: Lewis Bay Watershed

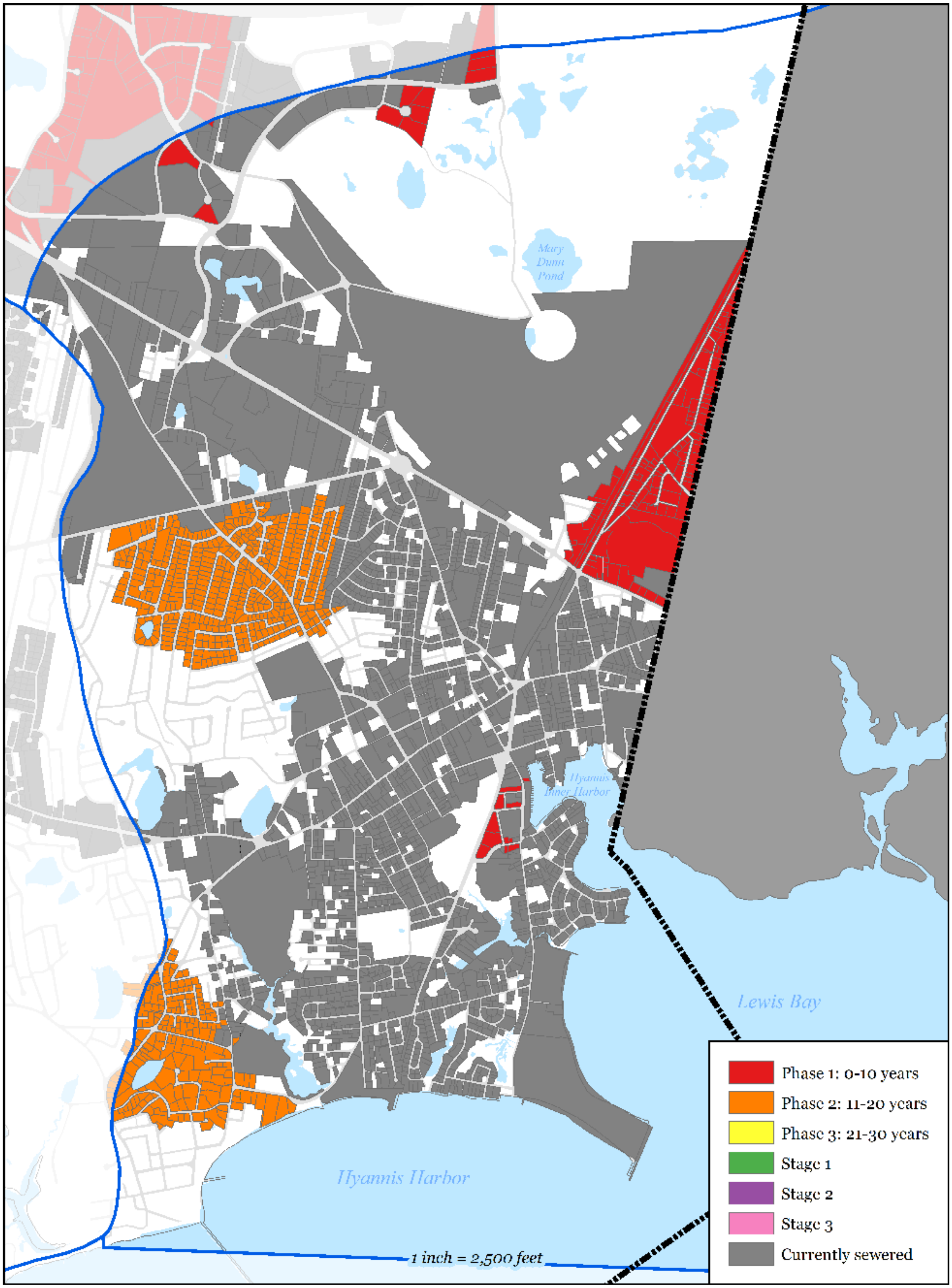

Figure 5-3: Sewer Expansion Plan in Lewis Bay Watershed

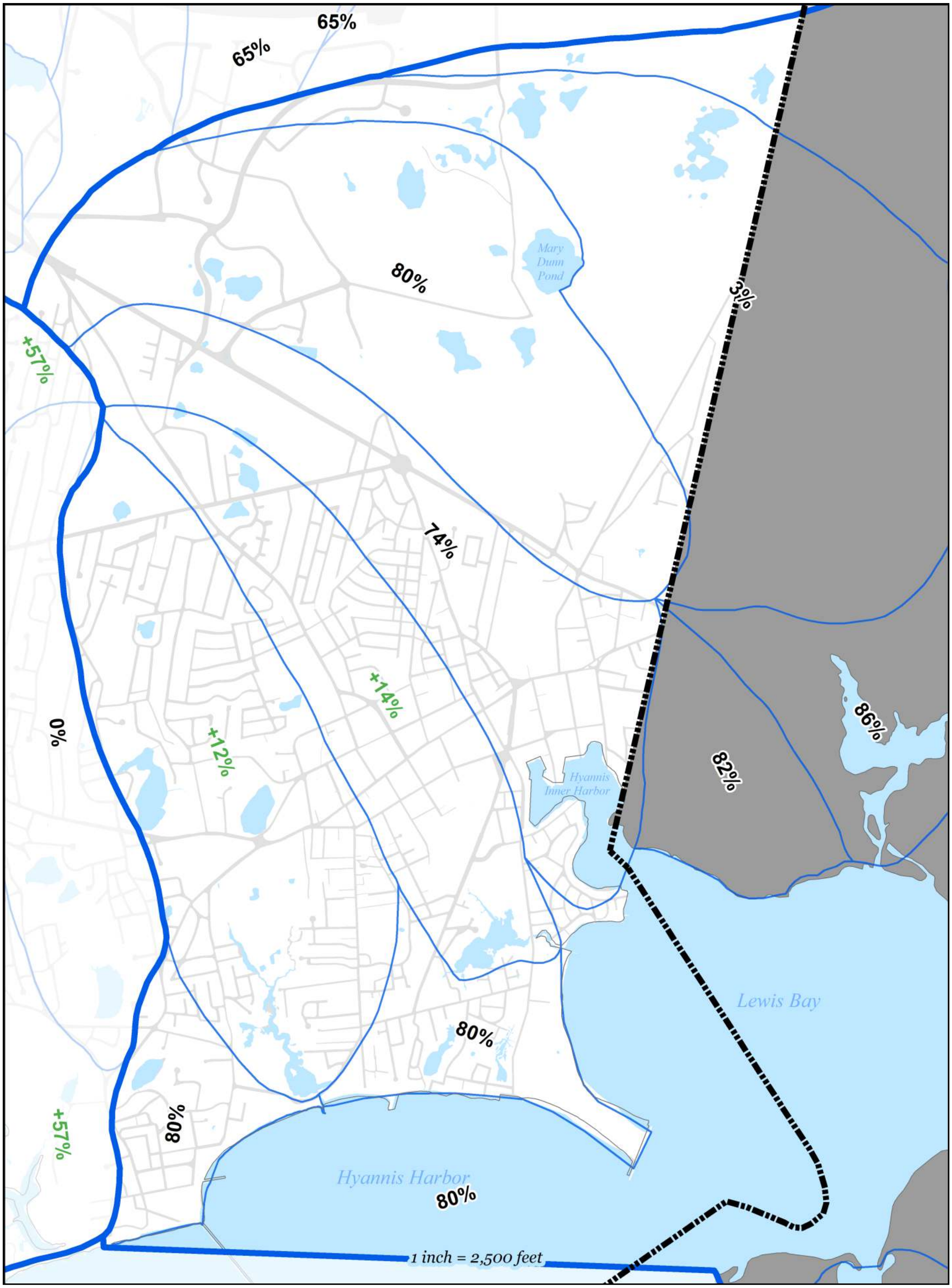

Figure 5-4: MEP-modeled Existing Septic Load Removal in Lewis Bay Watershed

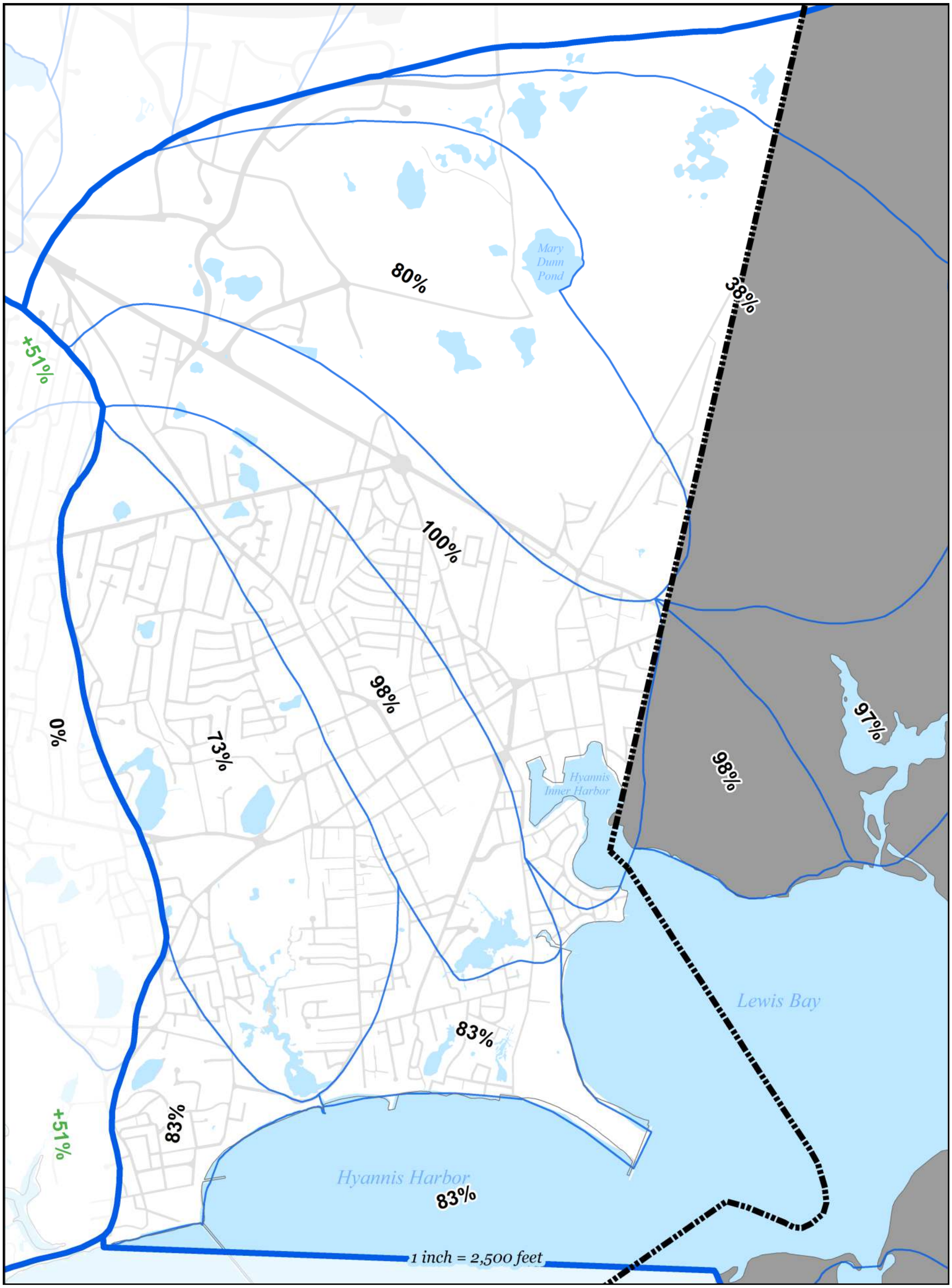

Figure 5-5: MEP-modeled Future Septic Load Removal in Lewis Bay Watershed

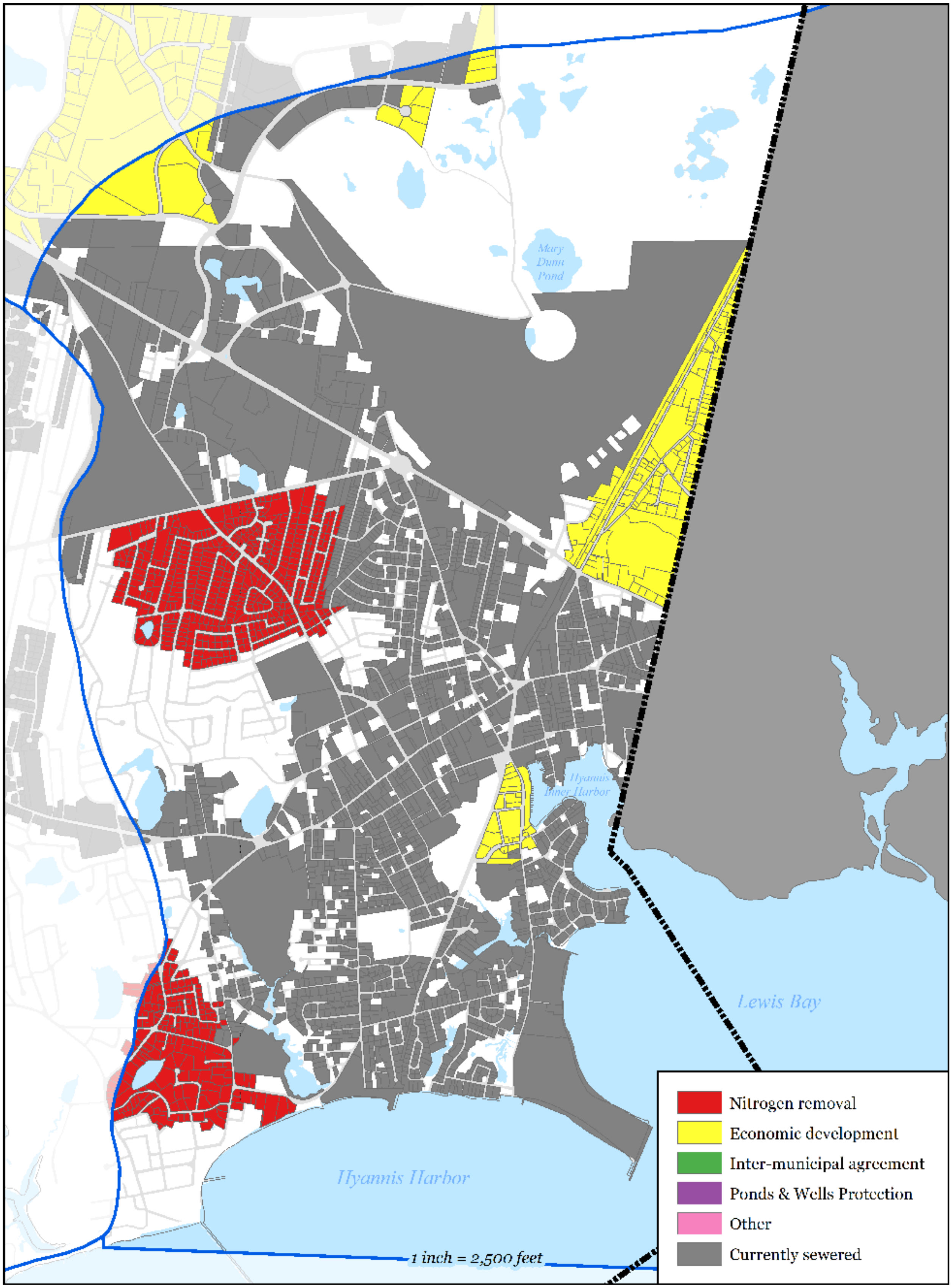

Figure 5-6: Needs Areas in Lewis Bay Watershed

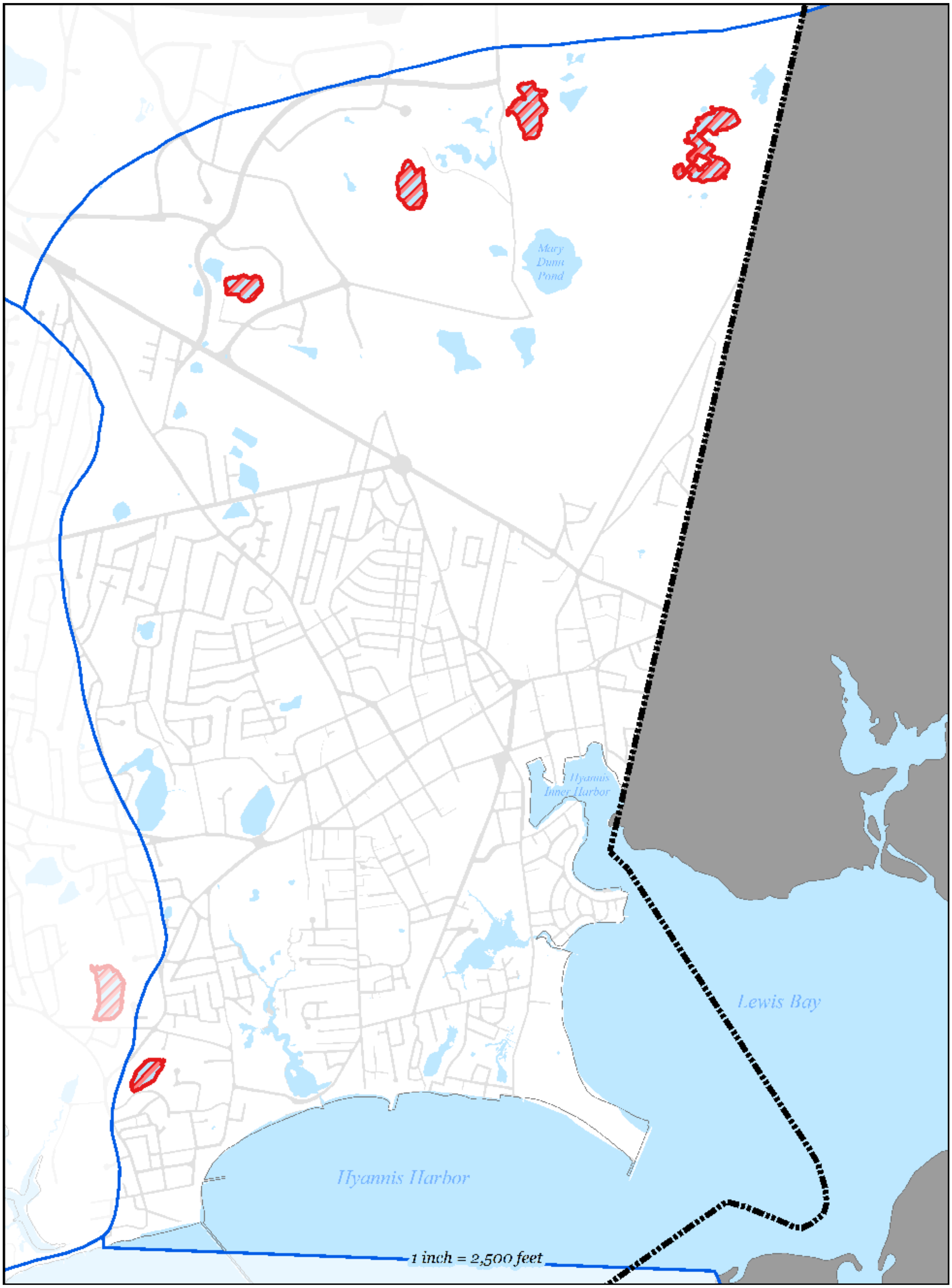

Figure 5-7: Impaired Ponds in Lewis Bay Watershed

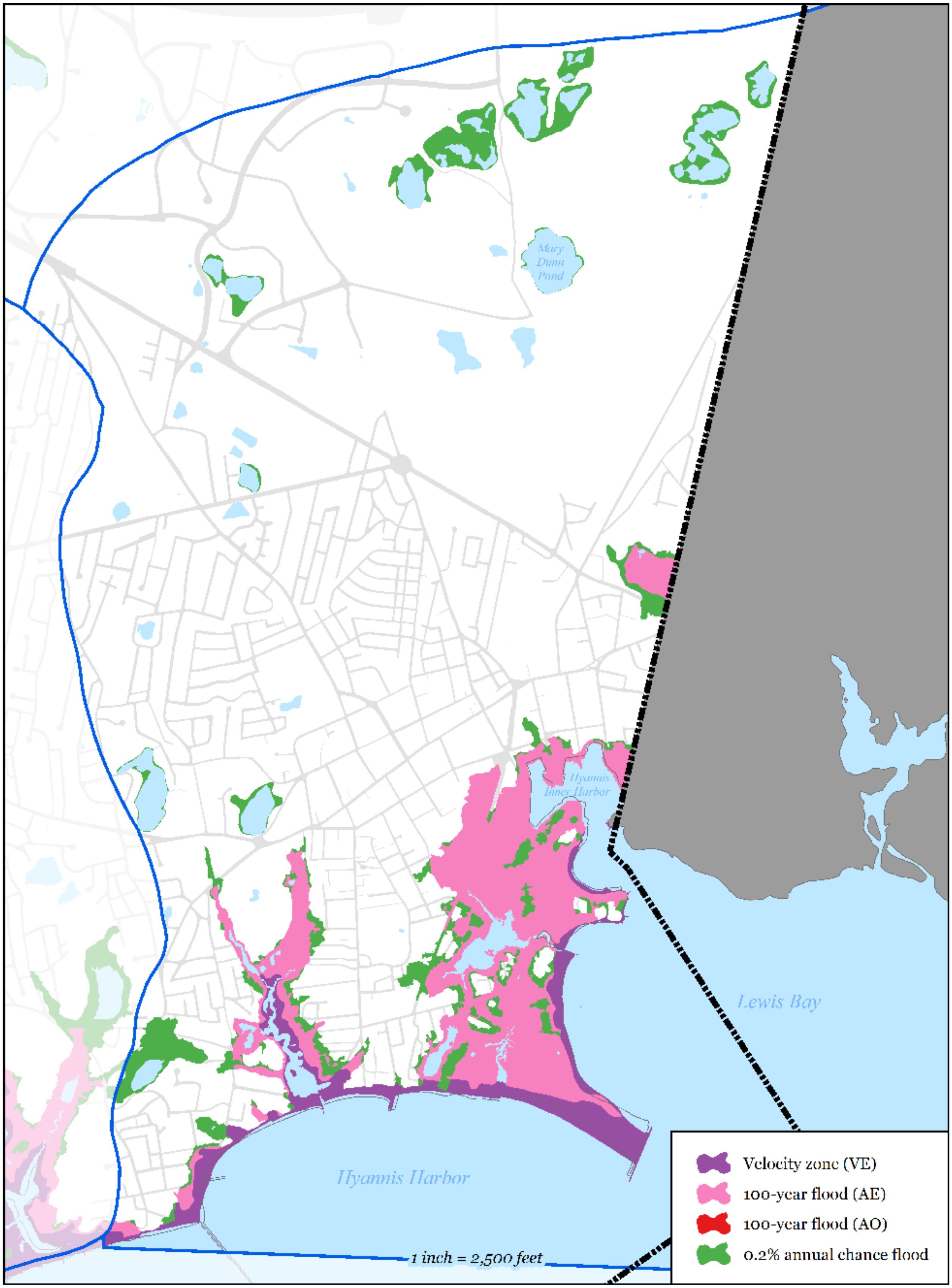

Figure 5-8: FEMA Flood Zones (2014) in Lewis Bay Watershed

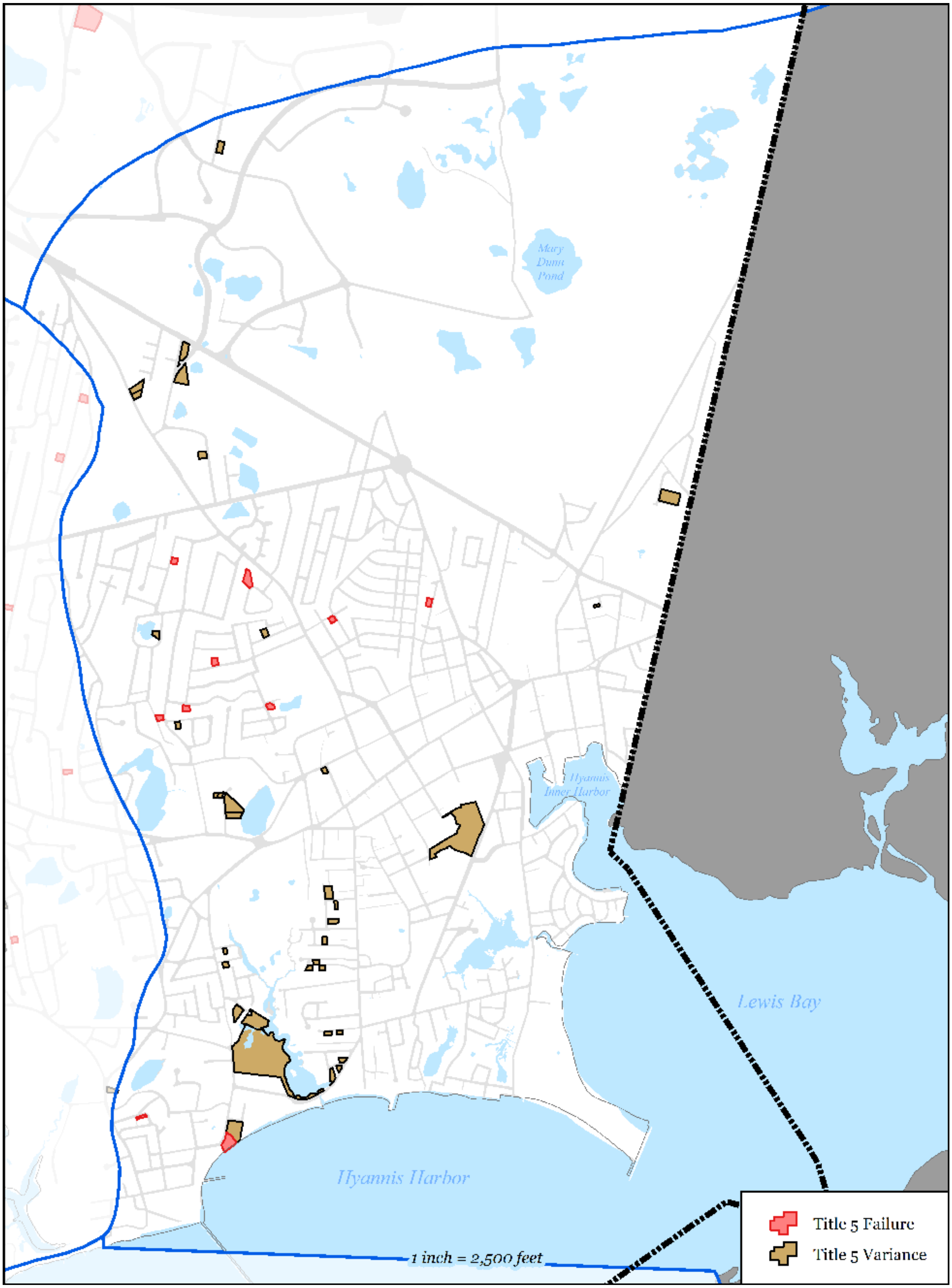

Figure 5-9: Parcels with Title 5 Septic Failures and Variances in Lewis Bay Watershed

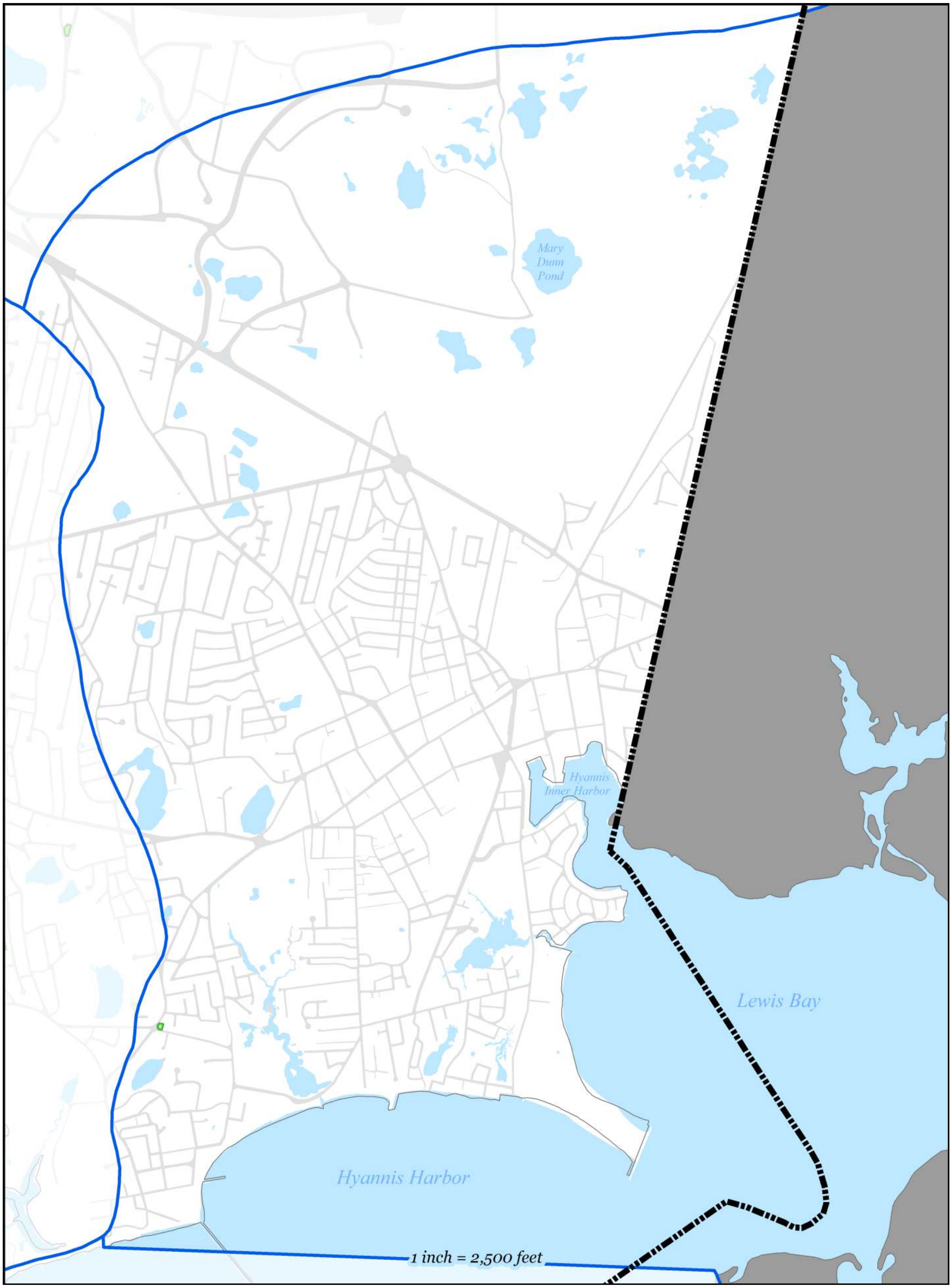

Figure 5-10: Parcels with I/A Septic Systems in Lewis Bay Watershed

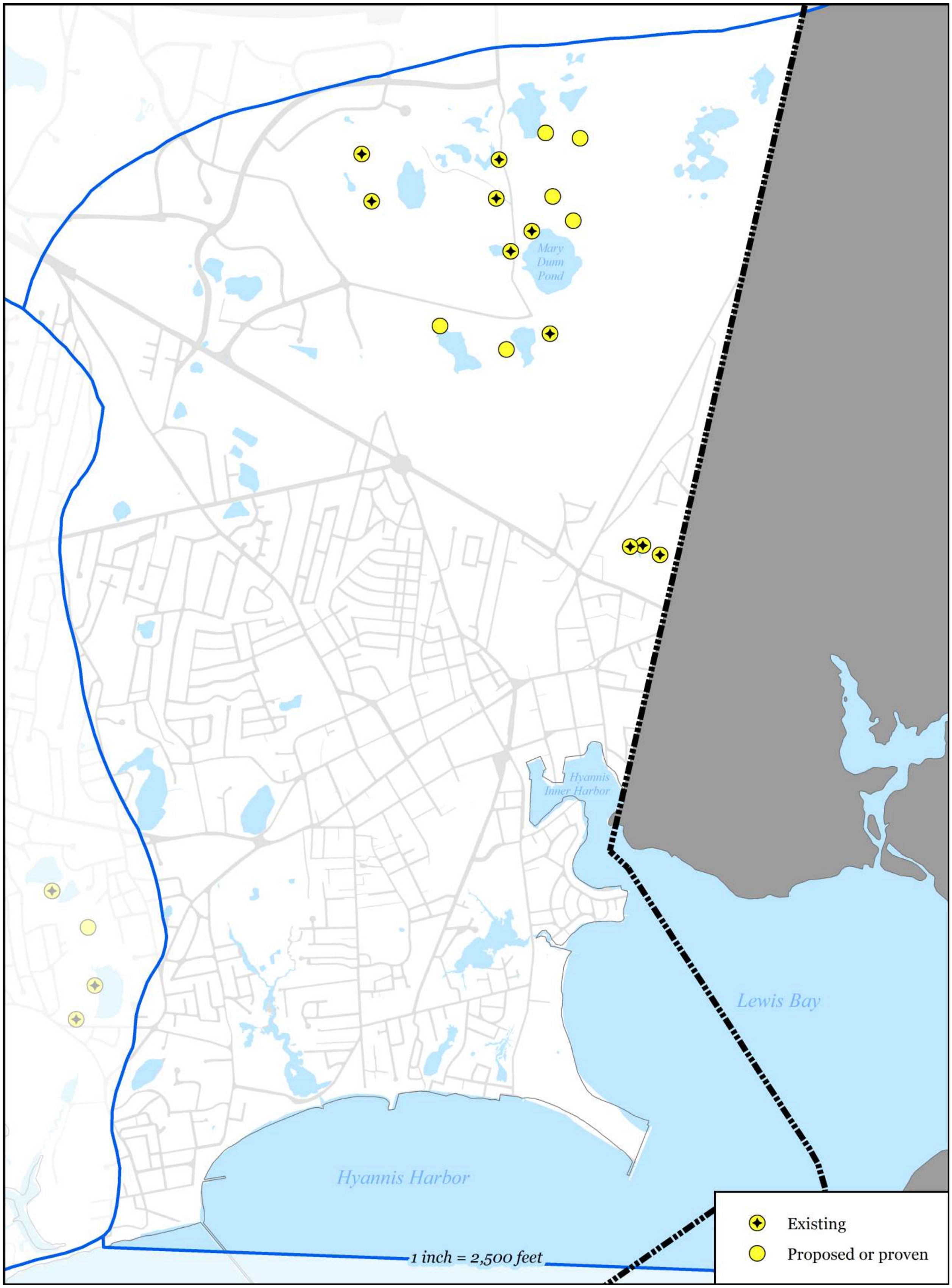

Figure 5-11: Public Water Supply Wells in Lewis Bay Watershed

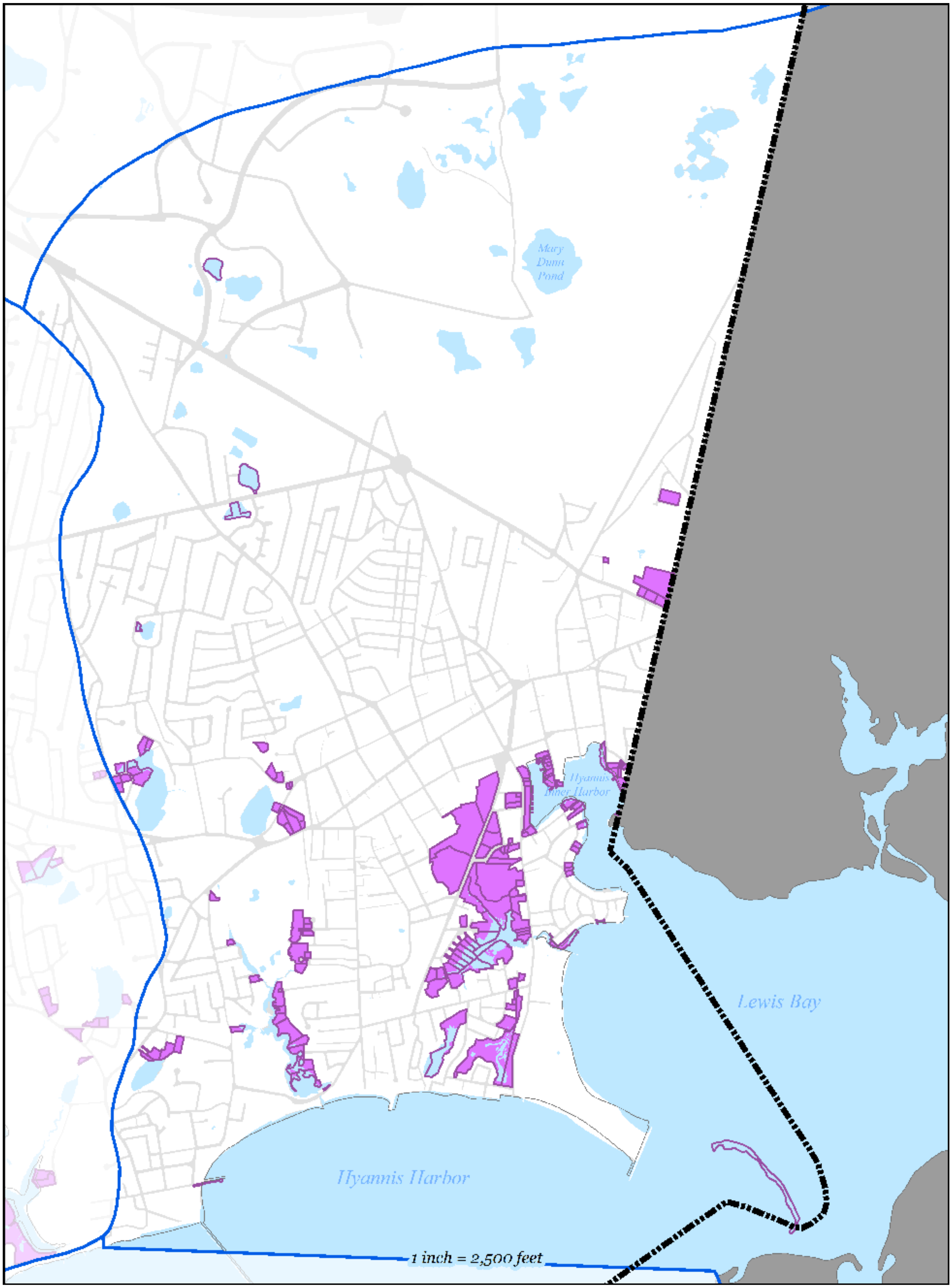

Figure 5-12: Parcels with Less than 4 feet Depth to Groundwater in Lewis Bay Watershed

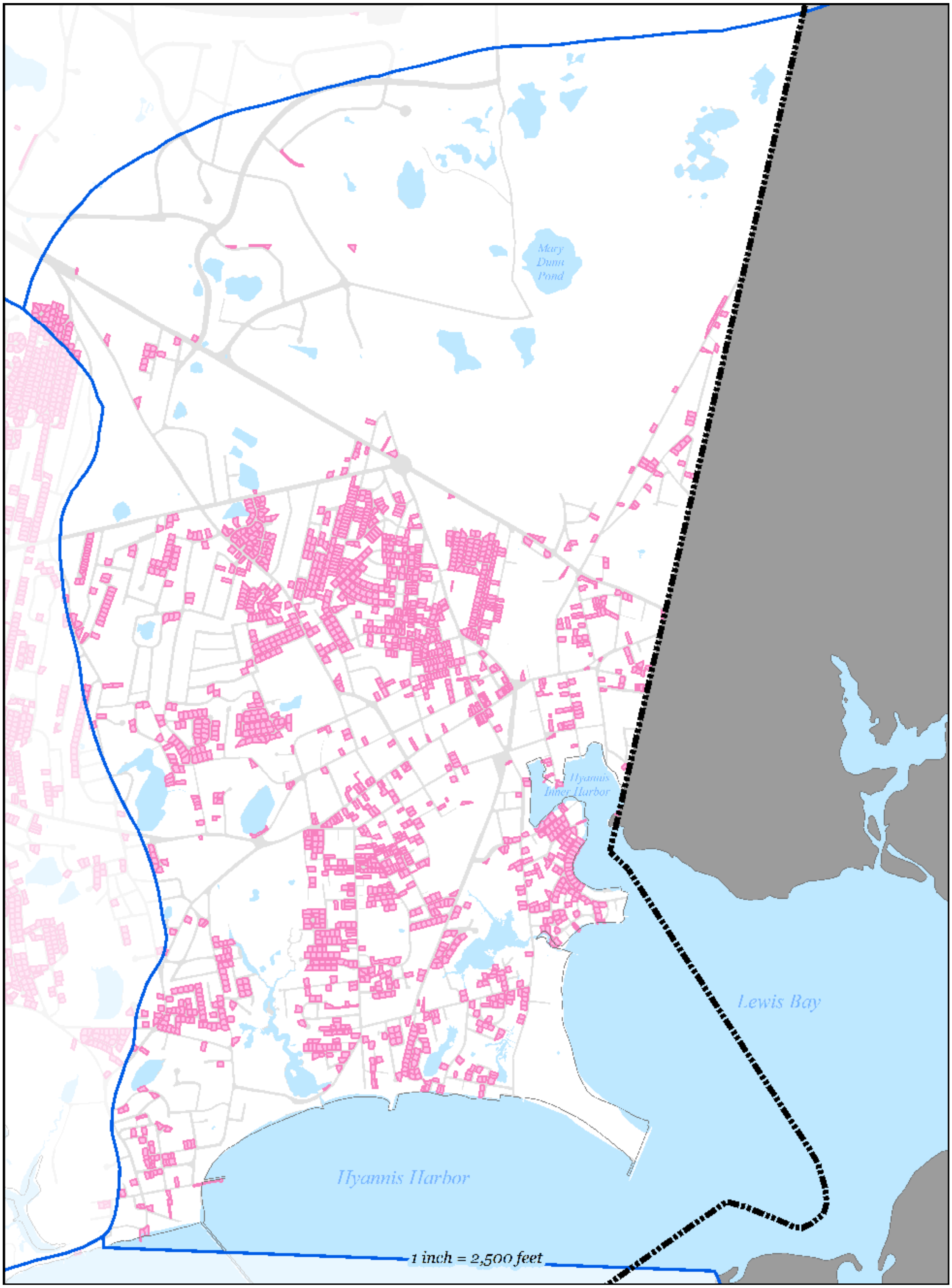

Figure 5-13: Parcels with Less than 0.25 acres in Lewis Bay Watershed

5.2.2 HALLS CREEK WATERSHED

The Halls Creek system is located within the Town of Barnstable with a southern shore bounded by Nantucket Sound. The Halls Creek estuary system is located to the west of the Lewis Bay embayment system. The 2008 Lewis Bay Embayment System MEP Report analyzes the Halls Creek system the nutrient capacity of the Halls Creek System. The estuarine system is separated from Nantucket Sound by a Squaw Island and the system exchanges tidal water with Nantucket Sound through a single inlet. For a detailed description of the embayment system, refer to the 2008 MEP Report for the Lewis Bay Embayment System (Appendix AA).

The source water for the Halls Creek system is the Halls Creek Watershed. The Halls Creek Watershed is located entirely within the Town of Barnstable (see Figure 5-14). Within the watershed there are 4 named freshwater ponds (Marchant Pond, Simmons Pond, Ben's Pond, and Dunn's Pond). The Hyannis Water District operates three public drinking water wells that are located within the watershed and COMM Water District operates one public drinking water well located on the western border of the watershed.

A large section of the upper reaches of the watershed is already served by municipal sewer. The 2008 MEP Model has shown that the Halls Creek system has an assimilative capacity to accept additional nitrogen, therefore it has not considered a needs area for nitrogen removal. As a result, significant municipal sewer extensions in the watershed are not proposed. However, there is one residential neighborhood located in the southwestern corner of the watershed that has been included in the sewer expansion plan to address other traditional wastewater needs as described below.

5.2.2.1 SUMMARY OF NEEDS

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Halls Creek Watershed, including pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the Halls Creek Watershed.

5.2.2.1.1 Nutrient Removal

The 2008 MEP Model has shown that the Halls Creek system has an assimilative capacity to accept additional nitrogen, therefore it has not considered a needs area for nitrogen removal. As a result, significant municipal sewer extensions in the watershed are not proposed. A large section of the upper reaches of the watershed is already served by municipal sewer.

5.2.2.1.2 Wastewater Needs (Other Needs)

Title 5Issues

The plan has been designed to will address traditional Title 5 concerns via traditional sewer expansion within the aforementioned residential neighborhood in the southwestern corner of the watershed. Utilizing the Town's wastewater planning GIS tool allowed Town staff to spatially map traditional Title 5 concerns such as small lot size, depth to groundwater, existing septic variances, existing known failed septic systems, and systems within Zone IIs. Parcels with area less than 0.25 acres were flagged because of they were considered difficult to site a traditional septic system, likely to need septic variances, and increased density leading to increased nutrient loading. Parcels with an average depth of groundwater of less than four feet were flagged as likely to require raised systems which are costly and less desirable for community aesthetics. Existing septic variances and existing known failed septic systems were also mapped.

The tool allows the Town to overlay these layers to identify the "hot-spots" for traditional Title 5 concerns. These areas were then incorporated into the plan where practical. Many of these "hot-spots" overlaid other needs such as nutrients and pond protection. The Plan for the Halls Creek Watershed addresses traditional Title 5 concerns as shown in the data presented below:

- Total parcels within the Halls Creek Watershed = 1,368
- Total parcels connected to existing municipal sewer = 329 (24%)
- Parcels with total area less than 0.25 acres = 642 (47%)
  - 164 (25%) already served by municipal sewer
  - 192 (30%) additional to be addressed with a traditional solution in the Plan
  - Total = 356 (55%)
- Parcels with average depth to groundwater less than four feet = 33 (2%)
  - 0 (0%) already served by municipal sewer
  - 23 (70%) additional to be addressed with a traditional solution in the Plan
  - Total = 23 (70%)
- Parcels with septic system variances = 5 (0.4%)
  - 3 (60%) will be addressed with a traditional solution in the Plan
- Parcels located within a Zone II = 856 (63%)
  - 329 (38%) already served by municipal sewer
  - 71 (8%) additional to be addressed with a traditional solution in the Plan
  - Total = 400 (47%)

5.2.2.1.3 Pond Protection

The Town's wastewater planning has included detailed studies of ponds 3 acres or larger throughout the Town. Through those studies, there is extensive water data for 3 ponds in the Halls Creek Watershed. Pond classification of these ponds is shown in Table 5-4.

Table 5-4: Halls Creek Watershed Pond Classification

	Ultra-Shallow 0 to 2.1m	Shallow 2.1 to 8.6m	Deep >8.6
Oligotrophic Total P<0-12 (ug/l)			
Mesotrophic Total P<12-24 (ug/l)	Bens Pond		
Eutrophic Total P<24-96 (ug/l)	Simmons Pond Dunns Pond		
Hypereutrophic			

Flood Zones

Low lying areas within the aforementioned residential neighborhood in the southwestern corner of the watershed adjacent to the Halls Creek estuary system have been identified as needs areas for sewer expansion due to being within the 100 year floodplain and/or the velocity zone, and generally having shallow depth to groundwater. As a result of these conditions, traditional title 5 septic systems are difficult and costly to site in these areas.

- Total parcels within the Halls Creek Watershed = 1,368
- Parcels within FEMA mapped 100-year flood zone (AE/AO) or velocity zone (VE) = 130
    - 0 (0%) already served by municipal sewer
    - 92 (71%) that will be addressed with a traditional solution in the Plan
    - Total = 92 (71%)

5.2.2.2 PROPOSED SOLUTIONS

The plan addresses the needs areas using the following techniques:

- Sewer Expansion
  - 329 of the 1,368 parcels (24%) located in the watershed are served by municipal sewer
  - 351 of the 1,368 parcels (26%) located in the watershed in the Town are included in the sewer expansion plan

- Stormwater upgrades
  - The Town's MS4 program will identify and provide solutions to existing stormwater outfalls.
    - 15 of the Town's 207 identified stormwater outfalls are located in the Halls Creek Watershed.
  - The Town's Public Road program invests on average $750,000 a year in stormwater improvements in the Town's public roads. These improvements generally include replacement of failed catch basins and leaching structures.

- Fertilizer Regulation
  - In 2014 the Town adopted a Fertilizer Nitrogen and Phosphorus Control Regulation (see Appendix PP). The regulations includes the following:
    - Provides Best Management Practices and performance standards for noncertified fertilizer applicators.
    - Outlines education, certification, enforcement and penalties.

5.2.2.3 FUTURE CONDITIONS

The plan accommodates future growth conditions as follows:

- The watershed has significant assimilative capacity to accept additional nitrogen.
- The majority of the watershed is significantly built-out and there are not significant development potential areas identified in the watershed.
- Adaptive management and monitoring
  - The Town will continue to monitor the embayment, review the Plan and provide formal updates as required.
  - Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.

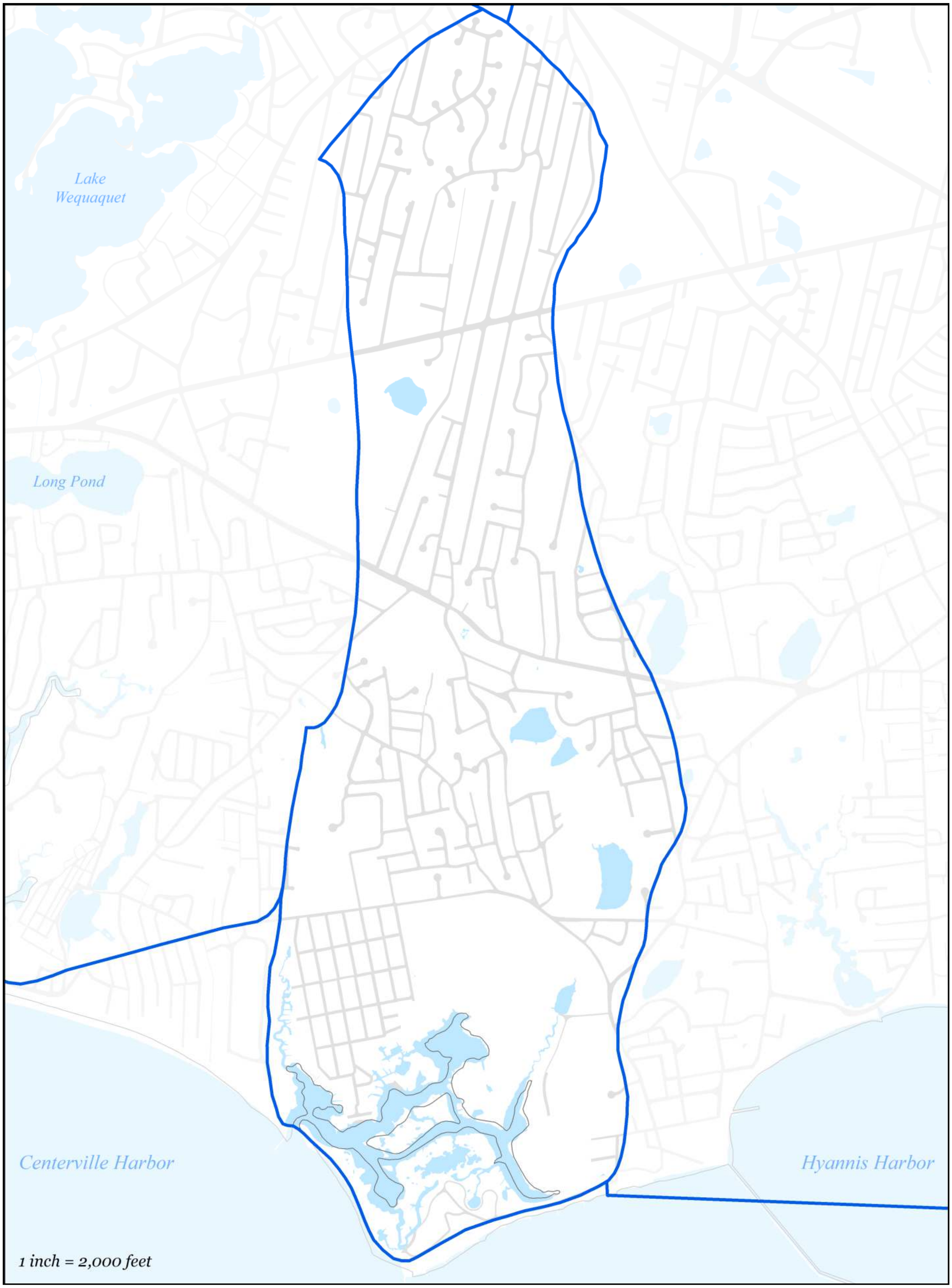

Figure 5-14: Halls Creek Watershed

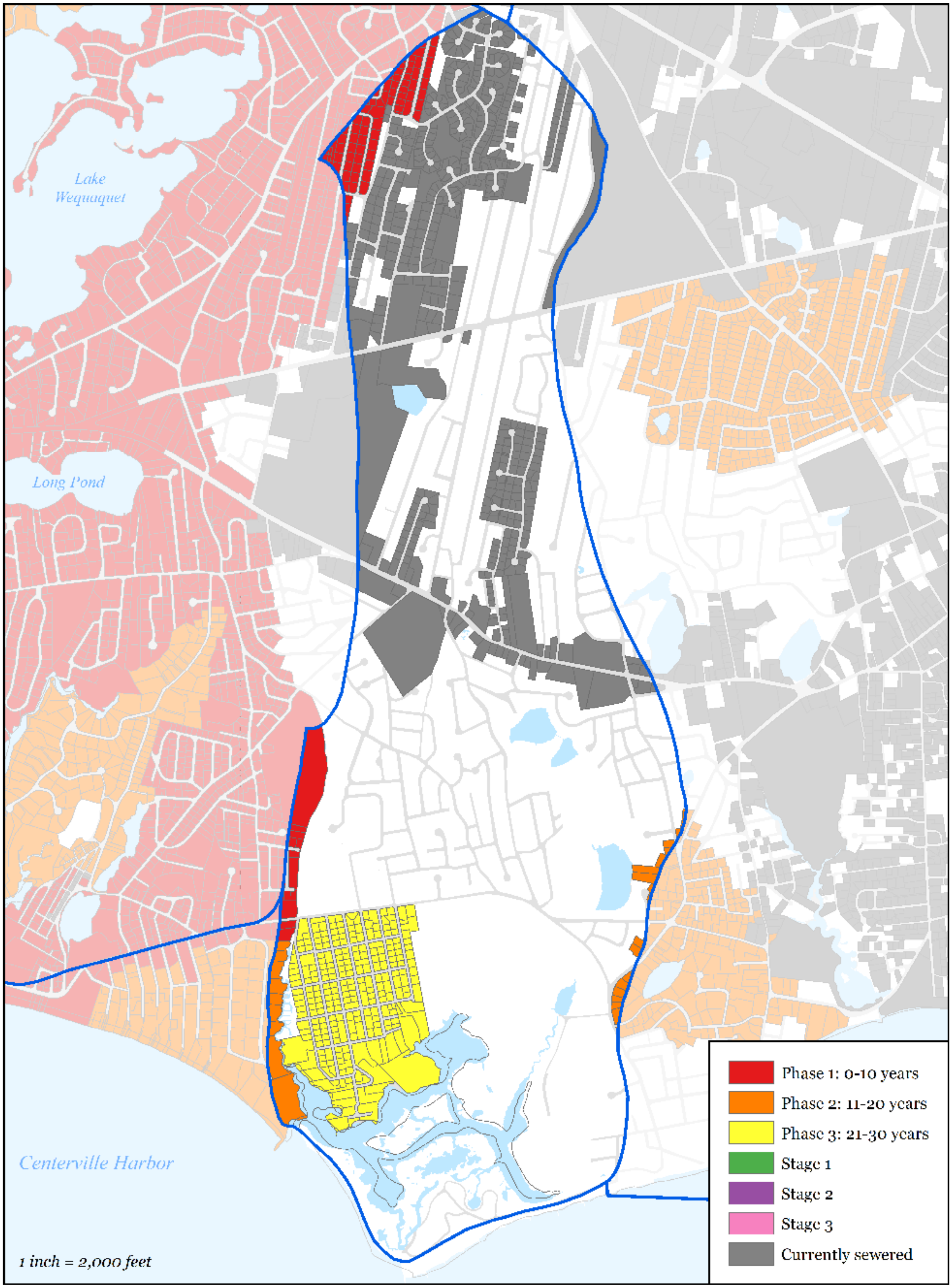

Figure 5-15: Sewer Expansion Plan in Halls Creek Watershed

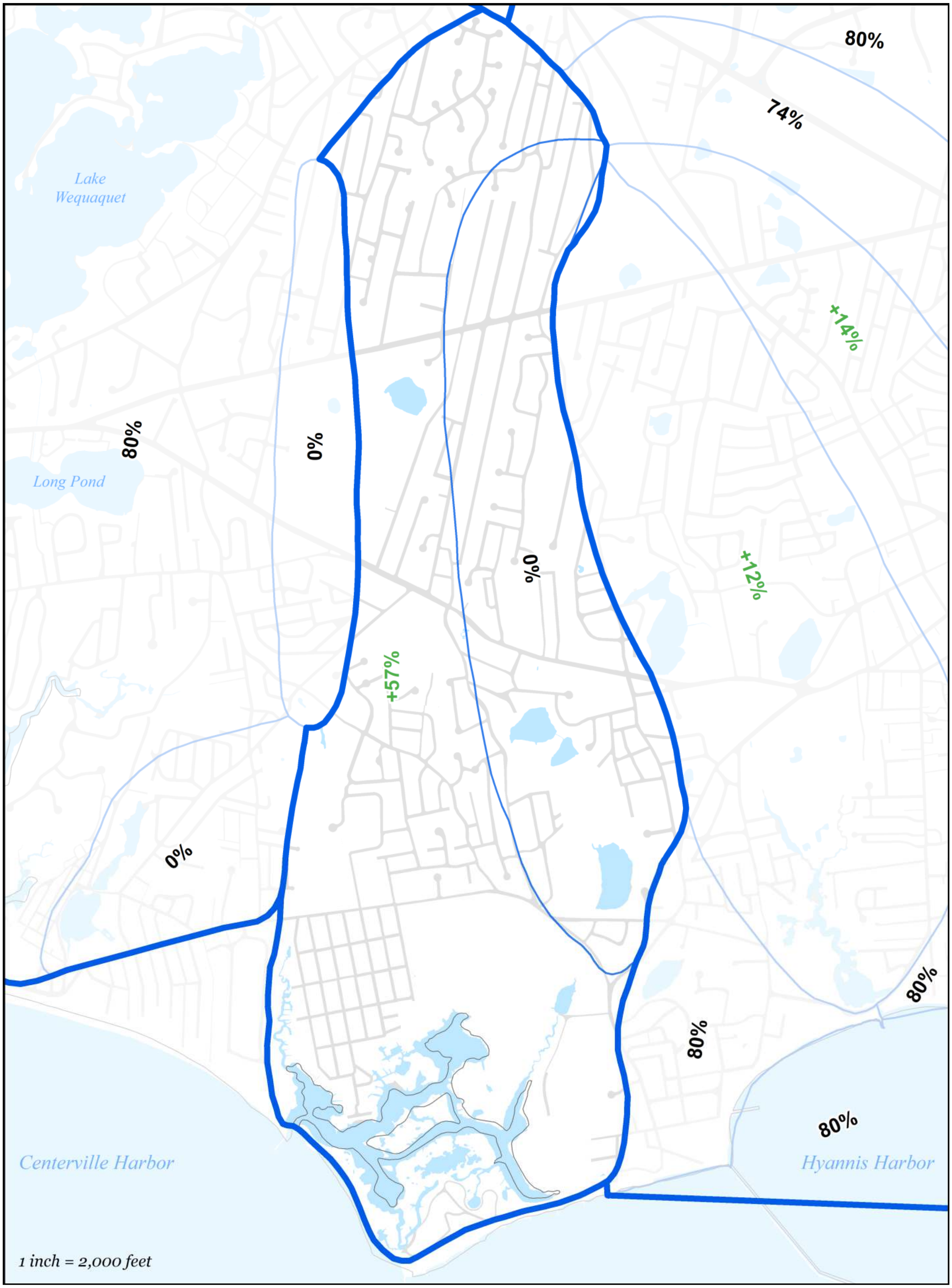

Figure 5-16: MEP-modeled Existing Septic Removal in Halls Creek Watershed

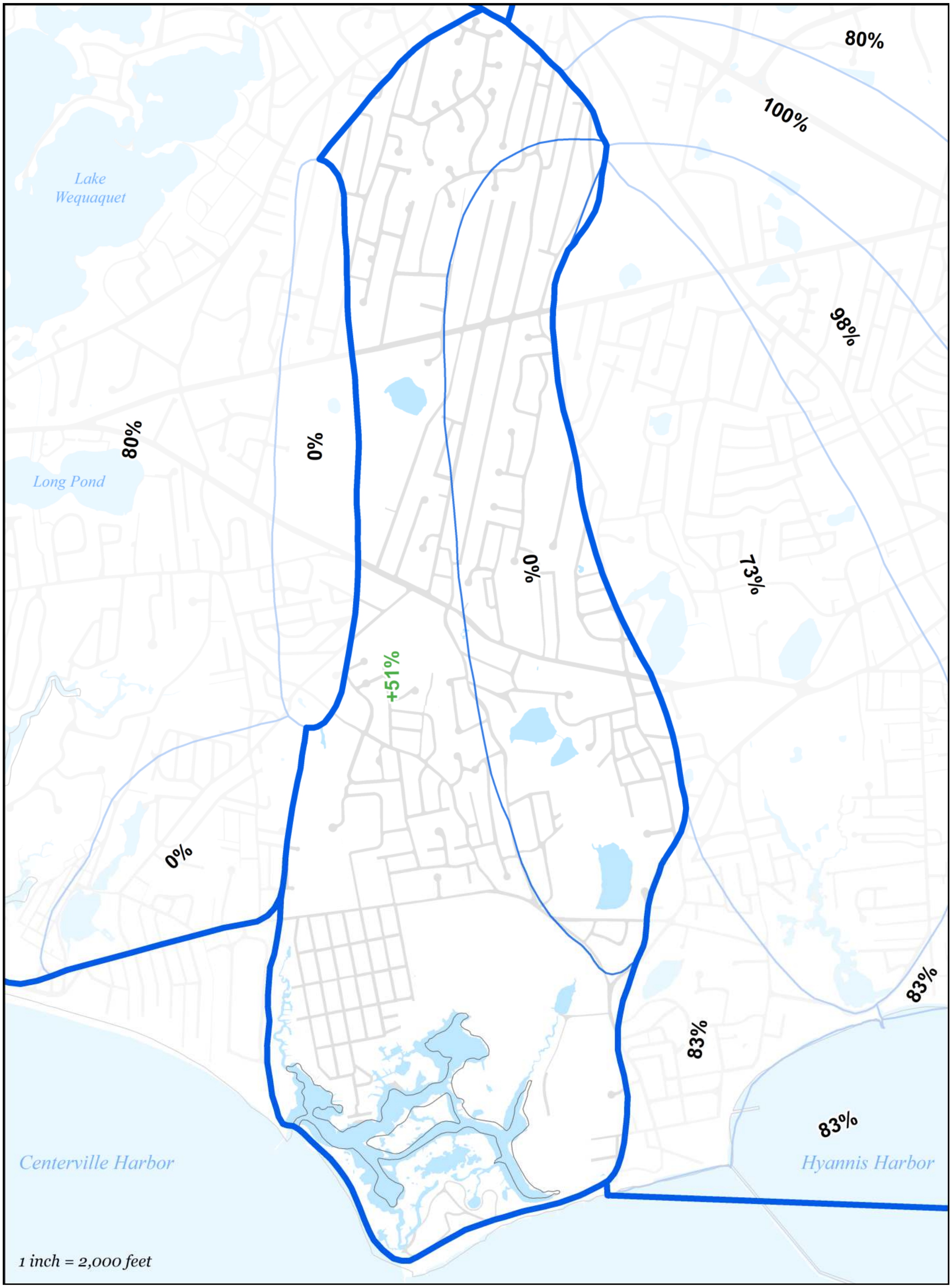

Figure 5-17: MEP-modeled Future Septic Removal in Halls Creek Watershed

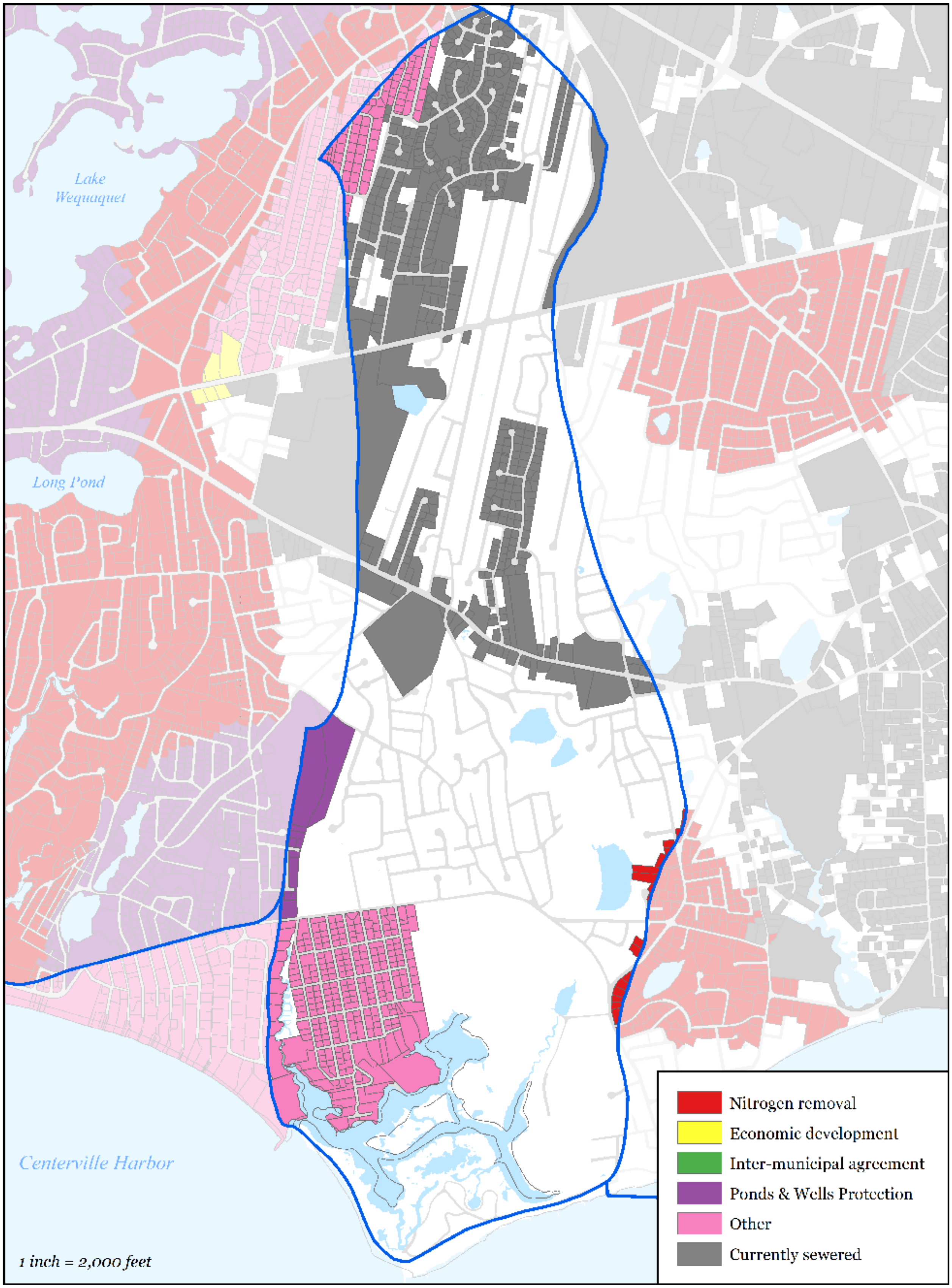

Figure 5-18: Needs Areas in Halls Creek Watershed

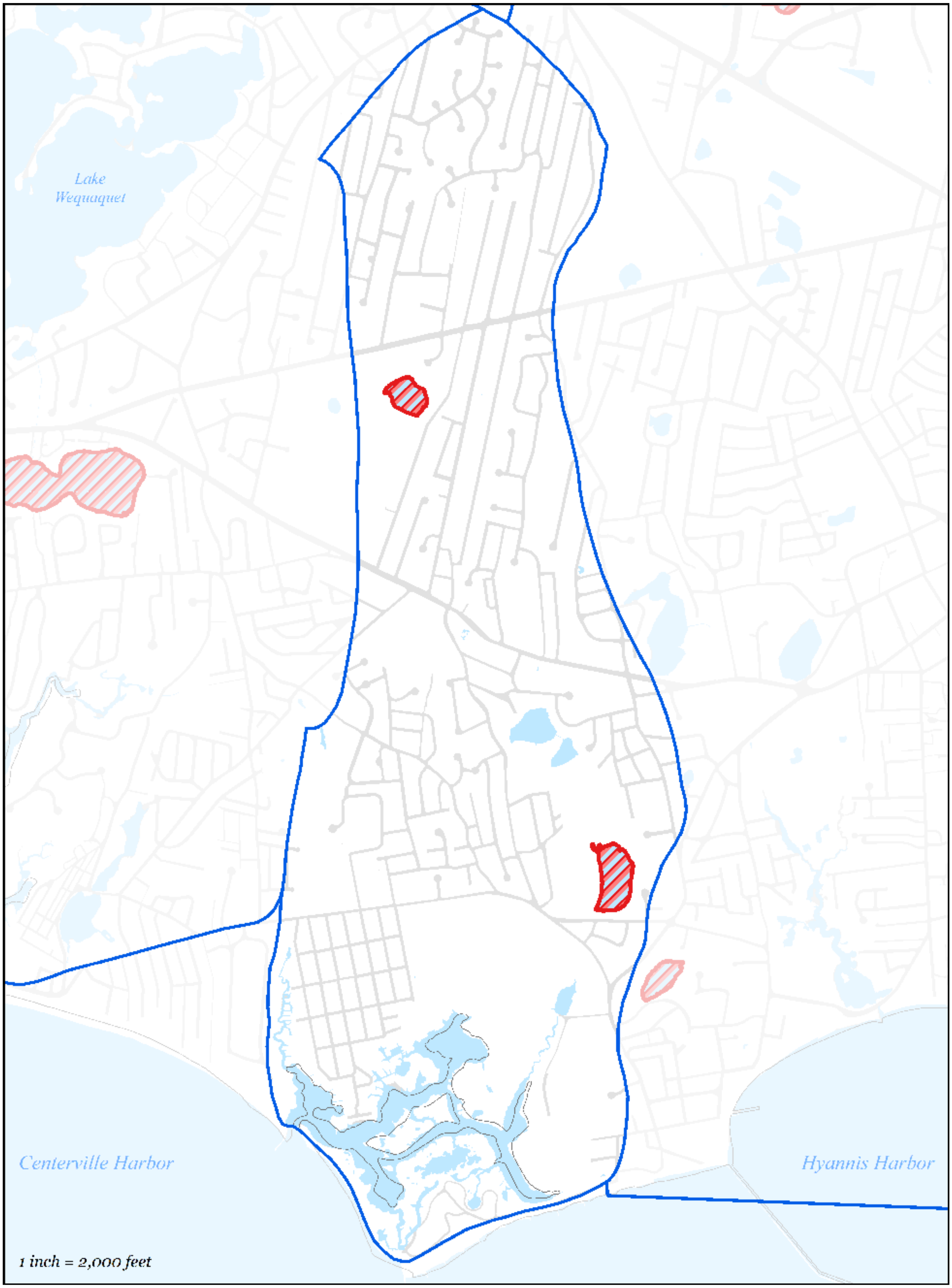

Figure 5-19: Impaired Ponds in Halls Creek Watershed

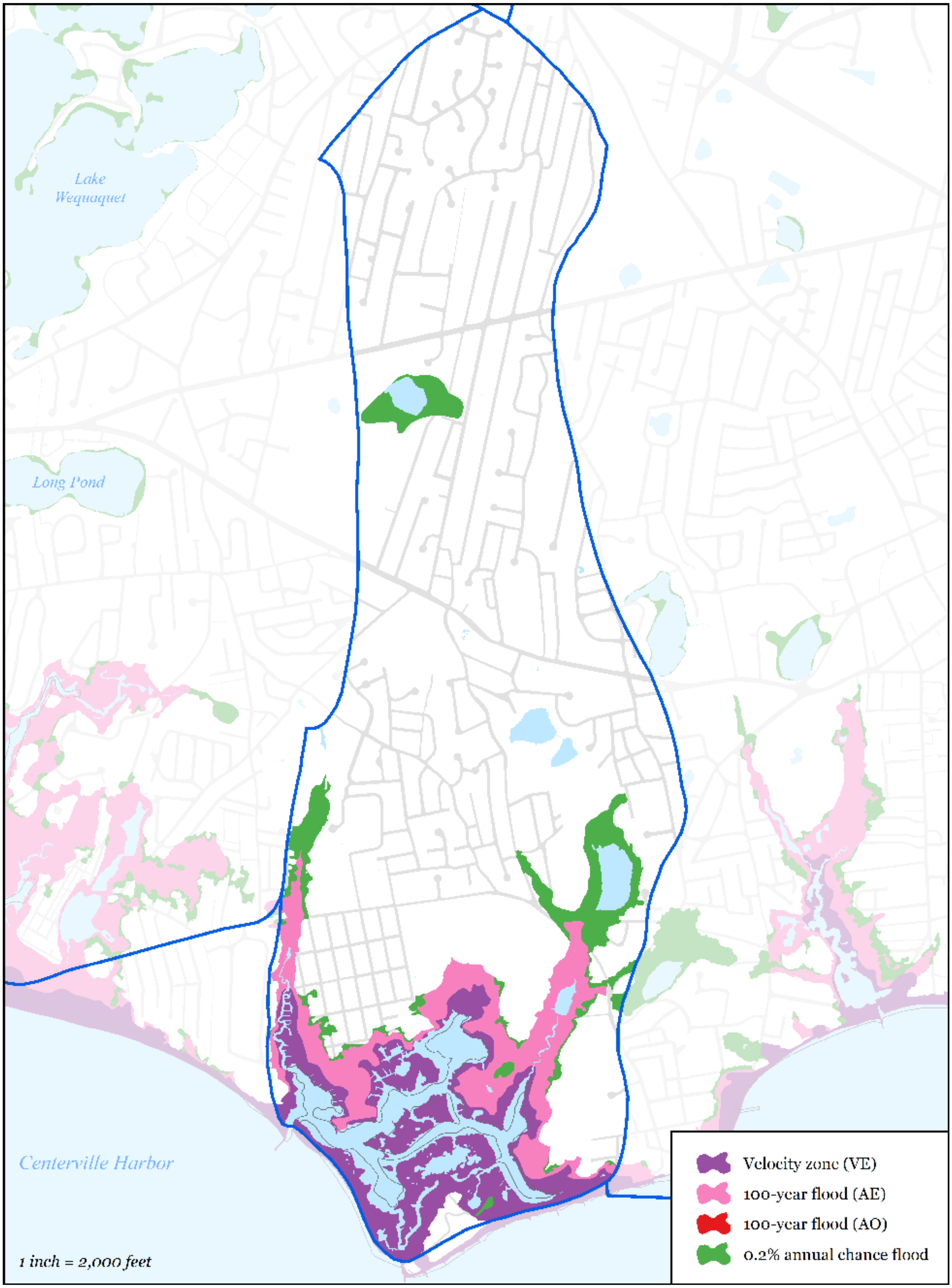

Figure 5-20: FEMA Flood Zones (2014) in Halls Creek Watershed

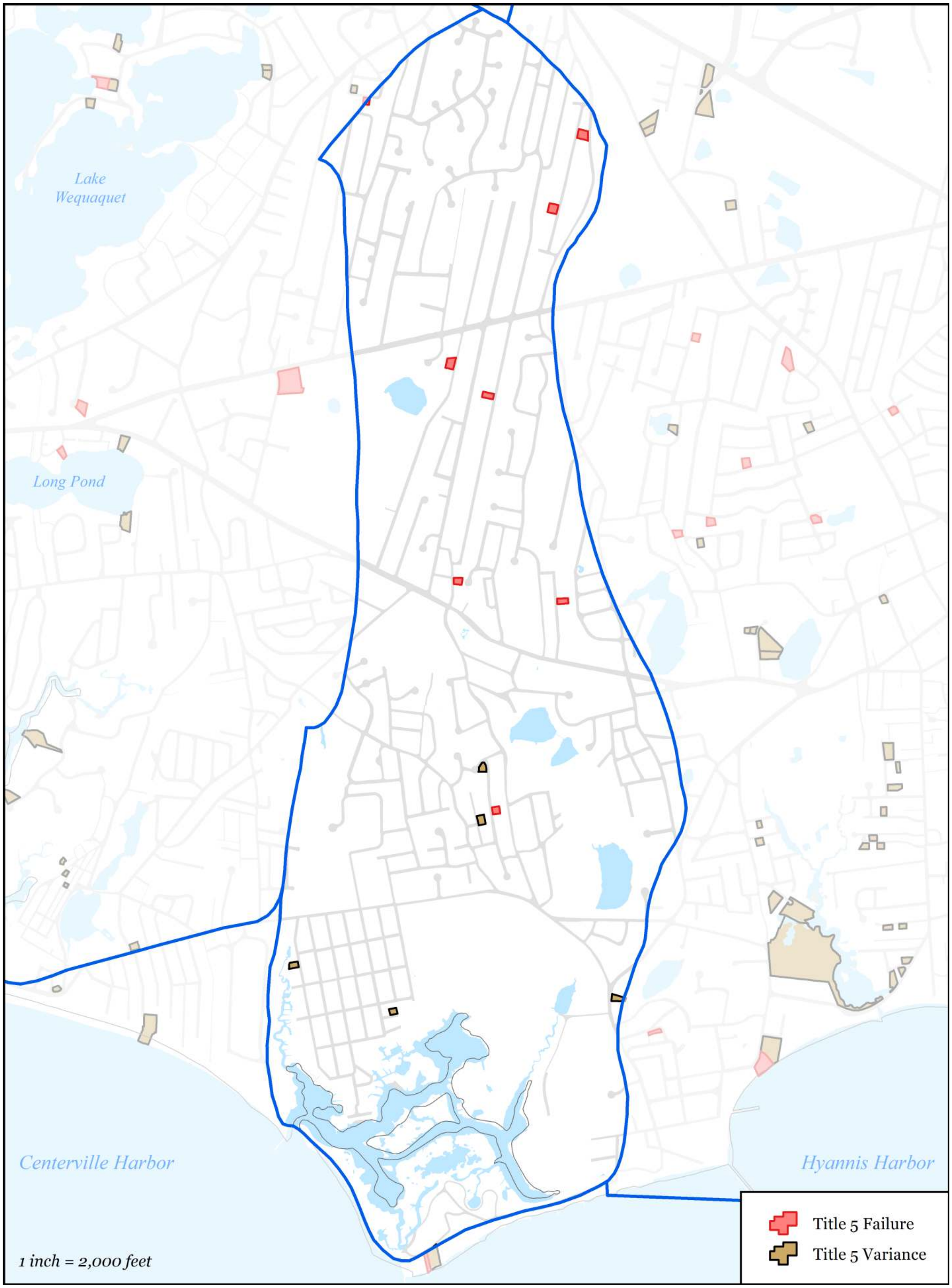

Figure 5-21: Parcels with Title 5 Septic Failures and Variances in Halls Creek Watershed

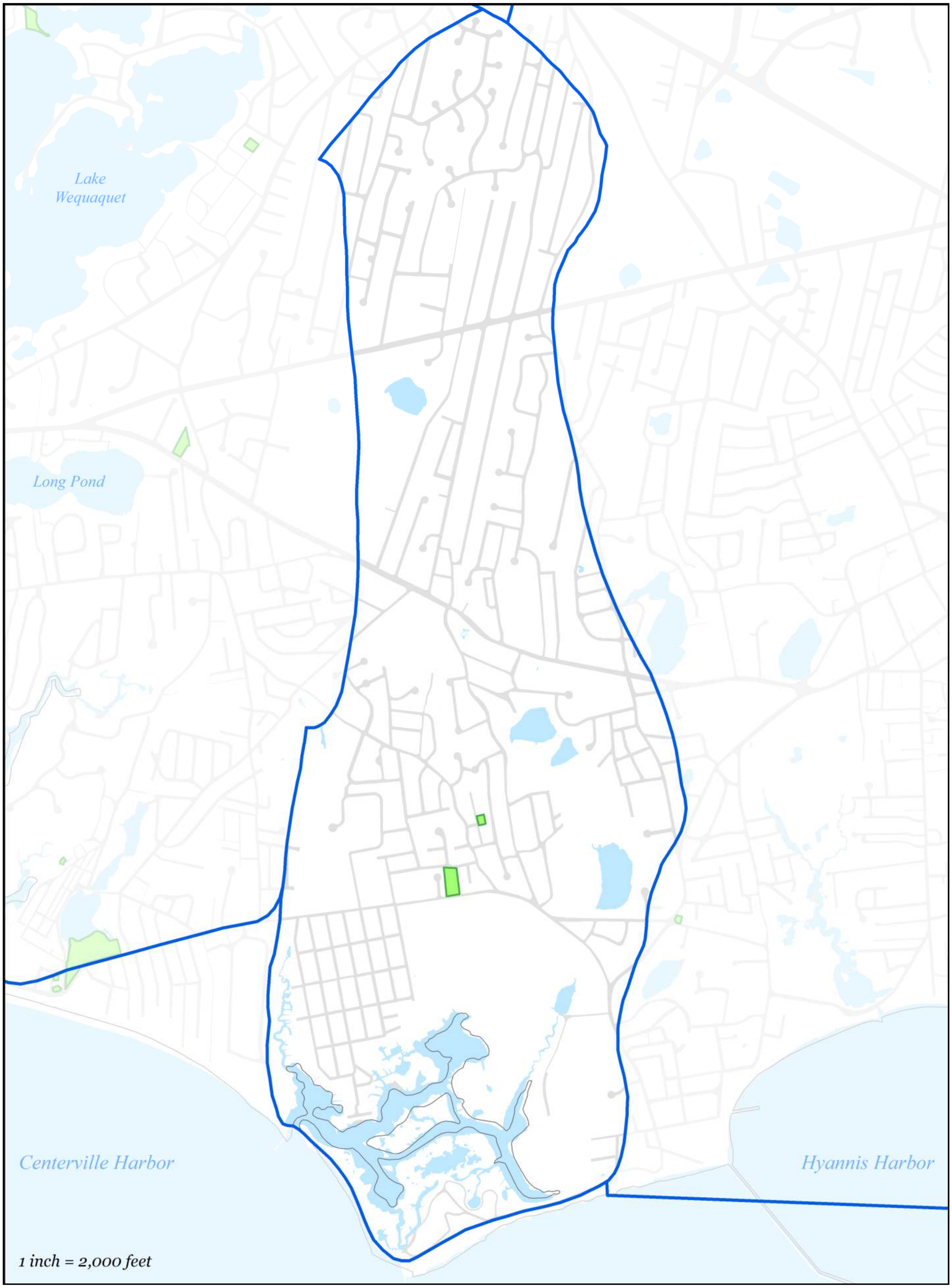

Figure 5-22: Parcels with I/A Septic Systems in Halls Creek Watershed

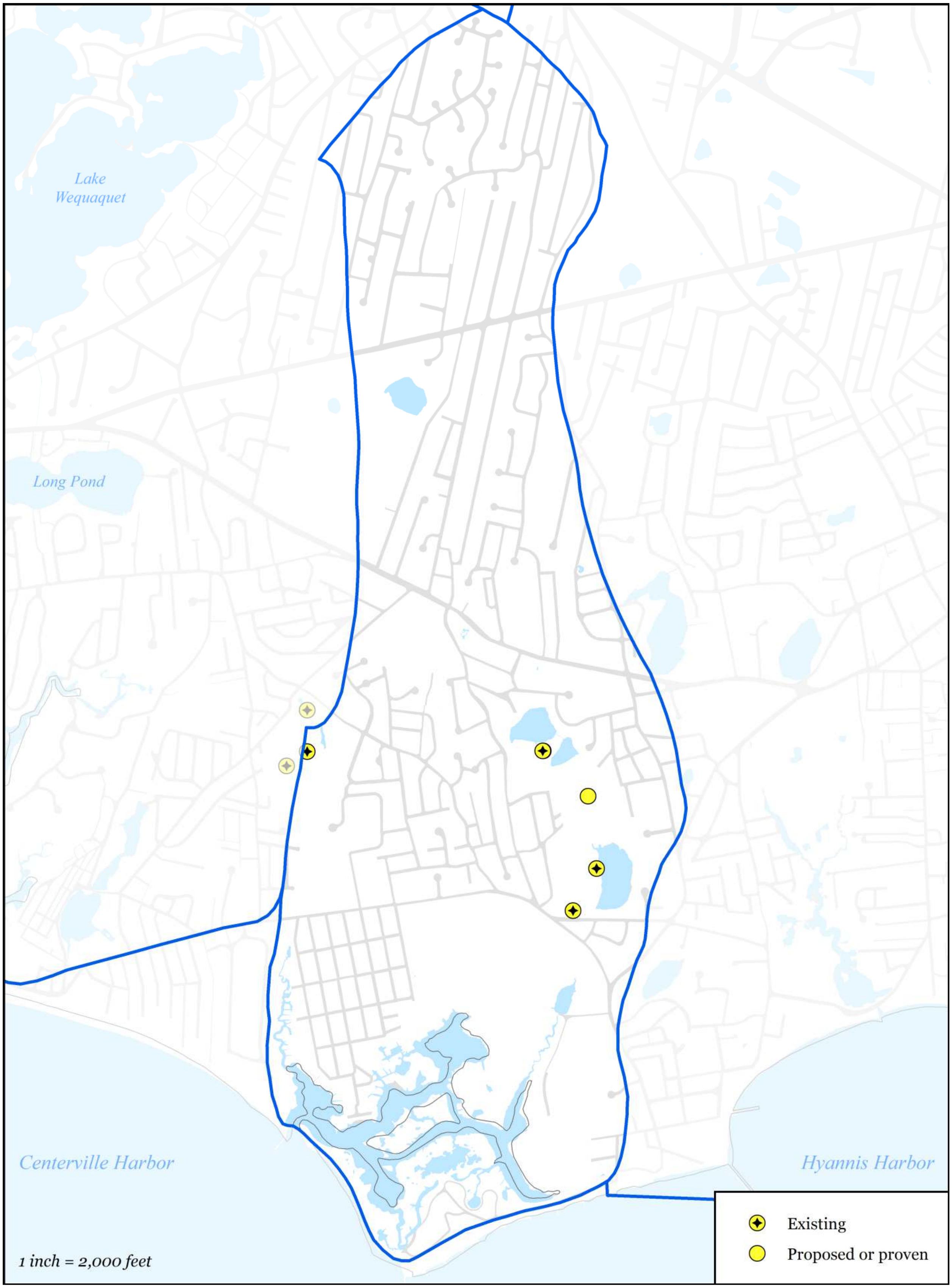

Figure 5-23: Public Water Supply Wells in Halls Creek Watershed

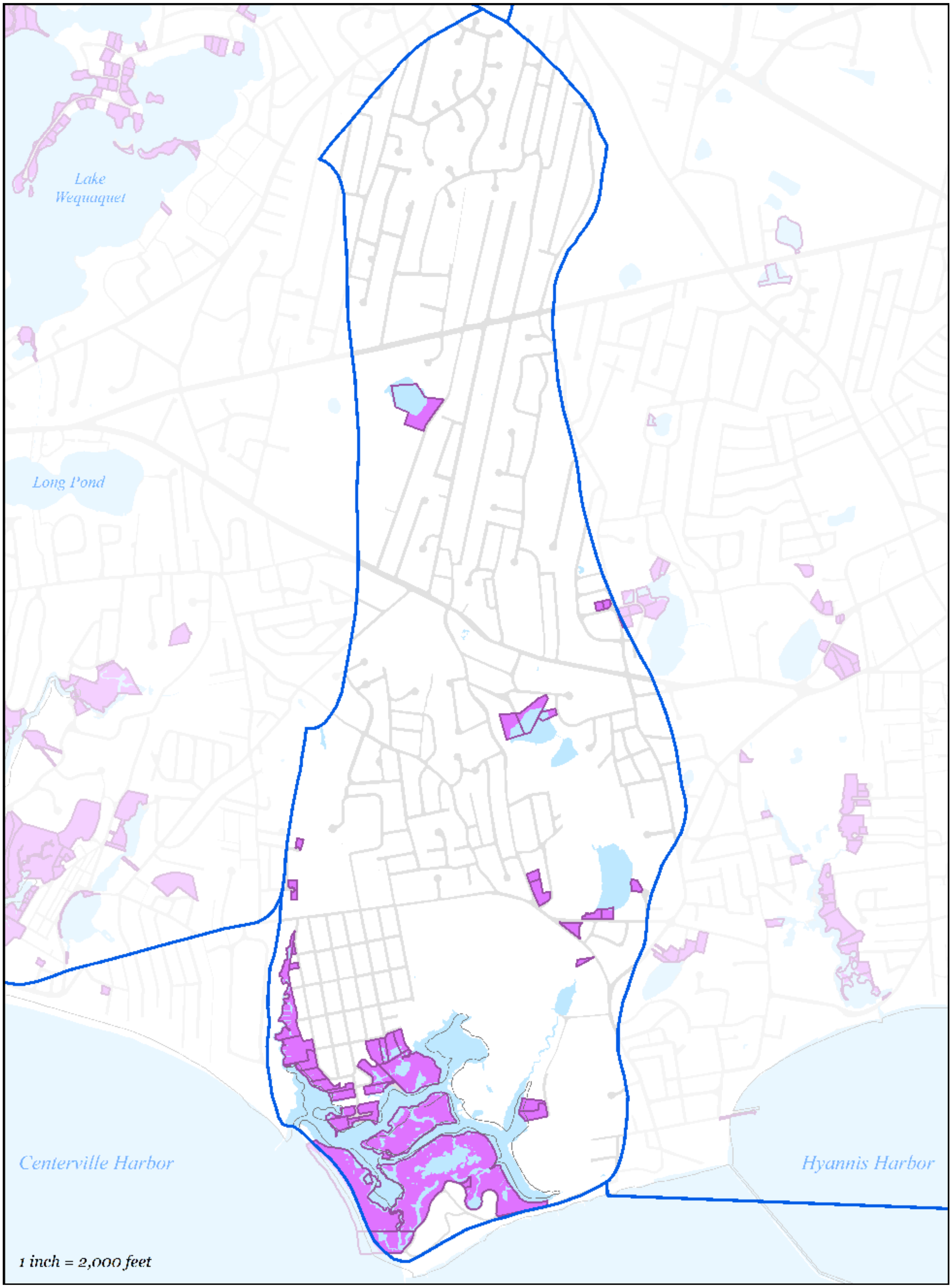

Figure 5-24: Parcels with Less than 4 feet Depth to Groundwater in Halls Creek Watershed

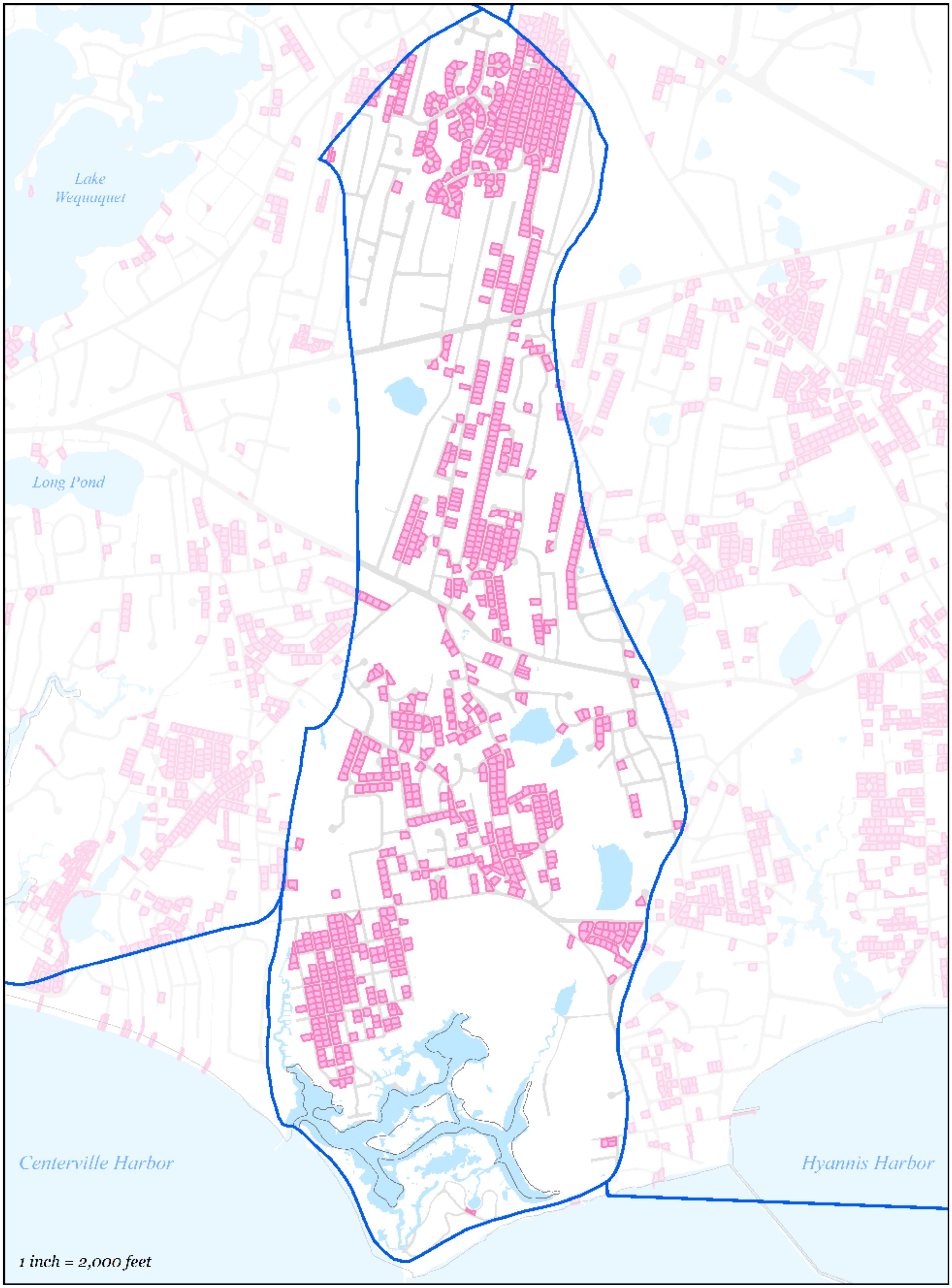

Figure 5-25: Parcels with Less than 0.25 acres in Halls Creek Watershed

5.2.3 CENTERVILLE RIVER WATERSHED

The Centerville River Embayment System is a complex embayment system located in the southern, central portion of the Town of Barnstable. The embayment has a lone inlet which connects Centerville Harbor to Nantucket Sound with a number of sub-embayments (East Bay, Centerville River, Bumps River, Scudder Bay and Centerville River marshes).. For a detailed description of the embayment system, refer to the 2006 MEP Report for the Centerville River Embayment (Appendix Y).

The source water for the Centerville River Embayment System is the Centerville River Watershed. The Centerville River Watershed is approximately 6,739 acres and is located entirely within the Town of Barnstable (see Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.
Figure 5-26). Within the watershed there are 39 identified surface waters including 14 named freshwater ponds (Wequaquet Lake, Bearses Pond, Shallow Pond, Long Pond, Red Lily Pond, Lake Elizabeth, Filends Pond, Lumbert Pond, West Pond, North Pond, Skunknet Pond, Michah Pond, Joshua's Pond, Shubael Pond) and 4 significant freshwater stream outlets (Skunknett River, Bumps River, Long Pond Stream, Lake Elizabeth). COMM Water District operates 6 drinking water wells that are located within the watershed. The Town operates two smaller wastewater treatments facilities within the Centerville River Watershed; the Marstons Mills School Treatment Plant (permitted for 42,900 GPD) and the Red Lily Pond shared septic system.

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Centerville River Watershed, including nutrient removal, pond protection, flood zone considerations and economic development, via sewer expansion into Centerville River Watershed.

5.2.3.1 SUMMARY OF NEEDS

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Centerville River Watershed, including nutrient removal, pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the Centerville River Watershed.

5.2.3.1.1 Nutrient Removal

The 2006 MEP technical report for the Centerville River system indicates that the system exceeds its critical threshold for nitrogen, resulting in impaired water quality. Based upon the findings of the MEP technical report, a TMDL for nitrogen has been developed and approved.

The Town's wastewater plan has been designed to exceed the septic load removals suggested in the 2006 MEP Report's threshold loading scenarios. Those scenarios modeled an 80% reduction in septic load (36.75 kg/day N) within the Centerville River East sub-embayment and no reduction in septic load in the other sub-embayments within the watershed. This corresponds to a 34% overall average watershed septic reduction target.

The Town's wastewater plan includes removal of 86% of the total septic load within the Centerville River East sub-embayment via proposed sewer connections (2,056 properties within the sub-embayment). As can be seen in Figure 5-27, the majority of the sewer expansion within the sub-embayment is planned for Phase 1, which will remove 65% of the total septic load within the sub-embayment.

The proposed additional sewer expansion within the other sub-embayments only further contributes to the overall septic load removal within the watershed as a whole. The plan will result in a total septic load reduction across the watershed of 54% (71.6 kg/day N). Phase 1 of the plan will result in a total septic load reduction within the watershed of 40% (52.7 kg/day N).

Nitrogen removal data reported above is from the Town of Barnstable's wastewater planning GIS tool and reflects calculated existing nitrogen loading on a parcel by parcel basis based upon existing water use data.

5.2.3.1.2 Wastewater Needs (Other Needs)

Title 5 Issues

Integral to the planning process was the Town's development a wastewater planning GIS tool which allowed Town staff to spatially map traditional Title 5 concerns such as small lot size, depth to groundwater, existing septic variances, existing known failed septic systems, and systems within Zone IIs. Parcels with area less than 0.25 acres were flagged because of they were considered difficult to site a traditional septic system, likely to need septic variances, and increased density leading to increased nutrient loading. Parcels with an average depth of groundwater of less than four feet were flagged as likely to require raised systems which are costly and less desirable for community aesthetics. Existing septic variances and existing known failed septic systems were also mapped.

The tool allows the Town to overlay these layers to identify the "hot-spots" for traditional sewering solutions. These areas were then incorporated into the plan where practical. Many of these "hot-spots" overlaid other needs such as nutrients and pond protection. The Plan for the Centerville River Watershed significantly address traditional Title 5 concerns as shown in the data presented below which was calculated using the Town's wastewater planning GIS tool:

- Total parcels within the Centerville River Watershed = 7998
- Parcels with total area less than 0.25 acres = 1,199
    - 1,019 (85%) will be addressed with a traditional solution in the Plan
- Parcels with average depth to groundwater less than four feet = 391
    - 336 (86%) will be addressed with a traditional solution in the Plan
- Parcels with septic system variances = 50
    - 42 (84%) will be addressed with a traditional solution in the Plan
- Parcels with known failed septic systems = 14
    - 10 (71%) will be addressed with a traditional solution in the Plan
- Parcels located within a Zone II = 3,333
    - 1,700 (51%) will be addressed with a traditional solution in the Plan

Flood Zones

Low lying areas to the south of the Centerville River and on the south side of Craigville Beach Road have been identified as needs areas for sewer expansion due to being within the 100 year floodplain and/or the velocity zone, and generally having shallow depth to groundwater. As a result of these conditions, traditional title 5 septic systems are difficult and costly to site in these areas. It should be noted that the parcels on the south side of Craigville Beach Road are generally outside of the Centerville River Watershed, but have been included in this section due to proximity to the watershed.

- Total parcels within the Centerville River Watershed = 7,998
- Parcels within 100 year flood plain and/or velocity zone = 822 (10%)
    - 652 (79%) will be addressed with a traditional solution in the Plan
    - This data does not include the aforementioned parcels on the south side of Craigville Beach Road that are outside of the watershed.

Contaminants of Emerging Concern (CEC's)

Contaminants of emerging concern (CECs) are increasingly being detected in surface water. (CECs) are made up of three general groups, endocrine disrupting compounds, pharmaceuticals, and personal care products. These compounds and potential contaminants are not currently regulated by the federal government because their toxicity is not well understood. Collecting wastewater with sewers and treating at a centralized treatment location allows the opportunity to treat wastewater for CEC's as they are better understood and future treatment technologies are developed.

5.2.3.1.3 Pond Protection

The Town's wastewater planning has included detailed studies of ponds 3 acres or larger throughout the Town. Through those studies, there is extensive water data for 16 ponds in the Centerville River Watershed. Pond classification of these ponds is shown in Table 5-5.

Table 5-5: Centerville River Watershed Pond classification

	Ultra-Shallow 0 to 2.1m	Shallow 2.1 to 8.6m	Deep >8.6m
Oligotrophic Total P<0-12 (ug/l)	Mill Pond Red Lily Pond	Joshua's Pond Shubael Pond Bearse Pond	Micah's Pond
Mesotrophic Total P<12-24 (ug/l)	Lumbert Pond Flowing Pond	Coleman Pond Shallow Pond	Lake Wequaquet
Eutrophic Total P<24-96 (ug/l)	Weathervane Pond	Round Pond Long Pond North Pond	
Hypereutrophic	Little Parker		

Four ponds within the watershed have been identified as impaired; Flowing Pond, Long Pond, and Round Pond. Additionally, during the planning process there was significant public interest in sewer expansion around Lake Wequaquet. Sewer expansion adjacent to the following ponds for protection from nutrients from septic systems has been proposed: Wequaquet Lake, Bearses Pond, Shallow Pond, Long Pond, Red Lily Pond, Lake Elizabeth, Filends Pond.

5.2.3.1.4 Economic Development

Within the Centerville River, the Route 28 corridor has also been identified by the Town as an area where a traditional solution is desired for economic development. Development within this corridor has historically been restricted by wastewater requirements (i.e. Title 5) and the Town's Salt Water Estuary's Regulation. The Town's wastewater plan has included sewer expansion along the entire Route 28 corridor to accommodate these goals. Sewer expansion is required within the Route 28 corridor to facilitate the sewer expansion needs of the western portion of the Town.

5.2.3.2 PROPOSED SOLUTIONS

The plan addresses the needs areas using the following techniques:

- Sewer Expansion
  - 4,434 parcels (55%) in the watershed are included in the sewer expansion plan
    - 3,348 parcels (76%) of which are in Phase 1.
  - Removal of 54% (71.6 kg/day N) of total watershed septic load.
    - Required removal per MEP = 34% (36.745 kg/day N).

- Stormwater upgrades
  - Stormwater runoff can contain nitrogen and phosphorus pollutants from fertilizers and pet and yard waste. Storm water will be managed by utilizing best management practices (BMPs) to mitigate the nutrients, and sediments, discharged by stormwater to the waterbodies and to their watersheds
  - The Town's MS4 program will identify and provide solutions to existing stormwater outfalls.
    - 40 of the Town's 207 identified stormwater outfalls are located in the Centerville River Watershed.
  - The Town's Public Road program invests on average $750,000 a year in stormwater improvements in the Town's public roads. These improvements generally include replacement of failed catch basins and leaching structures.

- Fertilizer Regulation
  - In 2014 the Town adopted a Fertilizer Nitrogen and Phosphorus Control Regulation (see Appendix PP). The regulations includes the following:
    - Provides Best Management Practices and performance standards for noncertified fertilizer applicators.
    - Outlines education, certification, enforcement and penalties.

5.2.3.3 FUTURE CONDITIONS

The plan accommodates future growth conditions as follows:

- The majority of the watershed is significantly built-out.
- Projected growth within the watershed.
  - The projected growth within the watershed is focused on the Route 28 corridor which will be addressed with traditional solutions (i.e. sewer expansion). Projected growth in these areas will be considered when sizing sewer infrastructure (pipes, pump stations, force mains, etc.).

- In order to address other needs within the watershed, the sewer expansion plan removes about 2 times the existing target septic load removal per MEP. This additional 34.8 kg/day N of removal can accommodate significant growth potential within the watershed while still meeting the nitrogen TMDL.
- Adaptive management and monitoring
    - The Town will continue to monitor the embayment, review the Plan and provide formal updates as required.
    - Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.

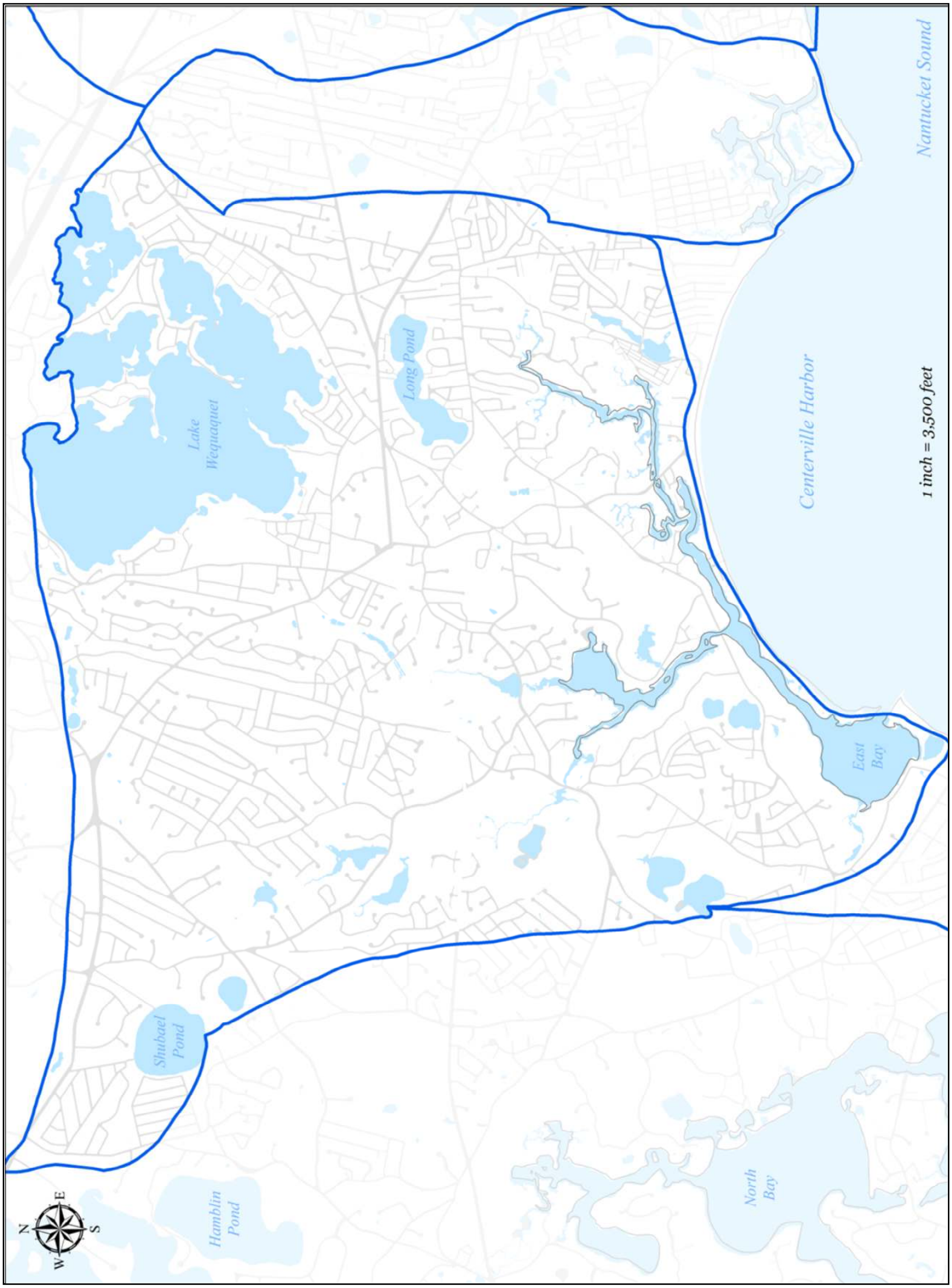

Figure 5-26: Centerville River Watershed

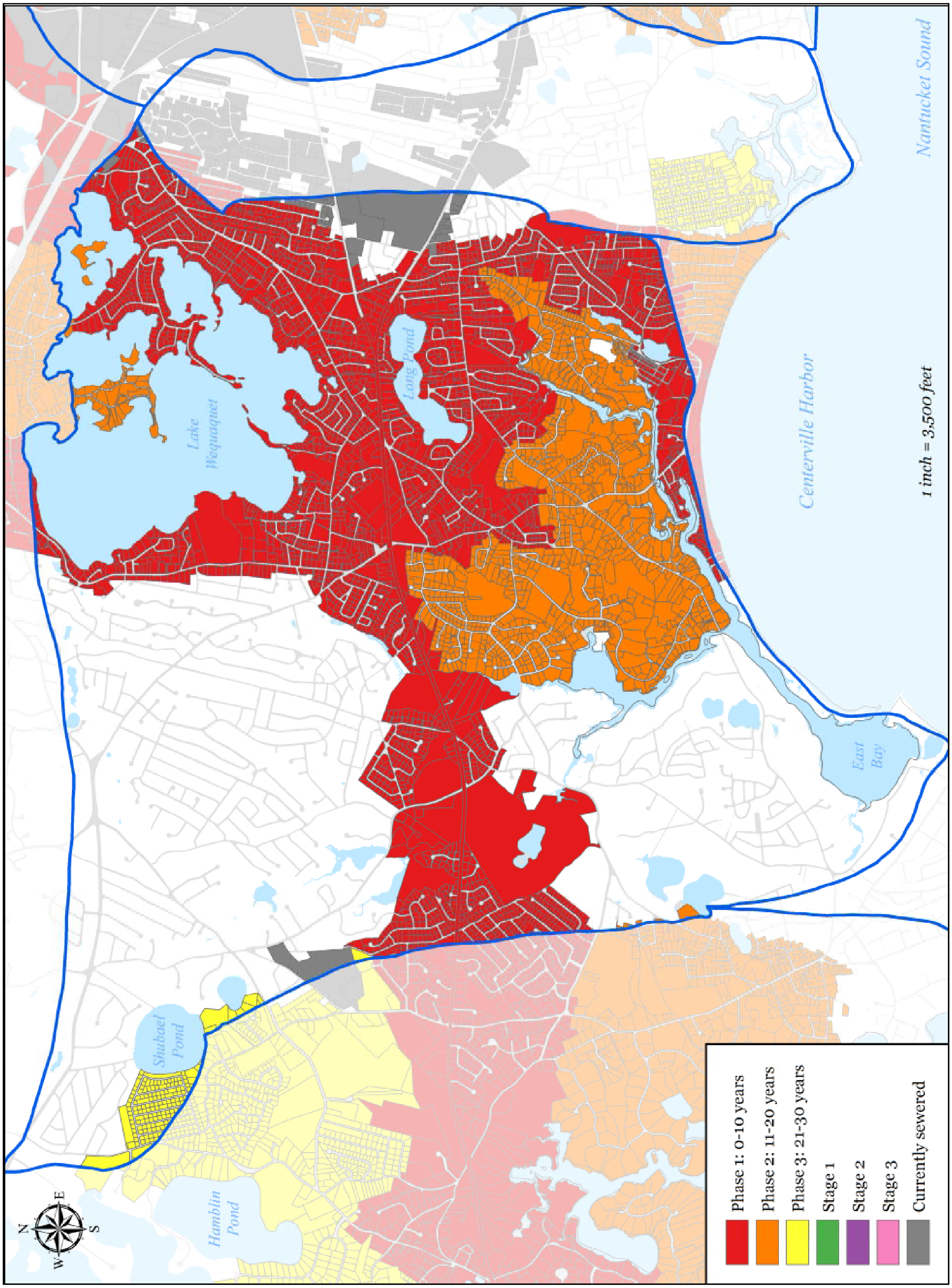

Figure 5-27: Sewer Expansion Plan in Centerville River Watershed

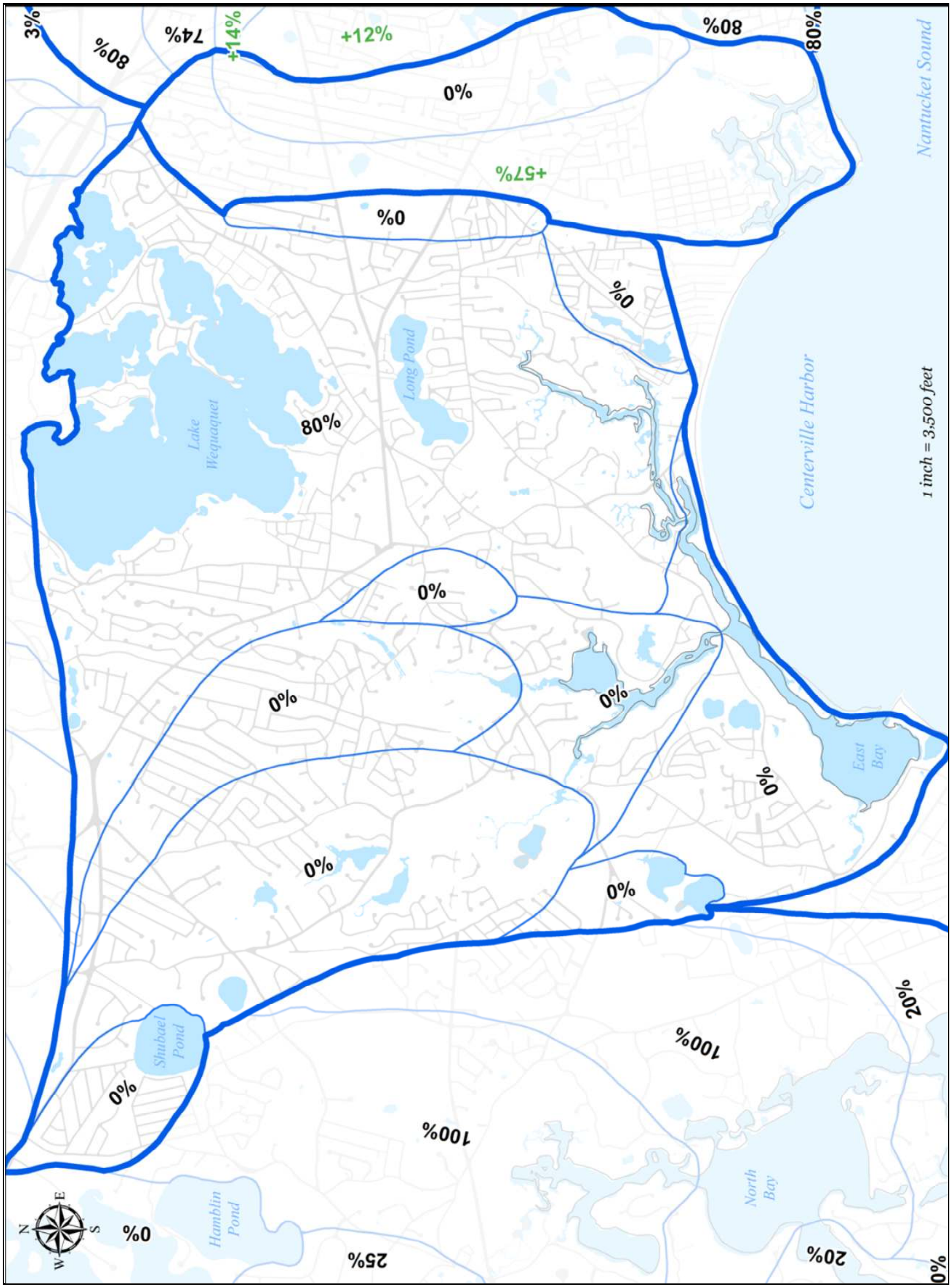

Figure 5-28: MEP-modeled Existing Septic Removal in Centerville River Watershed

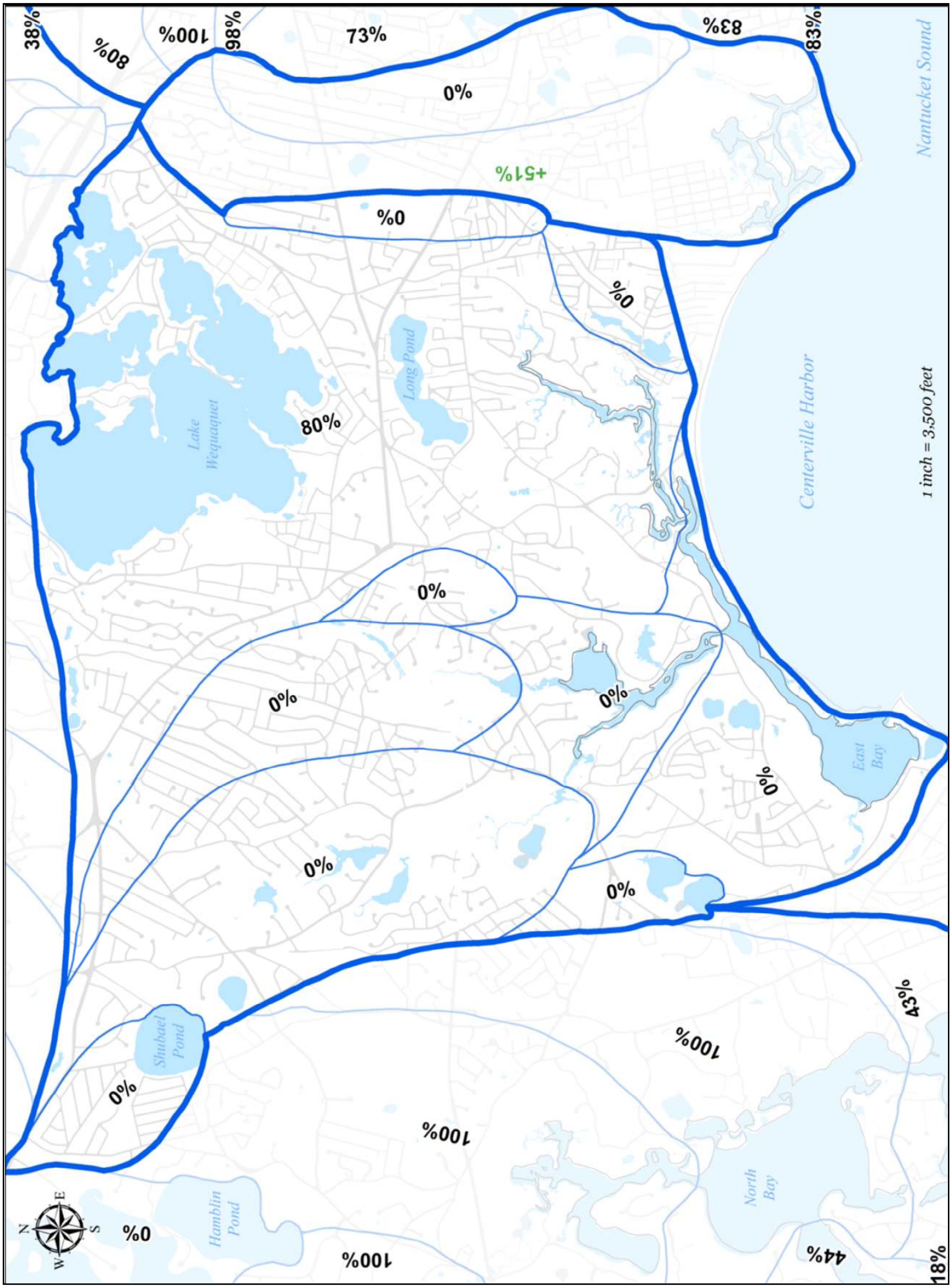

Figure 5-29: MEP-modeled Future Septic Removal in Centerville River Watershed

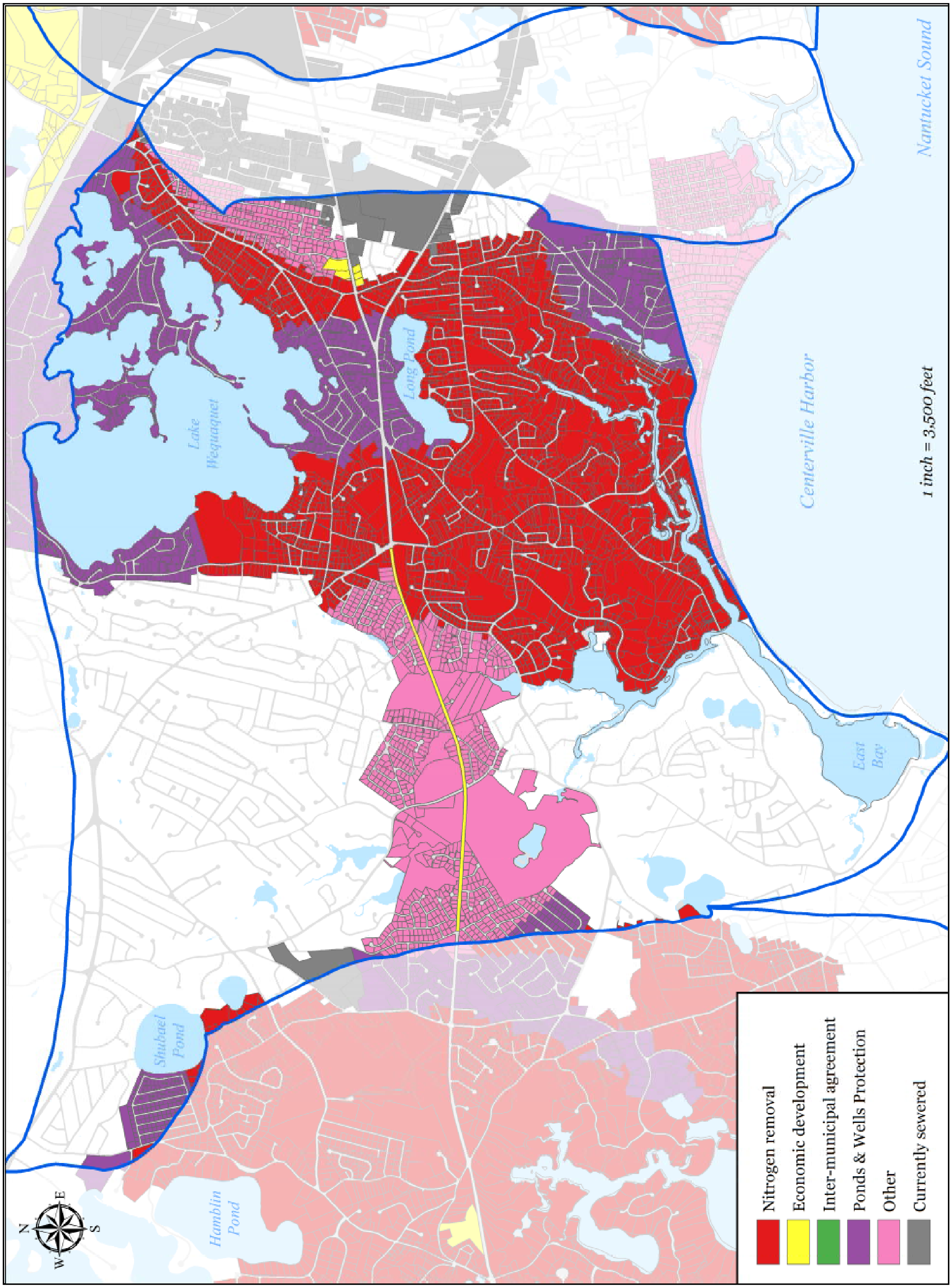

Figure 5-30: Needs Areas in Centerville River Watershed

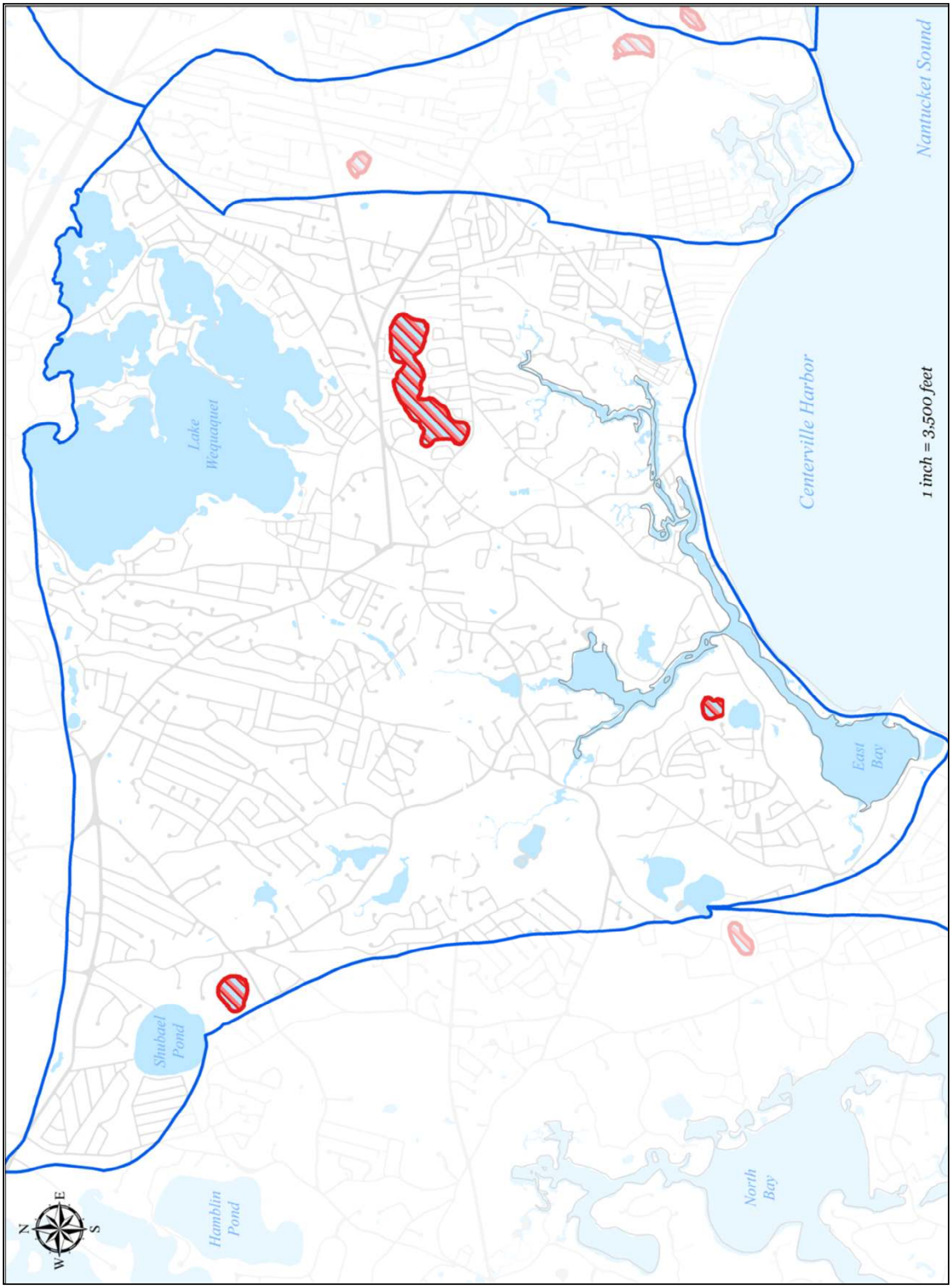

Figure 5-31: Impaired Ponds in Centerville River Watershed

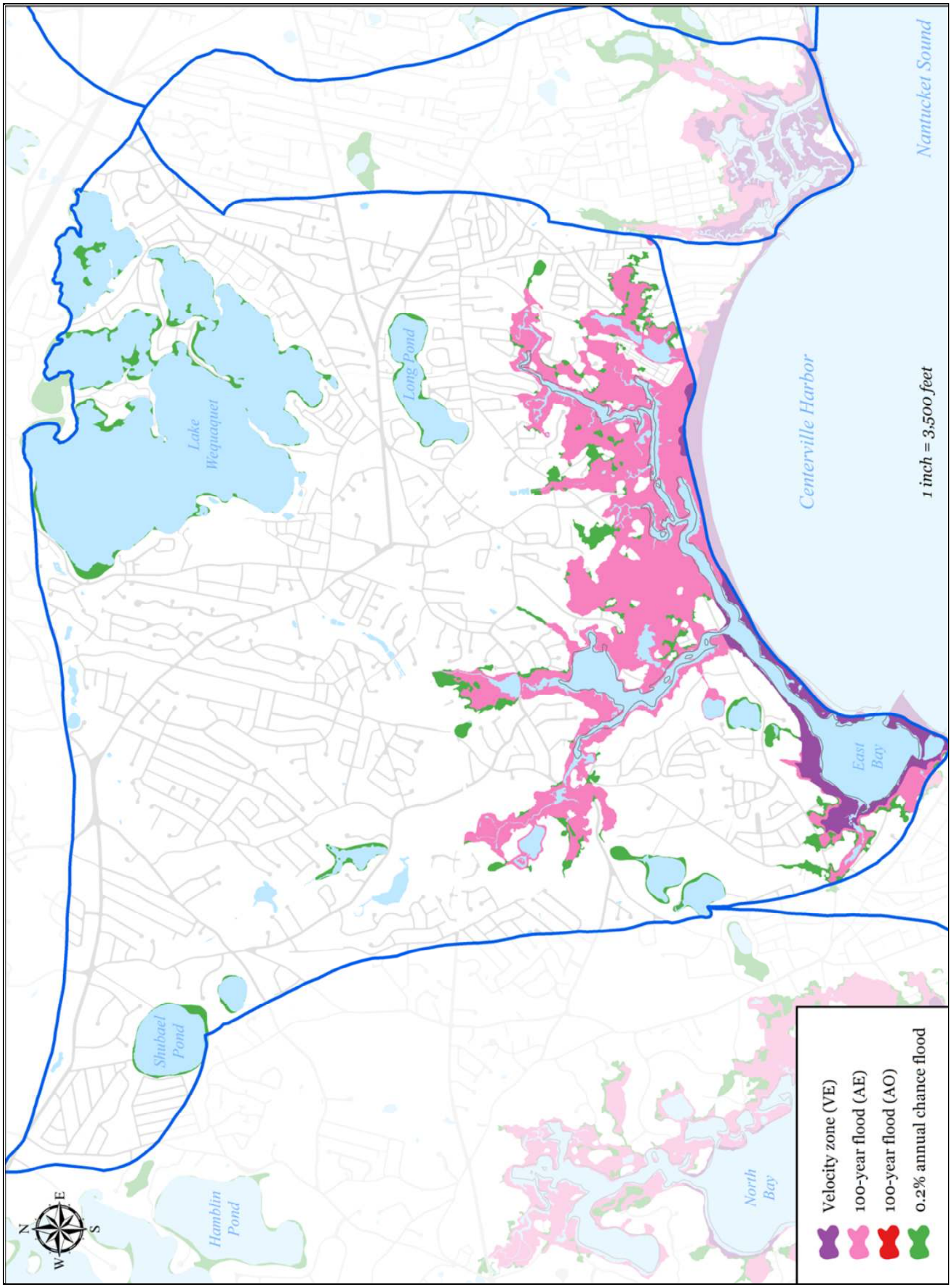

Figure 5-32: FEMA Flood Zones (2014) in Centerville River Watershed

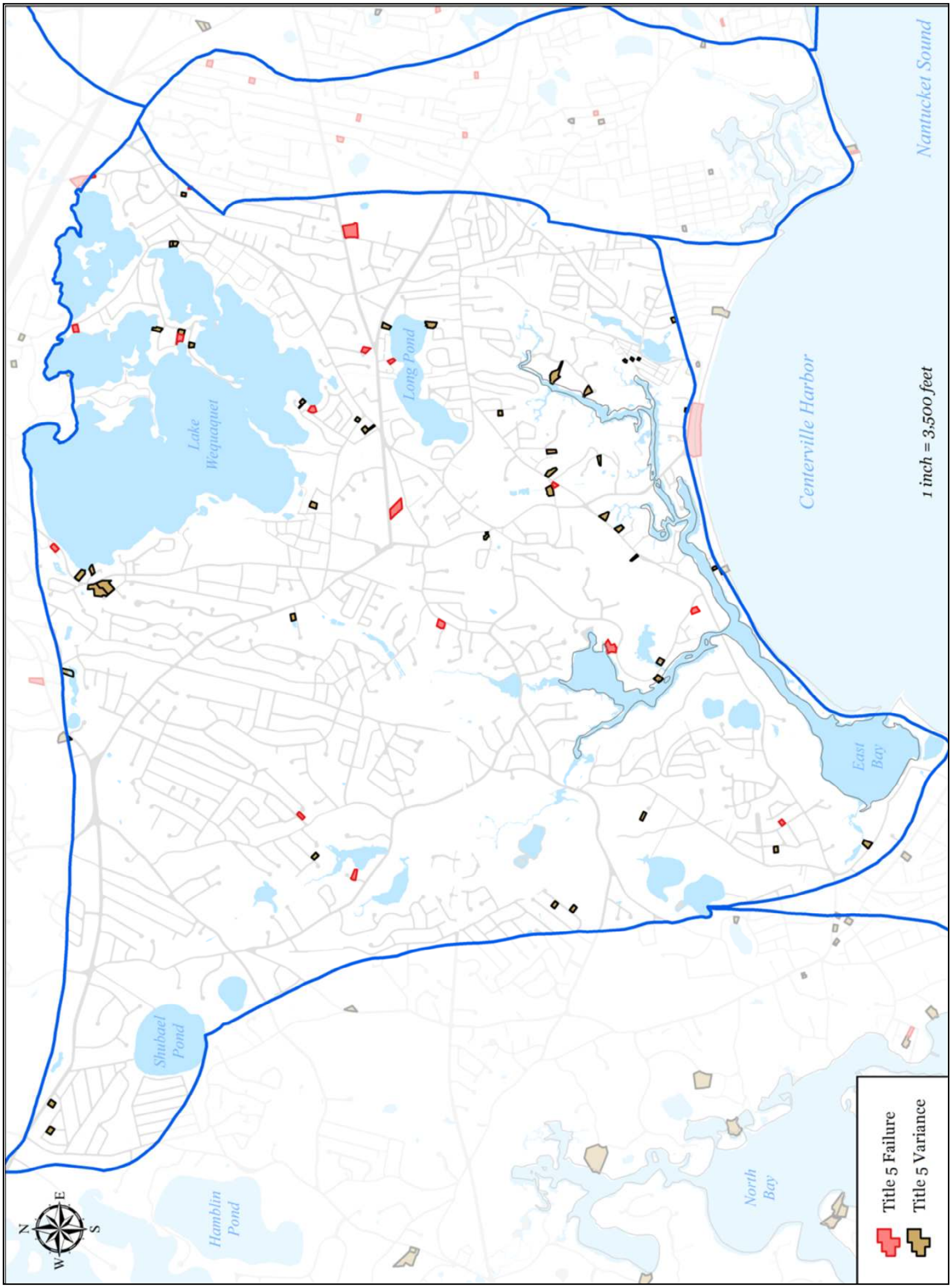

Figure 5-33: Parcels with Title 5 Septic Failures and Variances in Watershed

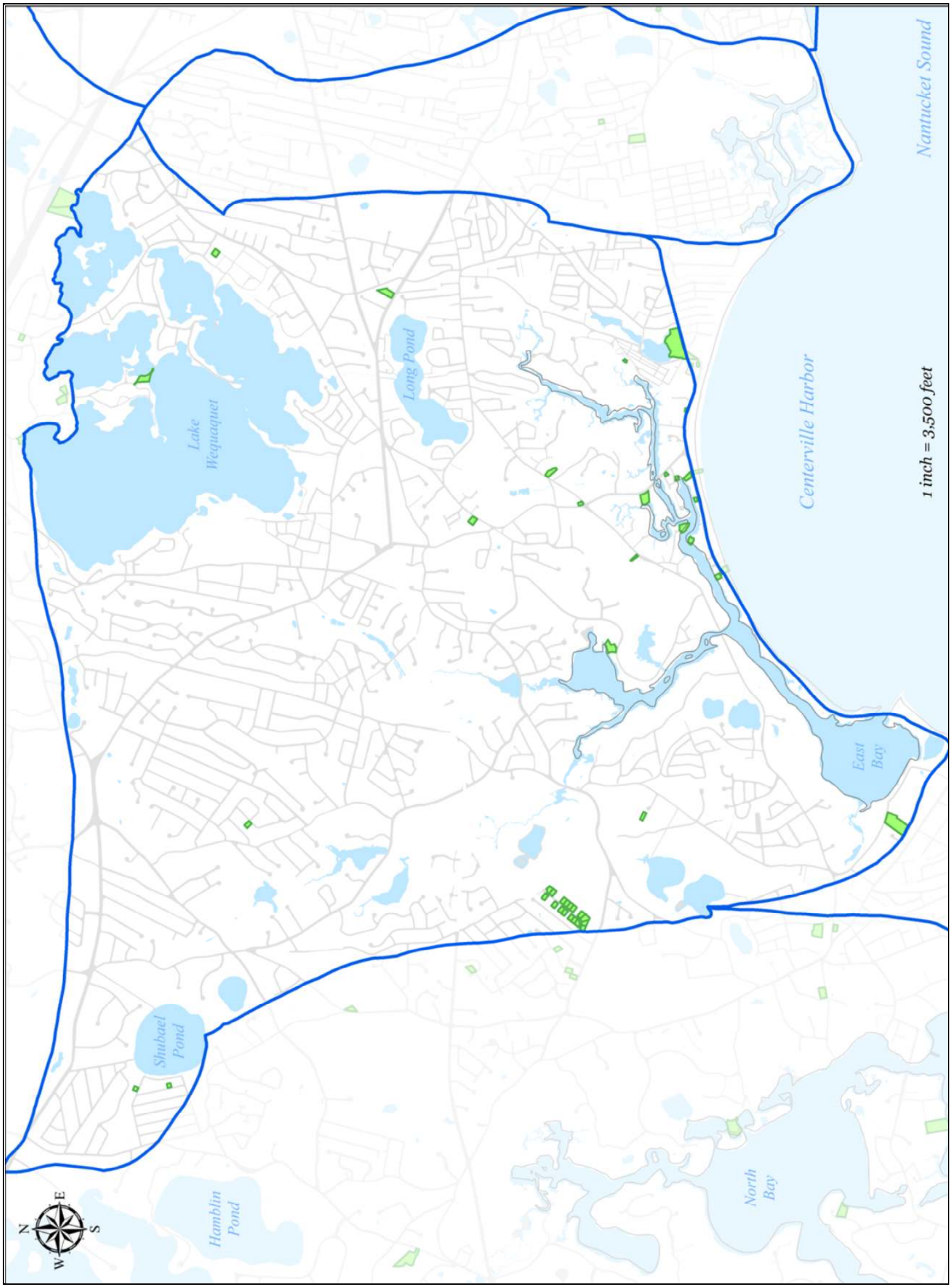

Figure 5-34: Parcels with I/A Septic Systems in Centerville River Watershed

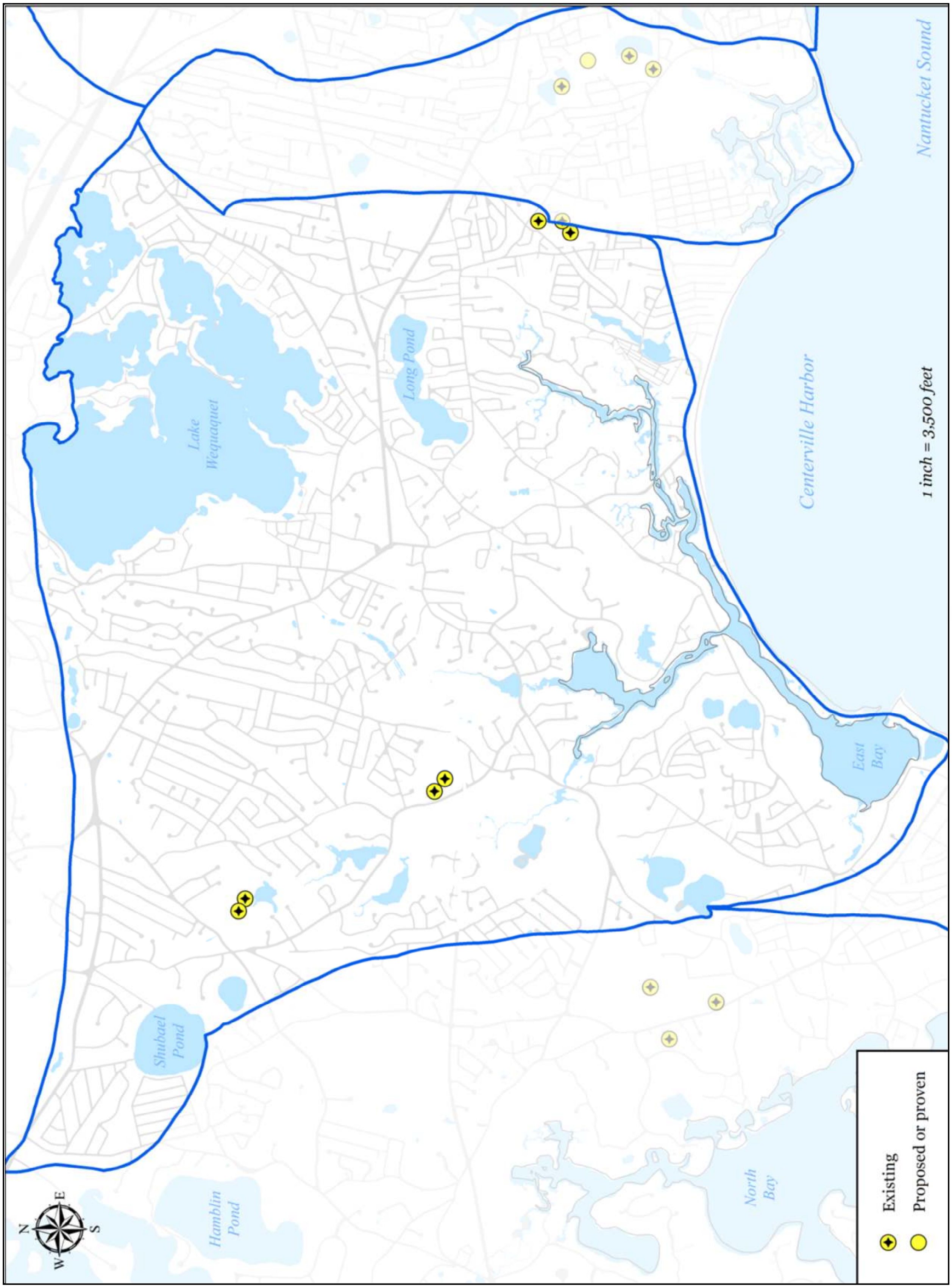

Figure 5-35: Public Water Supply Wells in Centerville River Watershed

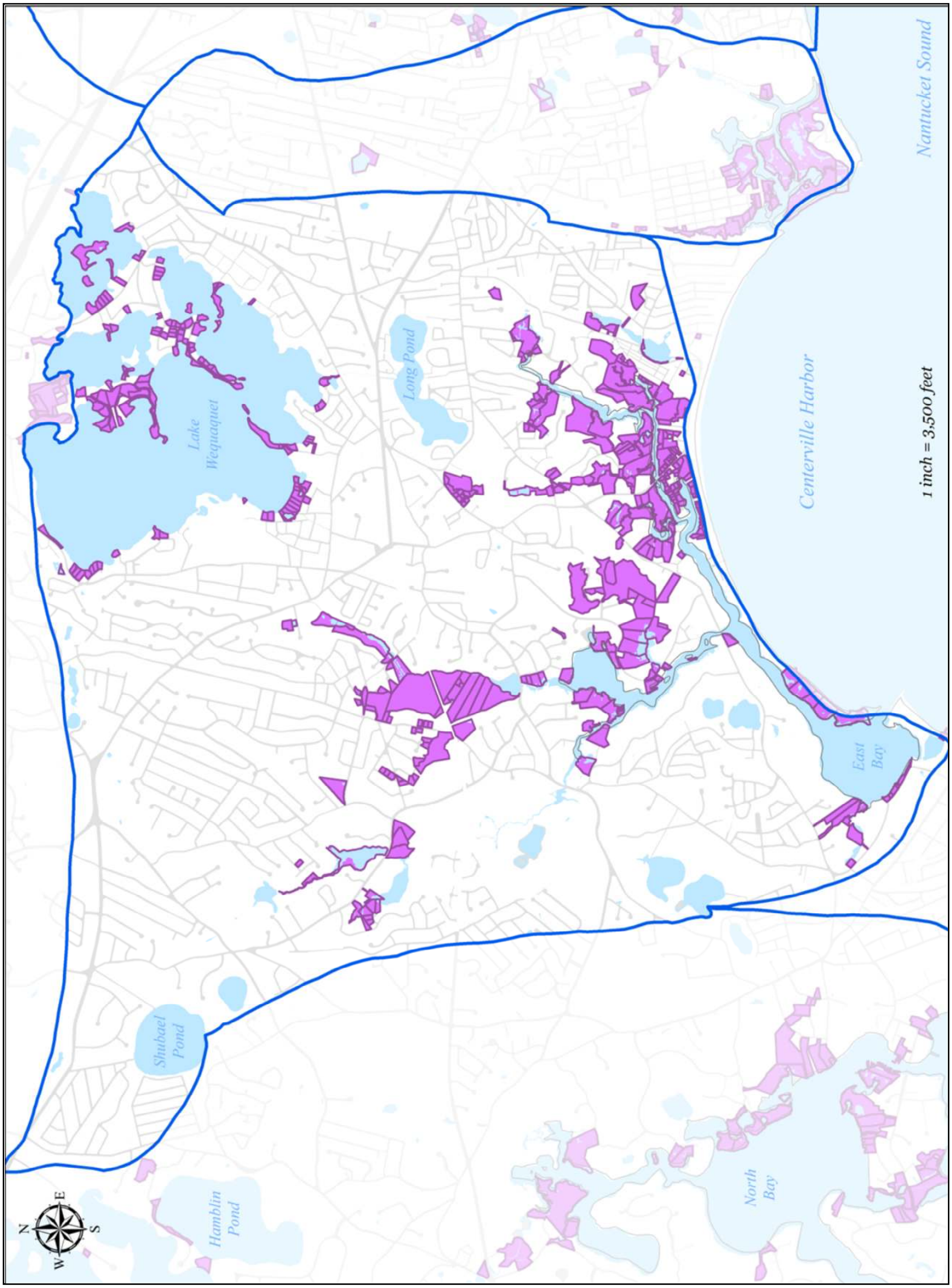

Figure 5-36: Parcels with Less than 4 feet Depth to Groundwater in Watershed

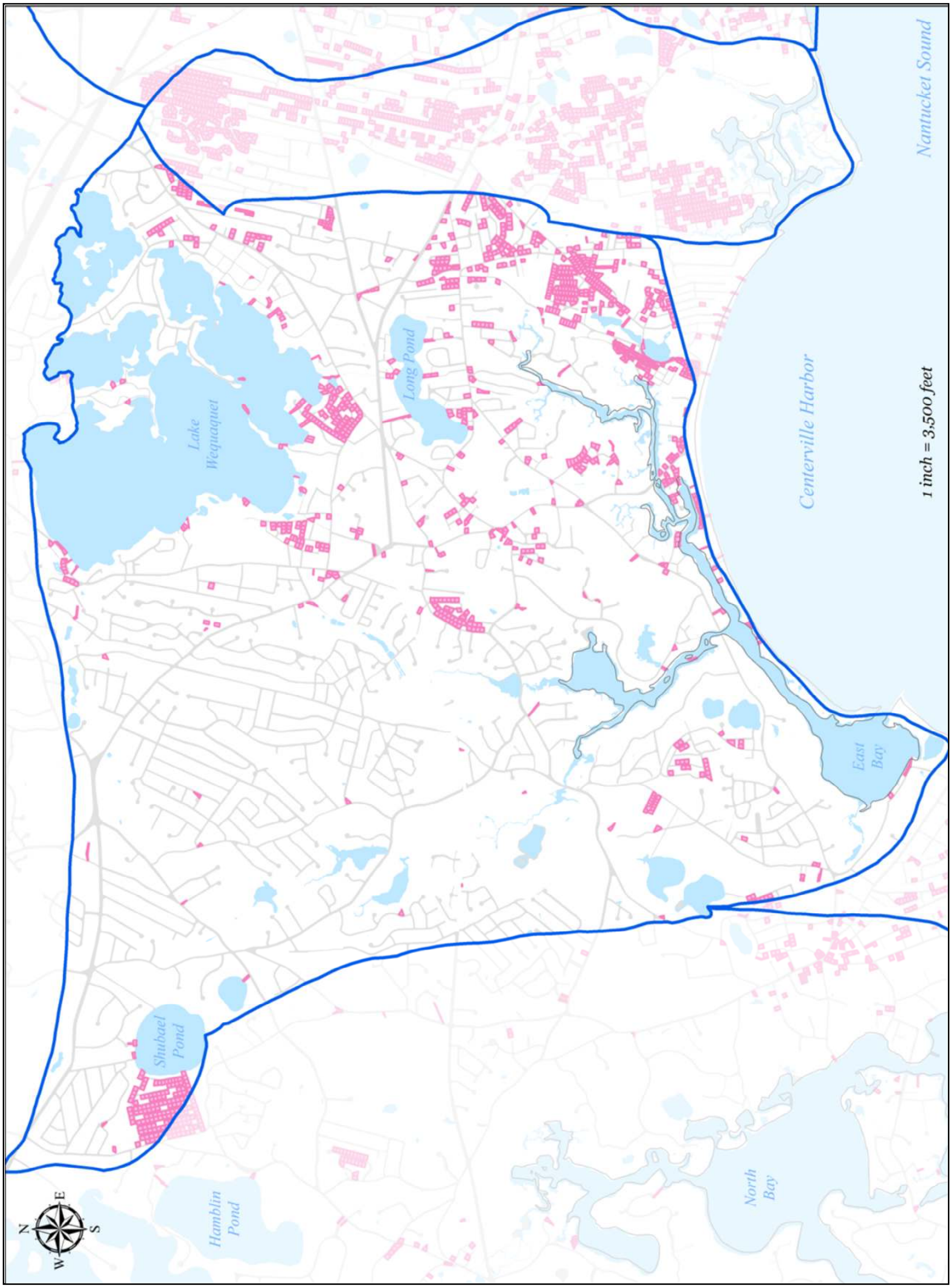

Figure 5-37: Parcels with Less than 0.25 acres in Centerville River Watershed

5.2.4 THREE BAYS WATERSHED

The Three Bays Embayment System is located in the southwestern portion of the Town of Barnstable. The embayment is a complex estuary with multiple inlets and sub-embayments (Cotuit Bay, West Bay, North Bay, Prince Cove, Warren's Cove). The estuary receives tidal waters from Nantucket Sound into its two large lower basins, Cotuit Bay to the west of Osterville Grant Island and West Bay to the east of Grand Island. For a detailed description of the embayment system, refer to the 2006 MEP Report for the Three Bays Embayment (Appendix W).

The Three Bays Watershed is approximately 6,739 acres and is located almost entirely within the Town of Barnstable (see Figure 5-38). Within the watershed there are 39 identified surface waters including 14 named freshwater ponds and 4 significant freshwater stream outlets (Skunknett River, Bumps River, Long Pond Stream, Lake Elizabeth). Within the watershed, COMM Water District operates 9 drinking water wells and Cotuit Water District operates 4 drinking water wells. The Town does not operate any wastewater treatments facilities within the Three Bays Watershed.

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Three Bays Watershed, including nutrient removal, pond protection, traditional wastewater concerns and economic development, via sewer expansion into Three Bays Watershed. The Plan also includes non-traditional solutions, which will be installed in the first phase of the plan. The Town will not ask for credit up front, but will be monitoring the results of those solutions over 5-10 years, thus establishing their benefit. With that benefit firmly established, the Town would then ask DEP for relief from that amount of traditional nitrogen removal (sewers) contained in the later phases of the plan.

5.2.4.1 SUMMARY OF NEEDS

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Three Bays Watershed, including nutrient removal, pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the Three Bays Watershed.

5.2.4.1.1 Nutrient Removal

The Town's wastewater plan has been designed to exceed the septic load removals modeled in the 2006 MEP Report's threshold loading scenarios in order to meet the regulatory TMDLs. A summary of the modeled threshold septic loading scenario is provided in Table 5-6. The Town's sewer expansion plan has been designed to achieve the threshold septic load removal percentages in each sub-embayment.

Table 5-6: MEP Threshold Septic Loading Modeling Scenario Summary

Sub-Embayment	MEP Present Septic Load (kg/day)	MEP threshold septic load (kg/day)	MEP threshold Septic Load to Remove (kg/day)	MEP Threshold septic load % change
Cotuit Bay	17.022	13.618	3.404	-20.0%
West Bay	15.490	12.392	3.098	-20.0%
Seapuit River	2.921	2.921	0.000	0.0%
North Bay	24.978	0.000	24.978	-100.0%
Prince's Cove	11.192	0.000	11.192	-100.0%
Warren's Cove	6.975	0.000	6.975	-100.0%
Prince's Cove Channel	4.767	0.000	4.767	-100.0%
Marstons Mills Crescent	3.573	0.000	3.573	-100.0%
Surface Water Sources				
Marstons Mills River	10.071	7.553	2.518	-25.0%
Little River	3.203	3.203	0.000	0.0%
Total	***100.192***	***39.687***	***60.505***	***60.4%***

Nitrogen removal data reported below in Table 5-7, is from the Town of Barnstable's wastewater planning GIS tool and reflects calculated existing nitrogen loading on a parcel by parcel basis based upon existing water use data.

Table 5-7: Nitrogen Removed from Three Bays Watershed by Traditional Solutions

	Parcels	Nitrogen (kg/day N)	% of Total Watershed Nitrogen Removed
Total Existing Watershed	5,625	121.4	N/A
Phase	**Parcels**	**Nitrogen (kg/day N)**	**% of Total Watershed Nitrogen Removed**
1	805	16.1	13.2%
2	843	24.7	20.3%
3	1,708	28.4	23.4%
Subtotal	***3,356***	***69.1***	***56.9%***
Stage	**Parcels**	**Nitrogen (kg/day N)**	**% of Total Watershed Nitrogen Removed**
1	21	0.3	0.3%
2	216	3.8	3.1%
3	121	1.7	1.4%
Subtotal	***358***	***5.8***	***4.8%***
Total	***3,714***	***74.9***	***61.7%***

5.2.4.1.2 Traditional Wastewater Needs (Other Needs)

Title 5 Issues

Integral to the planning process was the Town's development a wastewater planning GIS tool which allowed Town staff to spatially map traditional Title 5 concerns such as small lot size, depth to groundwater, existing septic variances, existing known failed septic systems, and Zone IIs. Parcels with area less than 0.25 acres were flagged because of they were considered difficult to site a traditional septic system, likely to need septic variances, and increased density leading to increased nutrient loading. Parcels with an average depth of groundwater of less than four feet were flagged as likely to require raised systems which are costly and less desirable for community aesthetics. Existing septic variances and existing known failed septic systems were also mapped.

The tool allows the Town to overlay these layers to identify the "hot-spots" for traditional sewering solutions. These areas were then incorporated into the plan where practical. Many of these "hot-spots" overlaid other needs such as nutrients and pond protection. The Plan for the Three Bays Watershed significantly address traditional Title 5 concerns as shown in the data presented below which was calculated using the Town's wastewater planning GIS tool:

- Total parcels within the Three Bays Watershed = 5,625
- Parcels with total area less than 0.25 acres = 336
    - 208 (62%) will be addressed with a traditional solution in the Plan
- Parcels with average depth to groundwater less than four feet = 143
    - 62 (43%) will be addressed with a traditional solution in the Plan
- Parcels with septic system variances = 36
    - 12 (33%) will be addressed with a traditional solution in the Plan
- Parcels with known failed septic systems = 2
    - 2 (100%) will be addressed with a traditional solution in the Plan
- Parcels located within a Zone II = 3,479
    - 2,671 (77%) will be addressed with a traditional solution in the Plan

Flood Zones

Low lying areas adjacent to the Three Bays system have been identified as needs areas for sewer expansion due to being within the 100 year floodplain and/or the velocity zone, and generally having shallow depth to groundwater. As a result of these conditions, traditional title 5 septic systems are difficult and costly to site in these areas.

- Total parcels within the Three Bays Watershed = 5,625
- Parcels within 100 year flood plain and/or velocity zone = 718 (13%)
    - 481 (67%) will be addressed with a traditional solution in the Plan (including those portions of the plan that are located within the 3 “stages”).

Contaminants of Emerging Concern (CEC’s)

Contaminants of emerging concern (CECs) are increasingly being detected in surface water. (CECs) are made up of three general groups, endocrine disrupting compounds, pharmaceuticals, and personal care products. These compounds and potential contaminants are not currently regulated by the federal government because their toxicity is not well understood. Collecting wastewater with sewers and treating at a centralized treatment location allows the opportunity to treat wastewater for CEC’s as they are better understood and future treatment technologies are developed.

5.2.4.1.3 Pond Protection

The Town’s wastewater planning has included detailed studies of ponds 3 acres or larger throughout the Town. Through those studies, there is extensive water data for 12 ponds in the Three Bays Watershed. Pond classification of these ponds is shown in Table 5-8.

Table 5-8: Three Bays Watershed Pond classification

	Ultra-Shallow 0 to 2.1m	Shallow 2.1 to 8.6m	Deep >8.6m
Oligotrophic Total P<0-12 (ug/l)			Hamblin Pond Middle Pond
Mesotrophic Total P<12-24 (ug/l)	Bog Pond	Patty's Pond	Lovell's Pond Mystic Lake
Eutrophic Total P<24-96 (ug/l)	Little Pond	Parker Pond Eagle Pond Muddy Pond Long Pond Sam's Pond	
Hypereutrophic			

Six ponds within the watershed have been identified as impaired; Pattys Pond, Little Pond, Eagle Pond, Muddy Pond, Long Pond, and Sam Pond.

5.2.4.1.4 Economic Development

Sewer expansion is required within the Route 28 corridor to facilitate the sewer expansion needs of the western portion of the Town. Additionally, the Route 28 corridor has also been identified by the Town as an area desired for economic development. Development within this corridor has historically been restricted by wastewater requirements (i.e. Title 5) and the Town's Salt Water Estuary's Regulation. The Town's wastewater plan has included sewer expansion of the entire Route 28 corridor to accommodate these goals.

5.2.4.2 PROPOSED SOLUTIONS

The Town's plan for the Three Bays Watershed incorporates both traditional solutions (sewer expansion) and non-traditional solutions (dredging, stormwater, etc.). The plan has been designed to meet the target septic removal via traditional sewer expansion alone. The sewer expansion is phased over three, 10-year phases, addressing the densest areas in the first two phases and the less dense (more expensive) areas in the third phase. During the first two phases, the Town intends to install non-traditional solutions, monitor them, and present the monitoring results to regulators. If the non-traditional solutions are effective, the Town's goal would be to reduce the amount of sewer expansion required in Phase 3. However, the Town is not seeking "credit" for these non-traditional projects at this time and has presented a plan that meets the Three Bays Watershed TMDL via traditional sewer expansion alone.

The plan addresses the needs areas using the following techniques:

- Sewer Expansion
  - 3,714 parcels (66%) in the watershed are included in the sewer expansion plan
  - Removal of 61.7% (74.9 kg/day N) of total watershed septic load.

- Stormwater upgrades
  - The Three Bay's Stormwater Project will continue. Refer to Section 2.2.1.2 for projects completed to date.
  - The Town's MS4 program will identify and provide solutions to existing stormwater outfalls.
    - 36 of the Town's 207 identified stormwater outfalls are located in the Three Bays Watershed.
  - The Town's Public Road program invests on average $750,000 a year in stormwater improvements in the Town's public roads. These improvements generally include replacement of failed catch basins and leaching structures.

- Mill Pond Dredging
  - Continue to evaluate, design, and permit the project as discussed in Section 2.3.2.2.

- Cranberry Bog Conversions
  - Continue to support partners (BCWC and others) in pursuit of projects to convert the cranberry bogs in the upper end of the Marstons Mills River system to nutrient removal practices as discussed in Section 2.3.2.1

- Alternative Septic Systems
  - Contiunue to support partners (BCWC and others) in evaluation of technologies and installation of pilot projects as discussed in Section 3.1.2.5.

- Aquaculture
  - Existing commercial aquaculture grants in the Three Bays = 62 acres.
  - Continue to evaluate aquaculture opportunities in Warren's Cove as discussed in Section 2.3.2.4.

- Dredging of Cotuit Bay Cut
  - Three phase project anticipated to be completed in the winter of 2020.
  - Anticipated to improve flushing within Cotuit Bay.

- Nutrient Regulation
  - In 2014 the Town adopted a Fertilizer Nitrogen and Phosphorus Control Regulation (see Appendix PP). The regulations includes the following:
    - Provides Best Management Practices and performance standards for noncertified fertilizer applicators.
    - Outlines education, certification, enforcement and penalties.

5.2.4.3 FUTURE CONDITIONS

- The majority of the watershed is significantly built-out.
- Projected growth within the watershed.
  - The projected growth within the watershed is focused on the Route 28 corridor which will be addressed with traditional solutions (i.e. sewer expansion). Projected growth in these areas will be considered when sizing sewer infrastructure (pipes, pump stations, force mains, etc.).
- Adaptive management and monitoring
  - The Town will continue to monitor the embayment, review the Plan and provide formal updates as required.
  - Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.

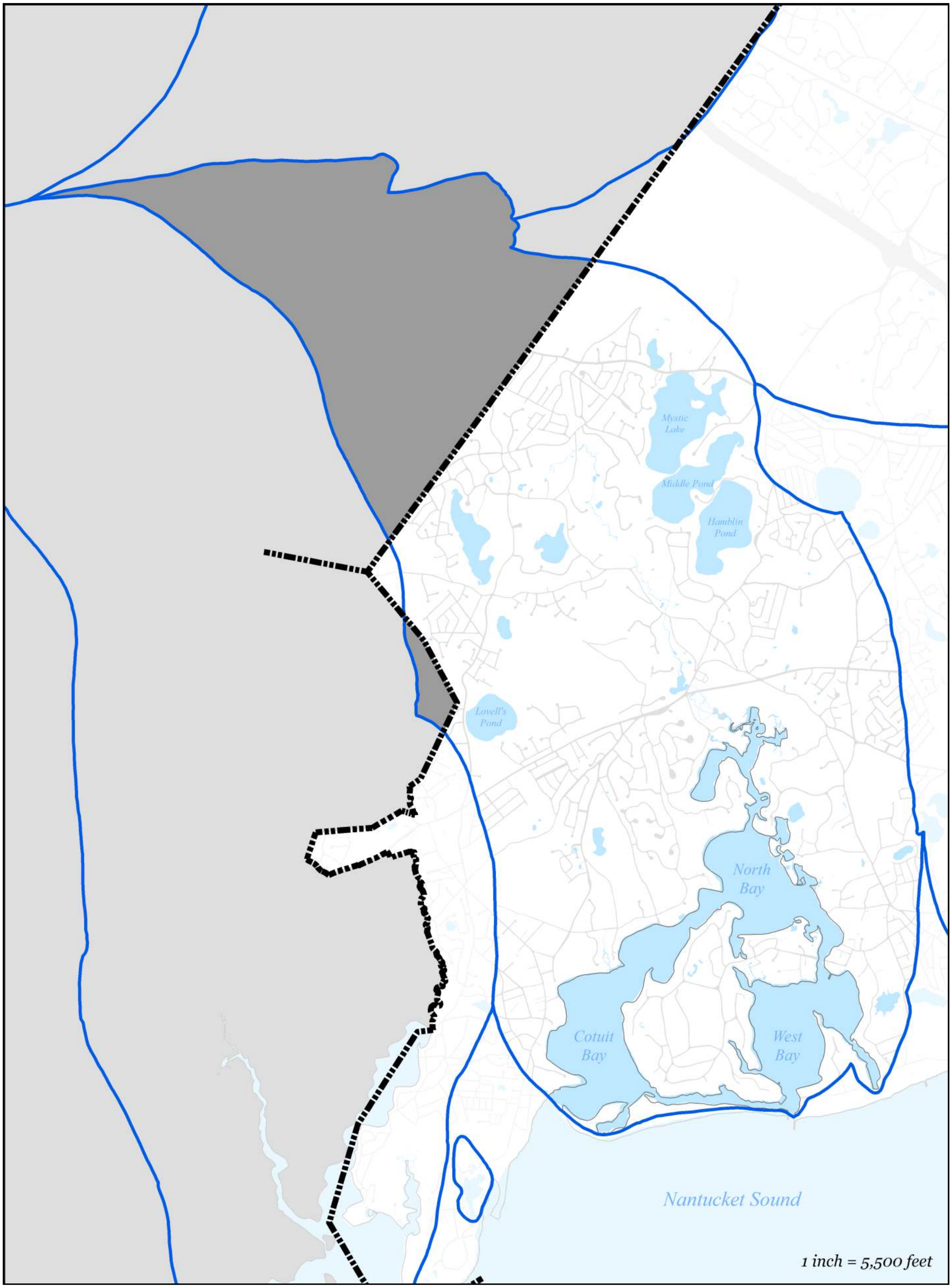

Figure 5-38: Three Bays Watershed

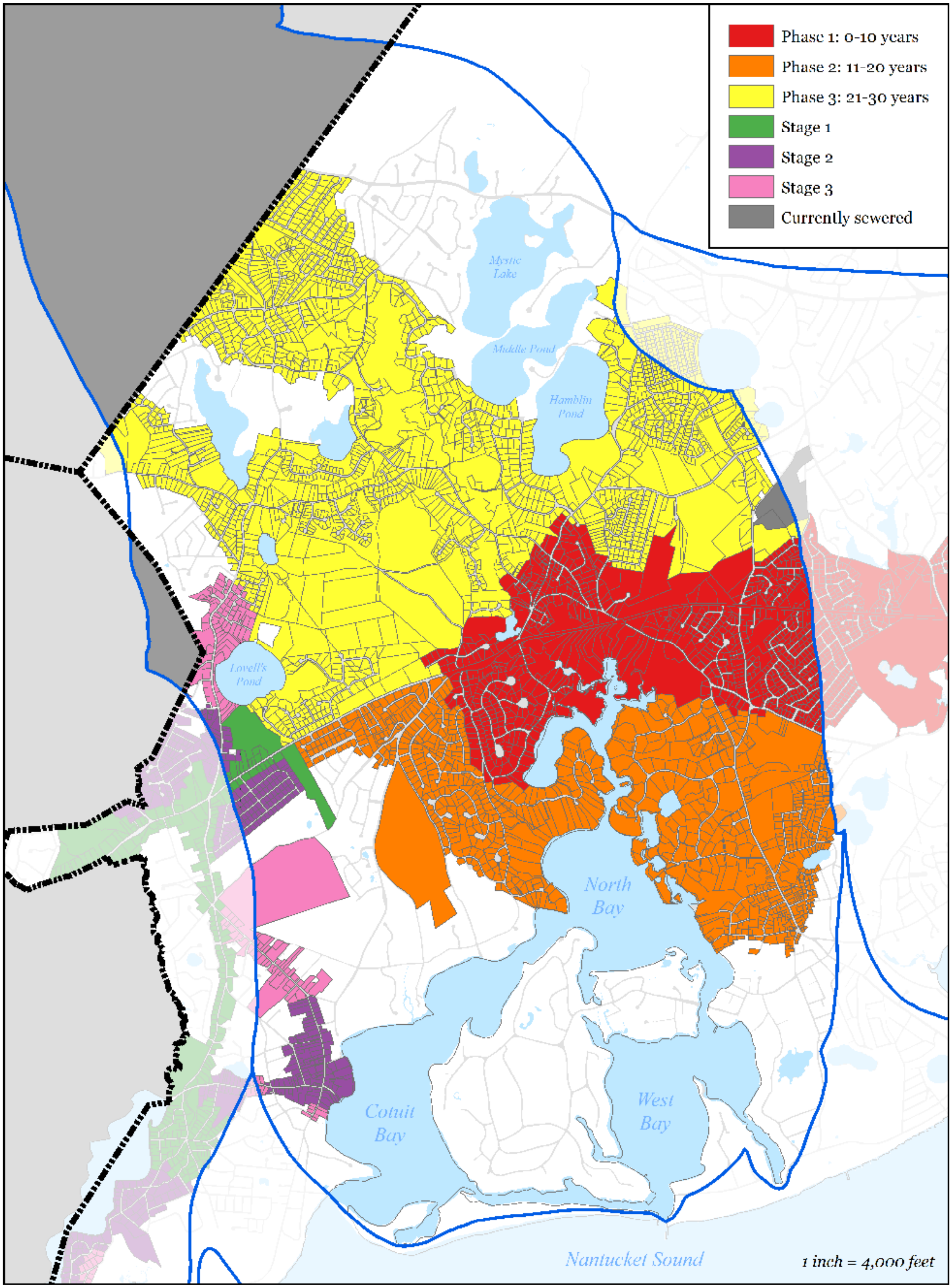

Figure 5-39: Sewer Expansion Plan in Three Bays Watershed

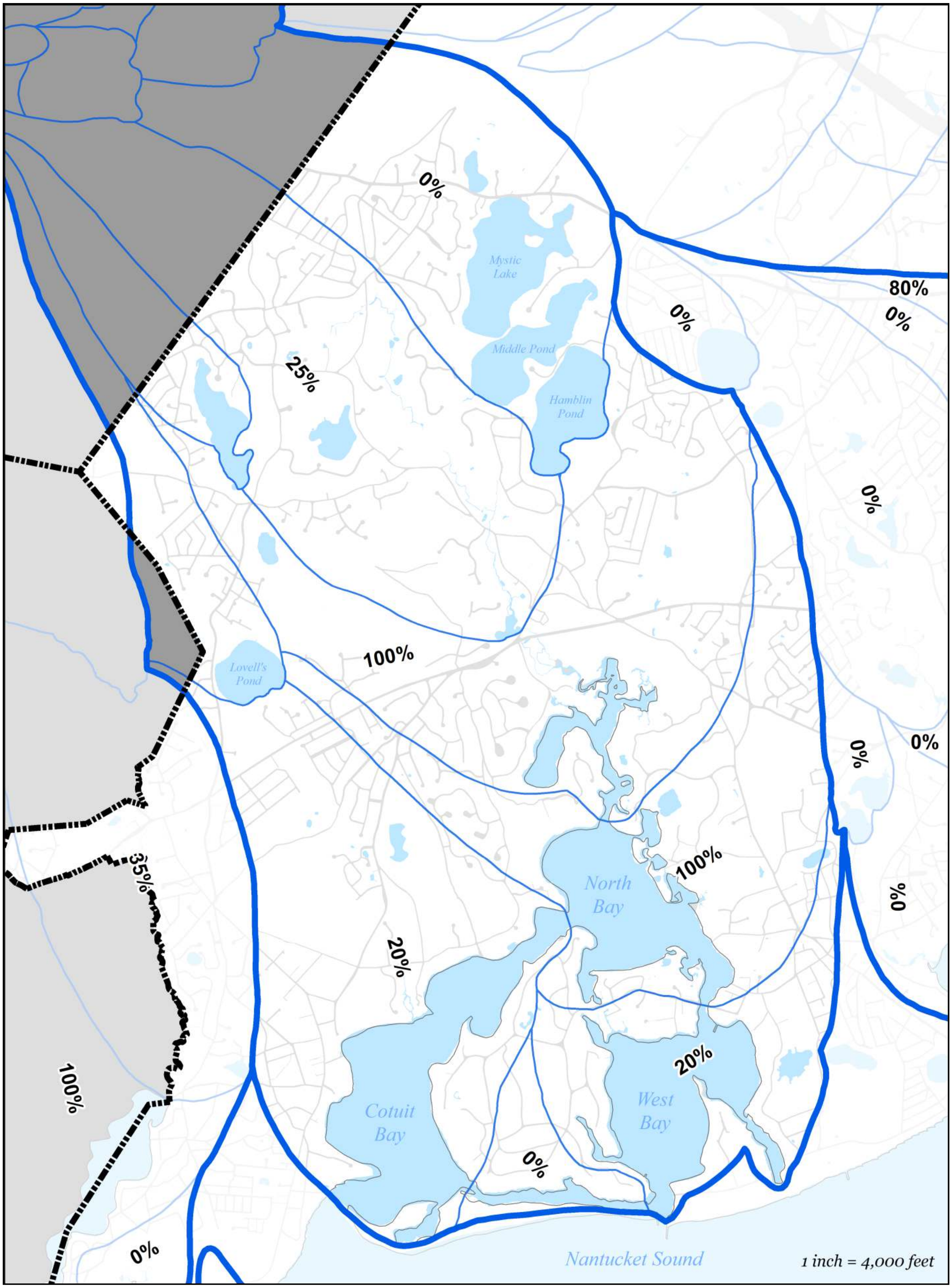

Figure 5-40: MEP-modeled Existing Septic Removal in Three Bays Watershed

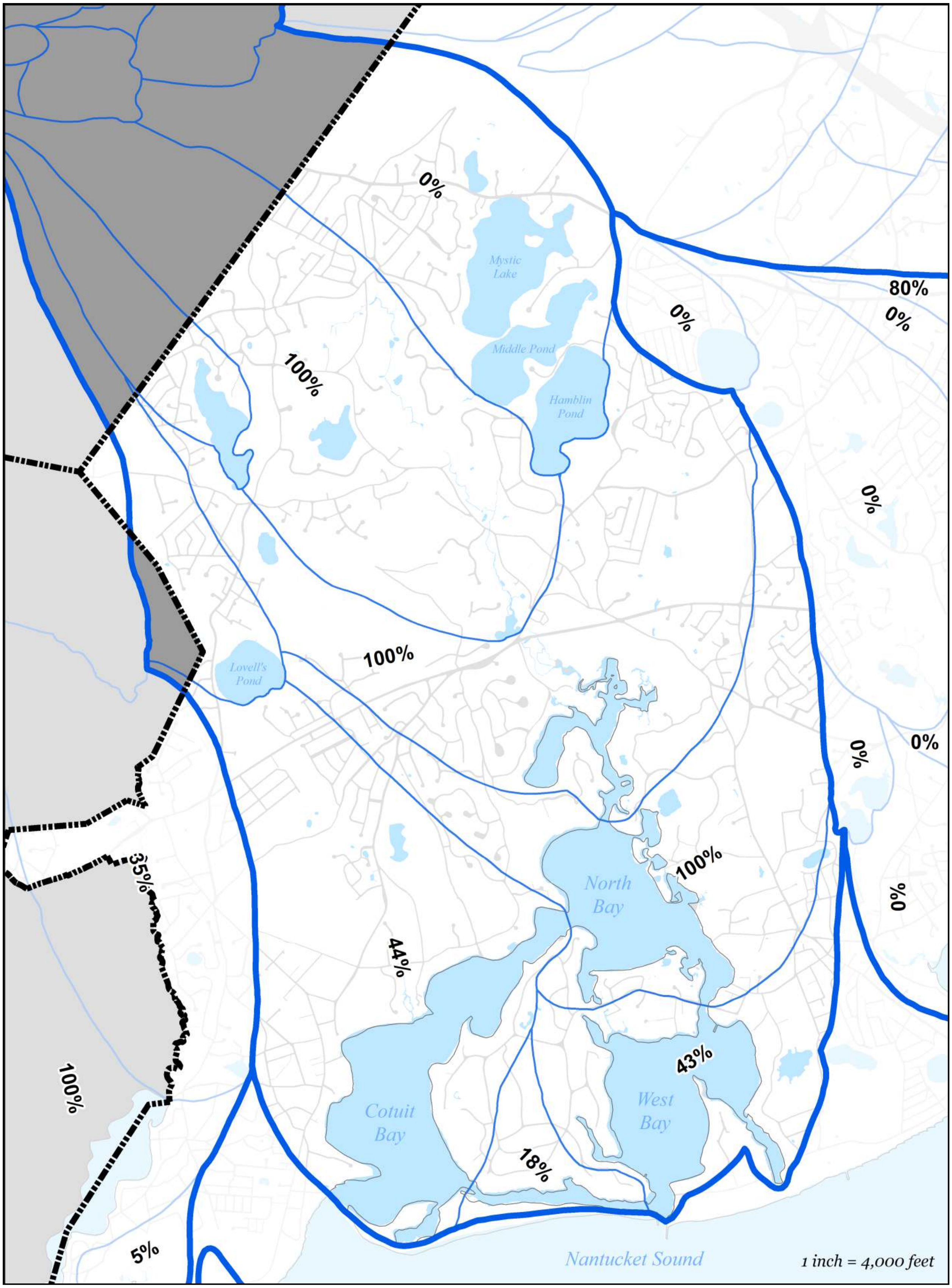

Figure 5-41: MEP-modeled Future Septic Removal in Three Bays Watershed

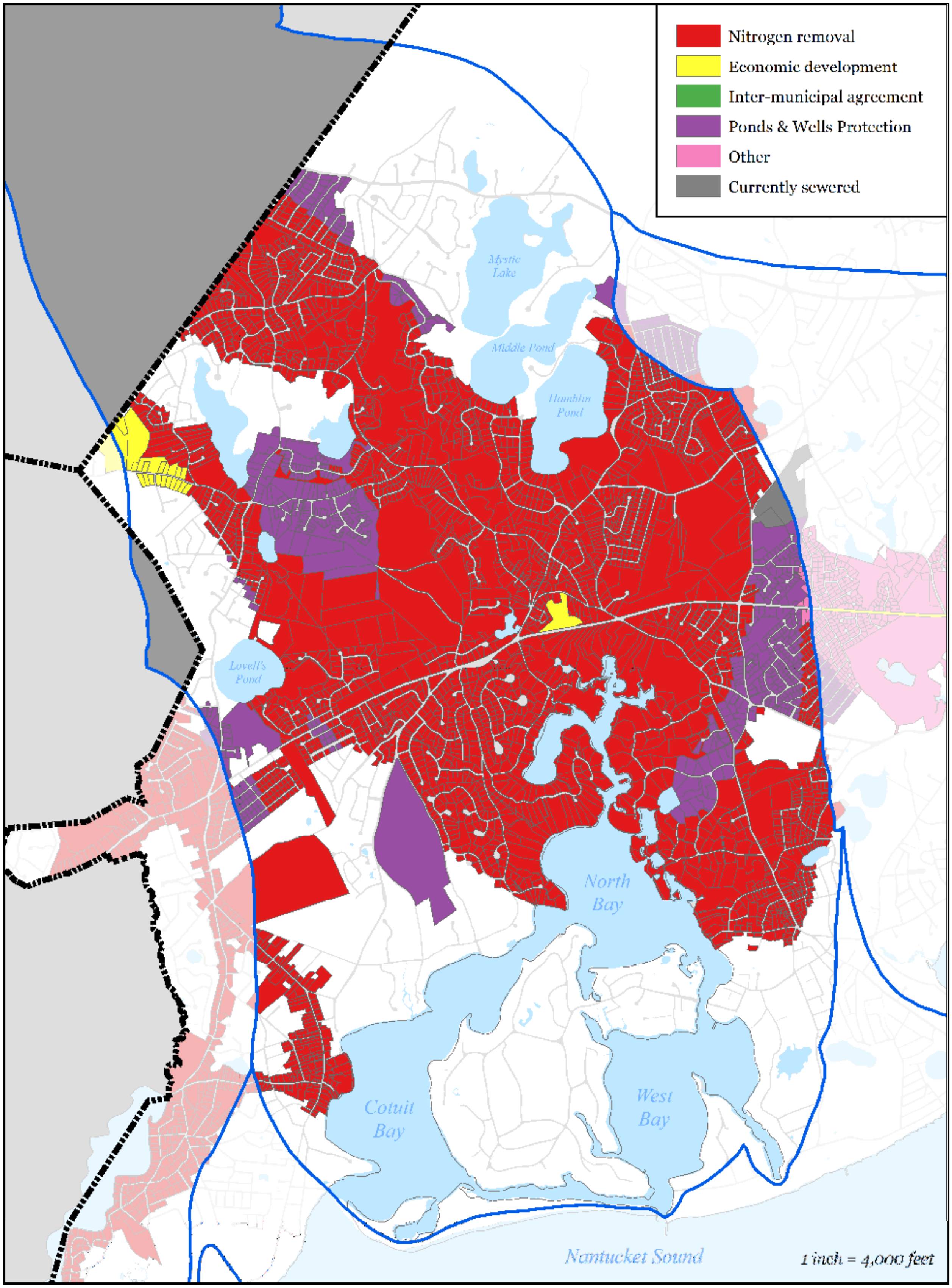

Figure 5-42: Needs Areas in Three Bays Watershed

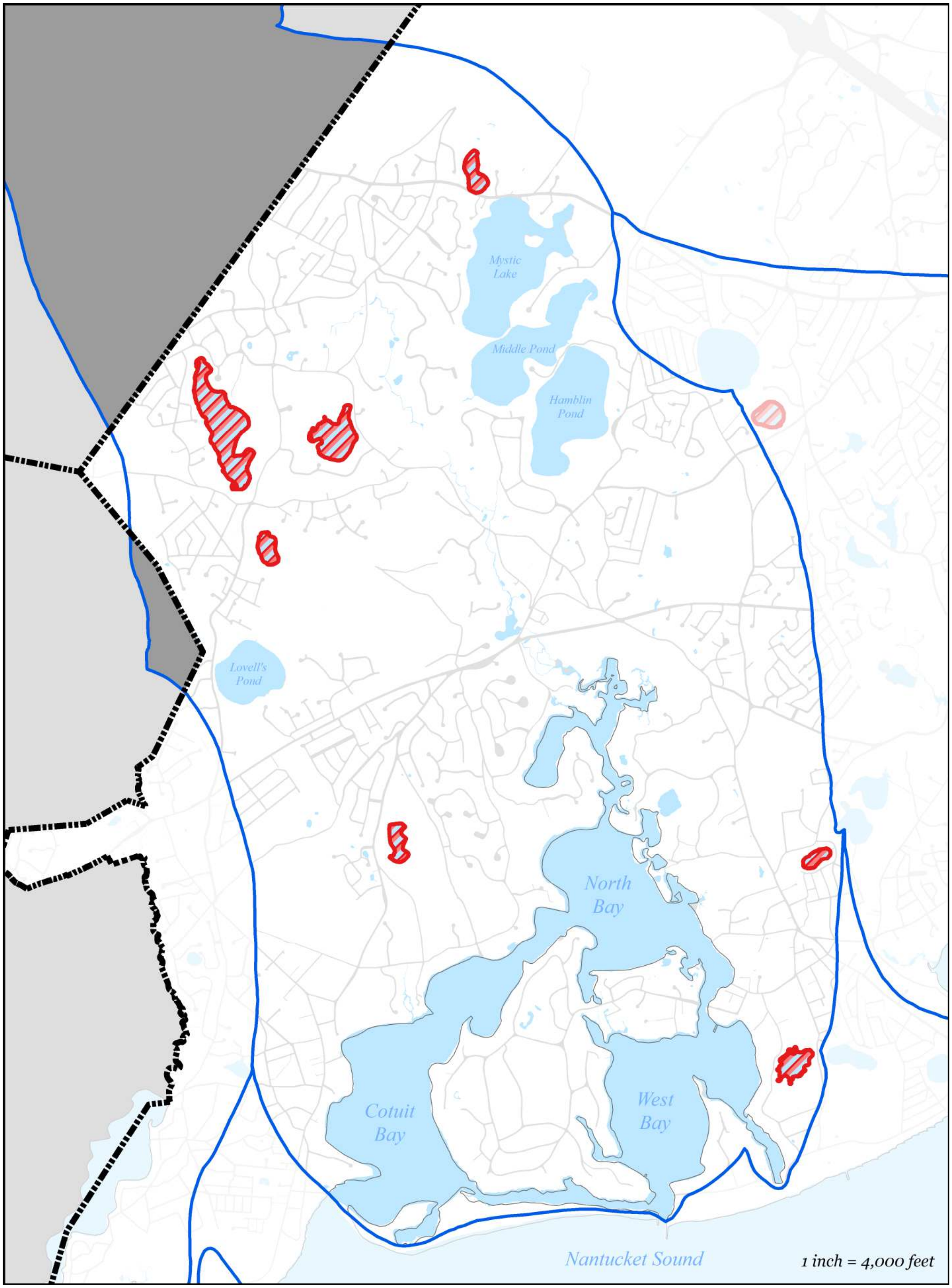

Figure 5-43: Impaired Ponds in Three Bays Watershed

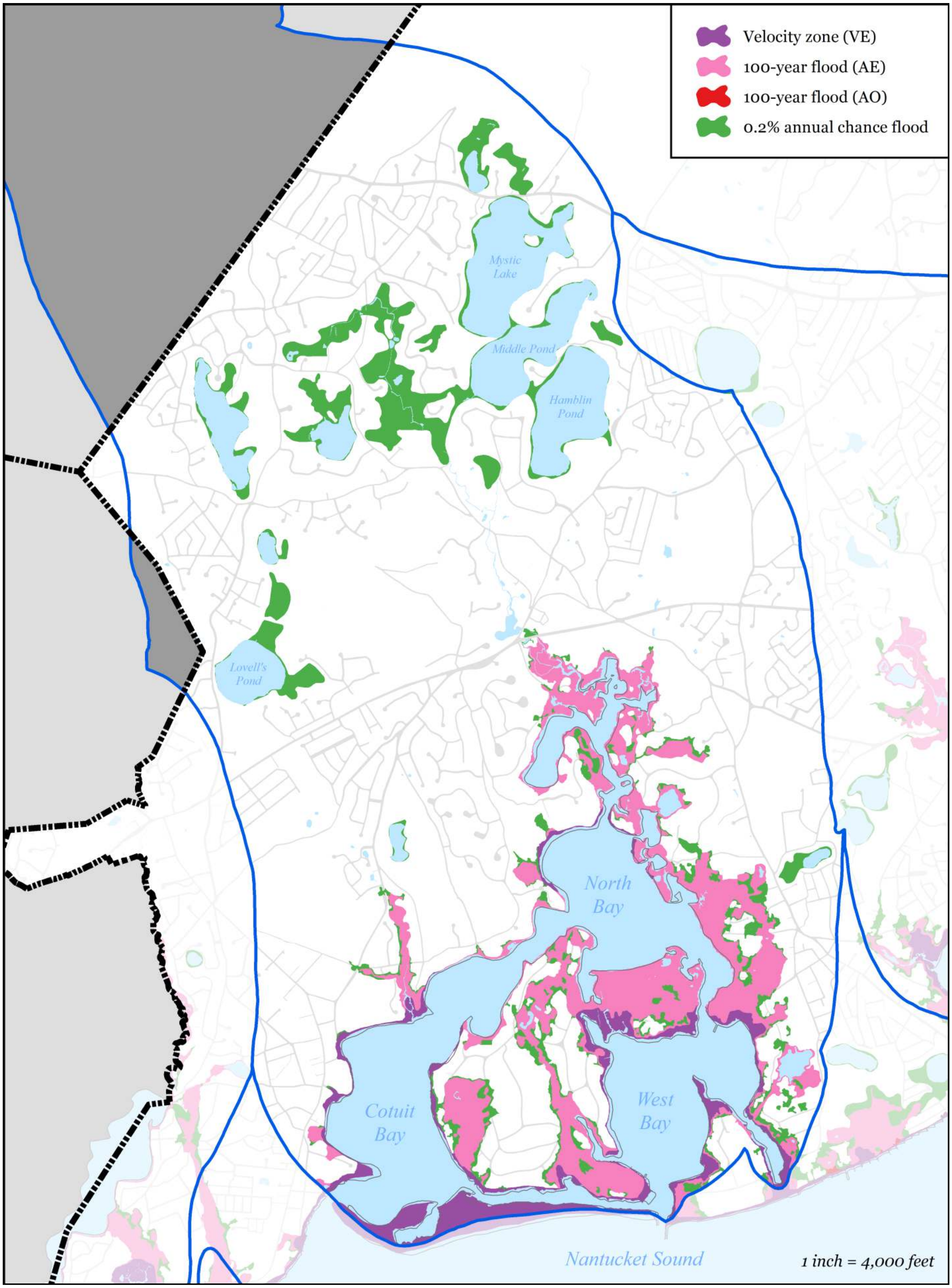

Figure 5-44: FEMA Flood Zones (2014) in Three Bays Watershed

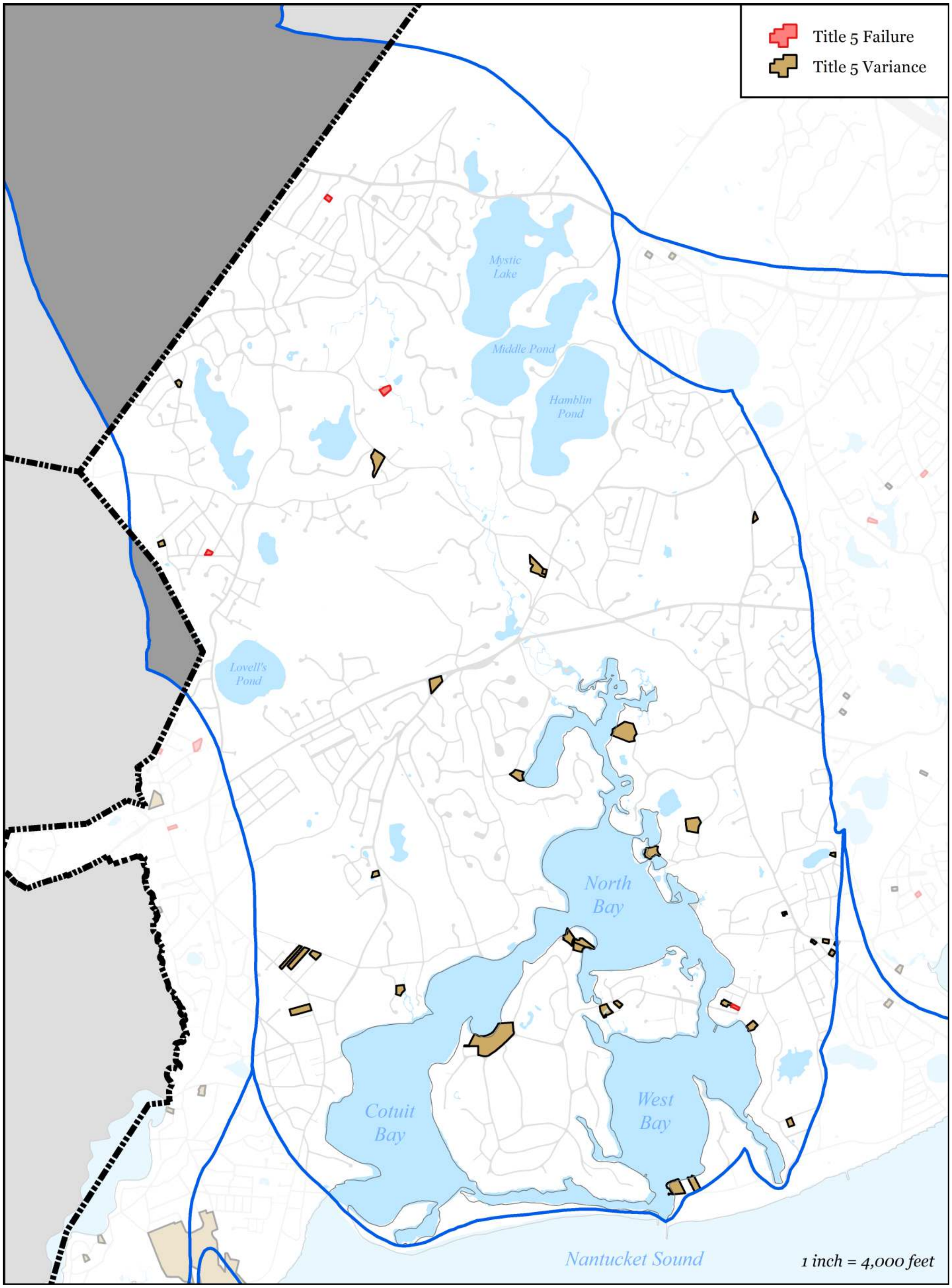

Figure 5-45: Parcels with Title 5 Septic Failures and Variances in Three Bays Watershed

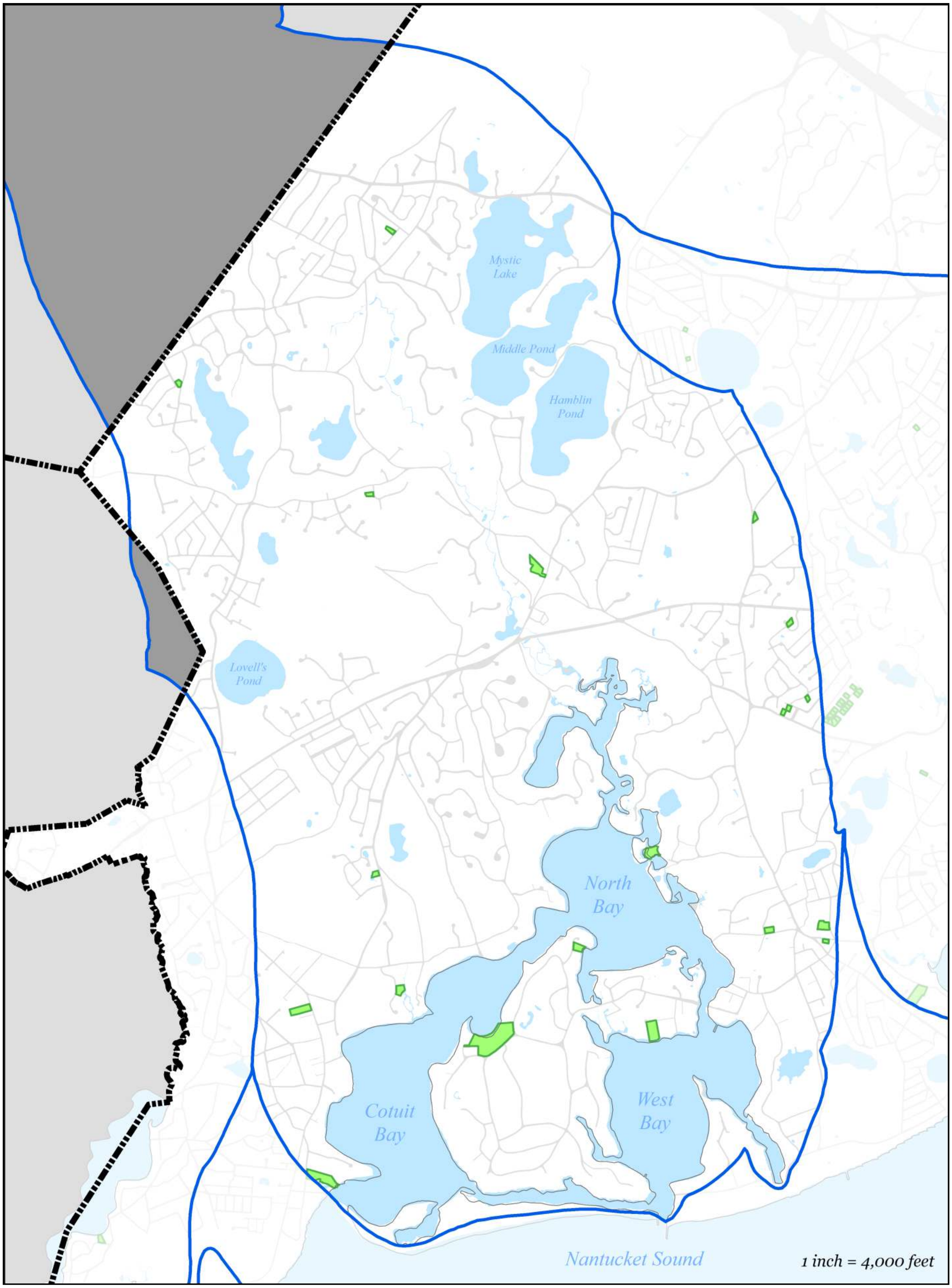

Figure 5-46: Parcels with I/A Septic Systems in Three Bays Watershed

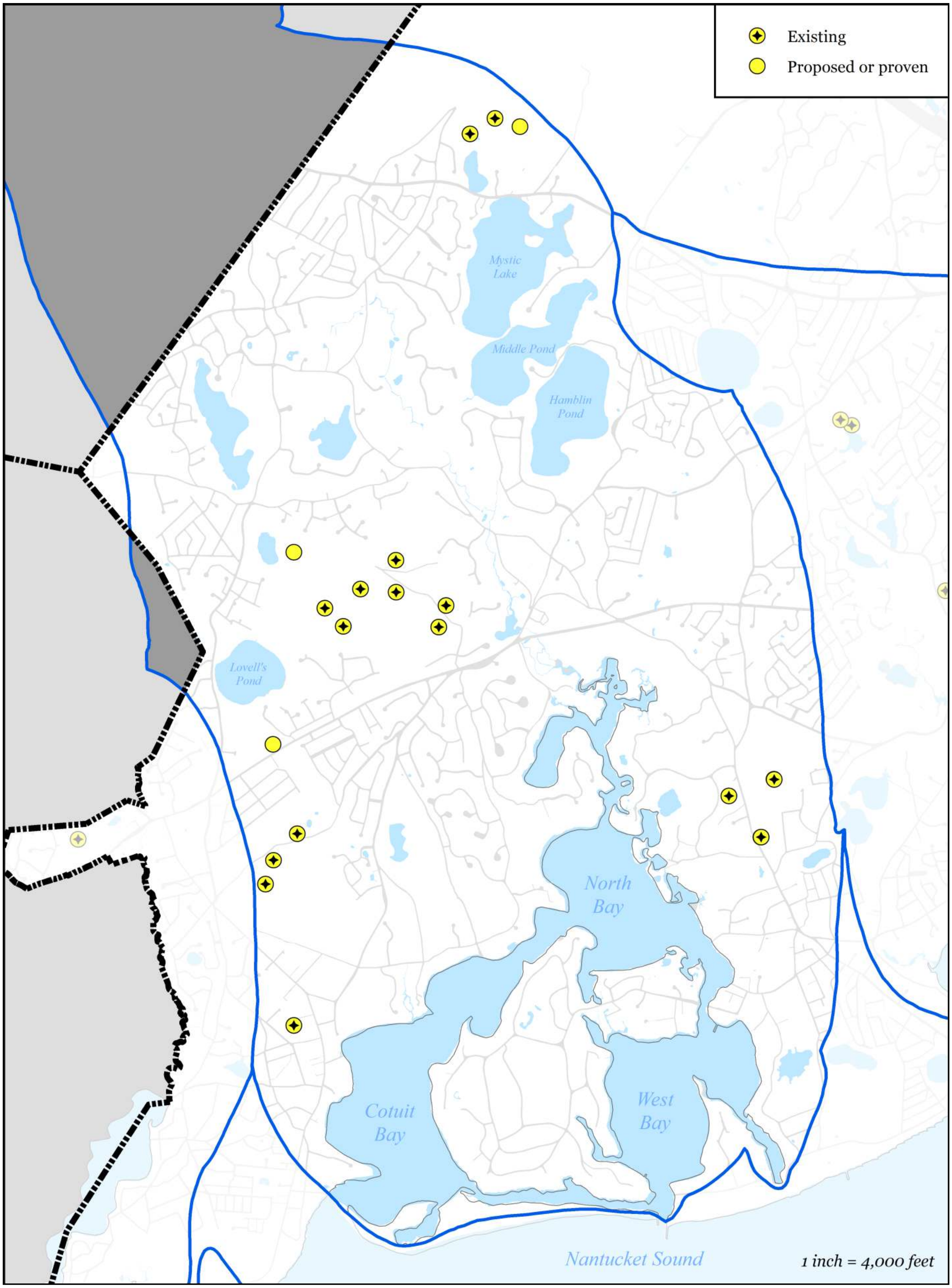

Figure 5-47: Public Water Supply Wells in Three Bays Watershed

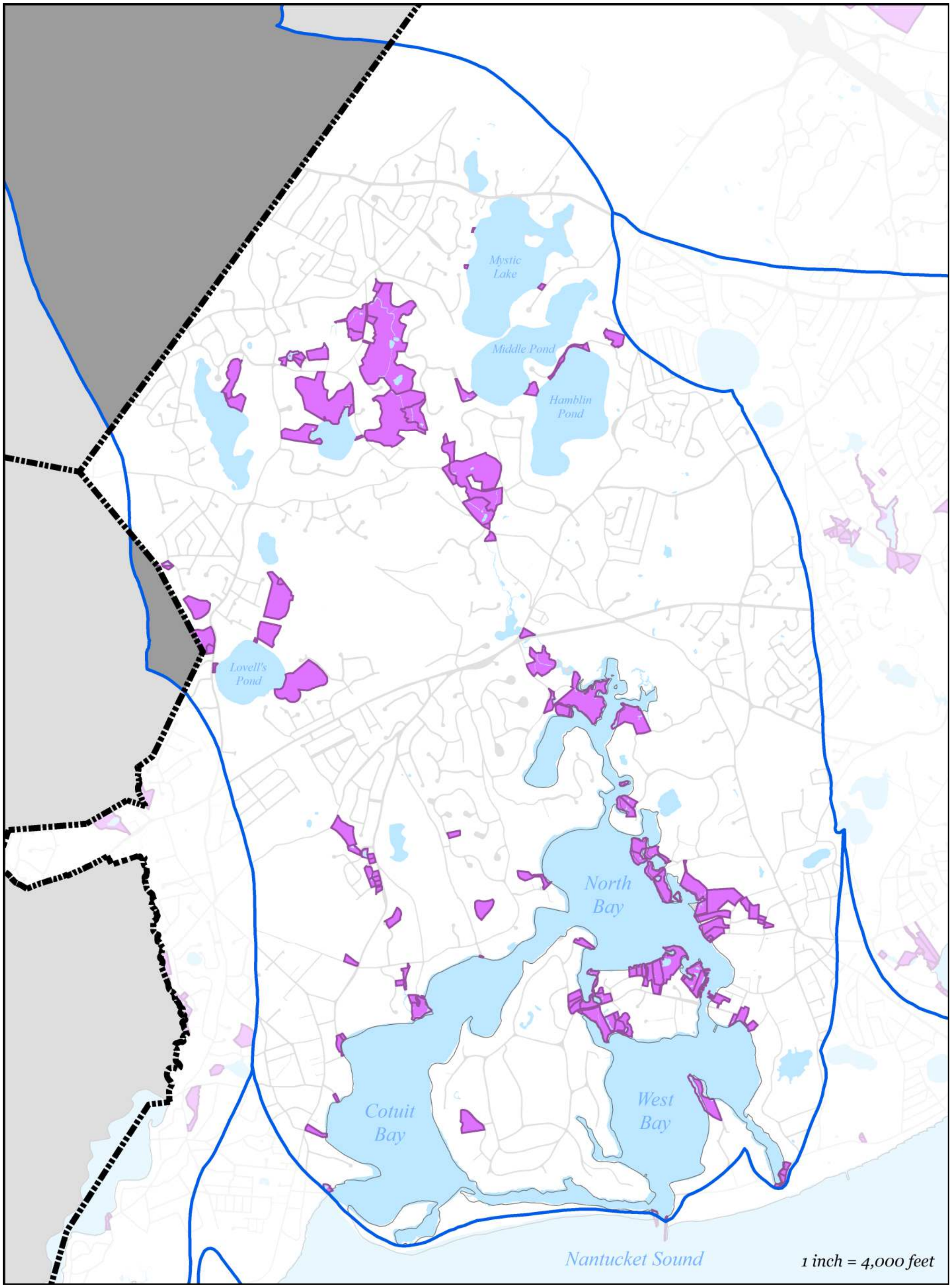

Figure 5-48: Parcels with Less than 4 feet Depth to Groundwater in Three Bays Watershed

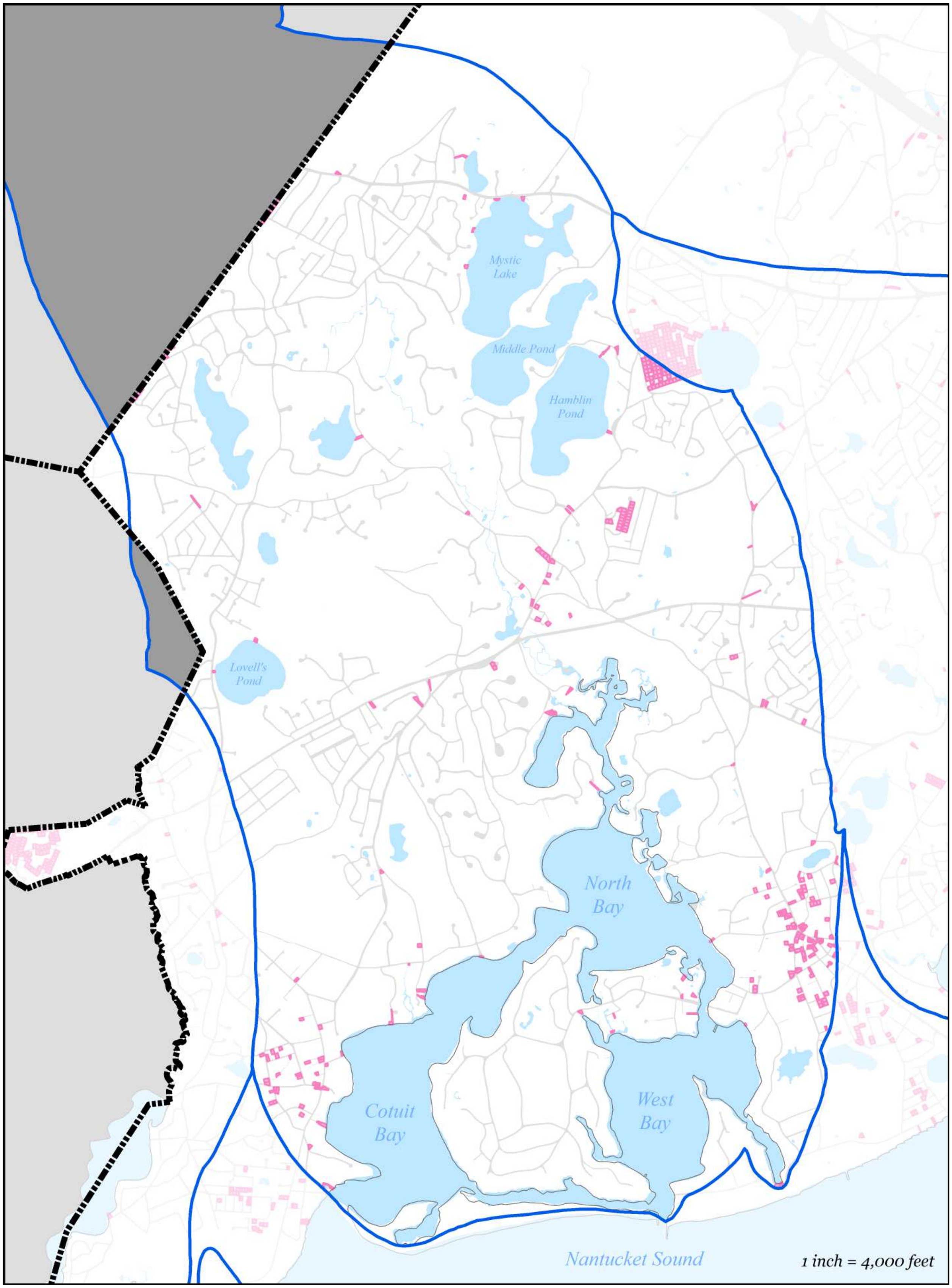

Figure 5-49: Parcels with Less than 0.25 acres in Three Bays Watershed

5.2.5 RUSHY MARSH POND WATERSHED

The Rushy Marsh Embayment System is a small estuary located within the village of Cotuit. It is bounded by Main Street Cotuit on one side and Nantucket Sound on the other, and is located between the Popponesset Bay and Three Bays watersheds. According to the MEP report, virtually all the watershed's freshwater and nutrients enter Rushy Marsh via groundwater seepage, as there are no significant surface inflows to this system. Refer to Figure 5-52 for a figure showing the Rushy Marsh Embayment system. For a detailed description of the embayment system, refer to the 2006 MEP Report for the Rushy Marsh Embayment System (Appendix V).

The open water area of the marsh is approximately 15 acres, thus making it a great salt pond. USGS maps from 1893 show Rushy Marsh as a fully tidal estuary with salt marsh along its eastern and northern shores. During the 1900's the tidal inlet became restricted due to sedimentation deposits and the formation of a barrier beach. There were attempts to keep the system tidal with pipes and culverts, but ultimately the process of barrier beach formation resulted in a freshening of Rushy Marsh Pond. By the turn of the century, the system was a brackish salt pond.

The pond currently does not support eelgrass, and mapping from 1951 indicates it was not present then either. Given this lack of documentation of an eelgrass population, it is not clear that even when the system was much better flushed, it supported eelgrass beds. However, to the extent that conditions could be improved to the level required for eelgrass colonization, the acreage would likely range from 4-12 acres, most likely in the southern channel and the margins of the main basin.

5.2.5.1 SUMMARY OF NEEDS

5.2.5.1.1 Nutrient Removal

The 2006 MEP report states "While Rushy Marsh Pond presently has a relatively low nitrogen load from its watershed, due to its small size and proportionally large undeveloped areas, it is still significantly impaired by nitrogen enrichment and is clearly eutrophic. This apparent paradox results from its very low tidal exchange rate, resulting from barrier beach processes restricting the inlet to Nantucket Sound."

5.2.5.1.2 PROPOSED SOLUTIONS

The 2006 MEP report suggested that even if the Town removed 100% of the septic load that feeds into this pond, the pond would still be impaired due to its isolation from the sound. They went on to hypothesize that "…in order to meet the threshold concentrations in the system, alternative approaches beyond load reductions are required to increase circulation and water exchange with Nantucket Sound."

MEP went on to run some simple models on the system assuming the inlet was increased to 4 feet and again to 10 feet. What they found was the total nitrogen concentrations were significantly reduced with the modeled inlets, and that the reduction would be large to meet the threshold limits that they suggested for the marsh.

In response to these findings the Town, working with Applied Coastal Research and Engineering (ACRE), designed and installed a new inlet consisting of a 10-foot wide box culvert in the southern portion of the basin in 2012. However, within several months the new inlet had completely shoaled and filled with sand to the point that the new inlet was undistinguishable from the existing beach (see Figure 5-50, and Figure 5-51), which eliminated tidal flow and flushing.

In 2014, the Town had the Wood Hole Group conduct a forensic analysis of the project. What they found was that the tidal prism of Rushy Marsh was inadequate to maintain a stable inlet given the rate of littoral sand transport along the beach. In fact, they concluded that a stable inlet is not feasible for the as-built inlet without substantial maintenance and the addition of hard structures (jettys), or an extended large pipe well into the surf zone. Their initial calculations indicated that the jetty lengths would have to be between 122 ft and 145 ft long.

Given this finding, and the Town's understanding of the difficulty of permitting new hard structures such as these in the surf zone, it elected to forgo any further action on this watershed.

Figure 5-50: Rushy Marsh New Inlet, Newly Installed, Perspective looking toward Nantucket Sound

Figure 5-51: Rushy Marsh New Inlet, After Shoaling, Perspective from Nantucket Sound

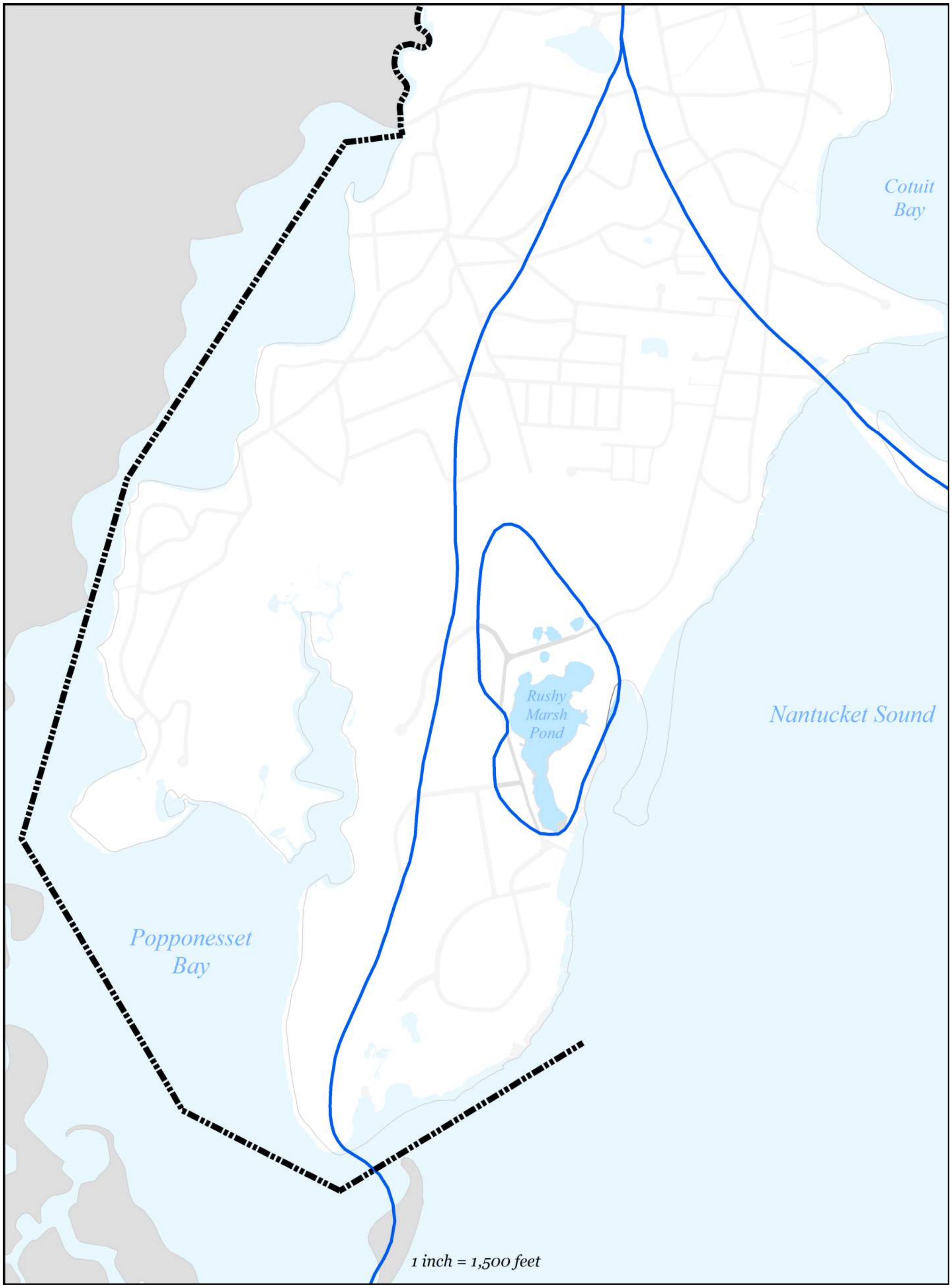

Figure 5-52: Rushy Marsh Watershed

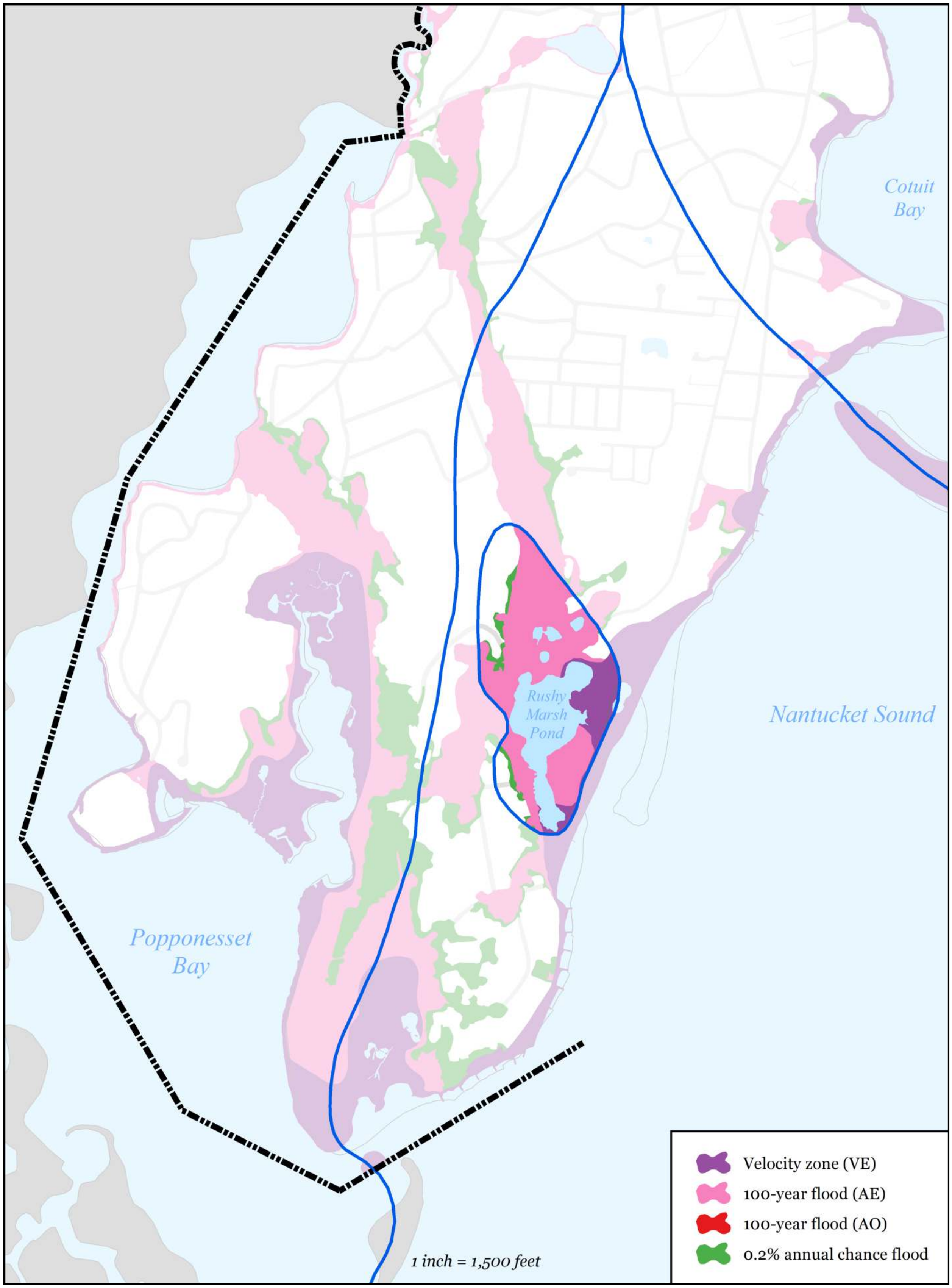

Figure 5-53: FEMA Flood Zones (2014) in Rushy Marsh Pond Watershed

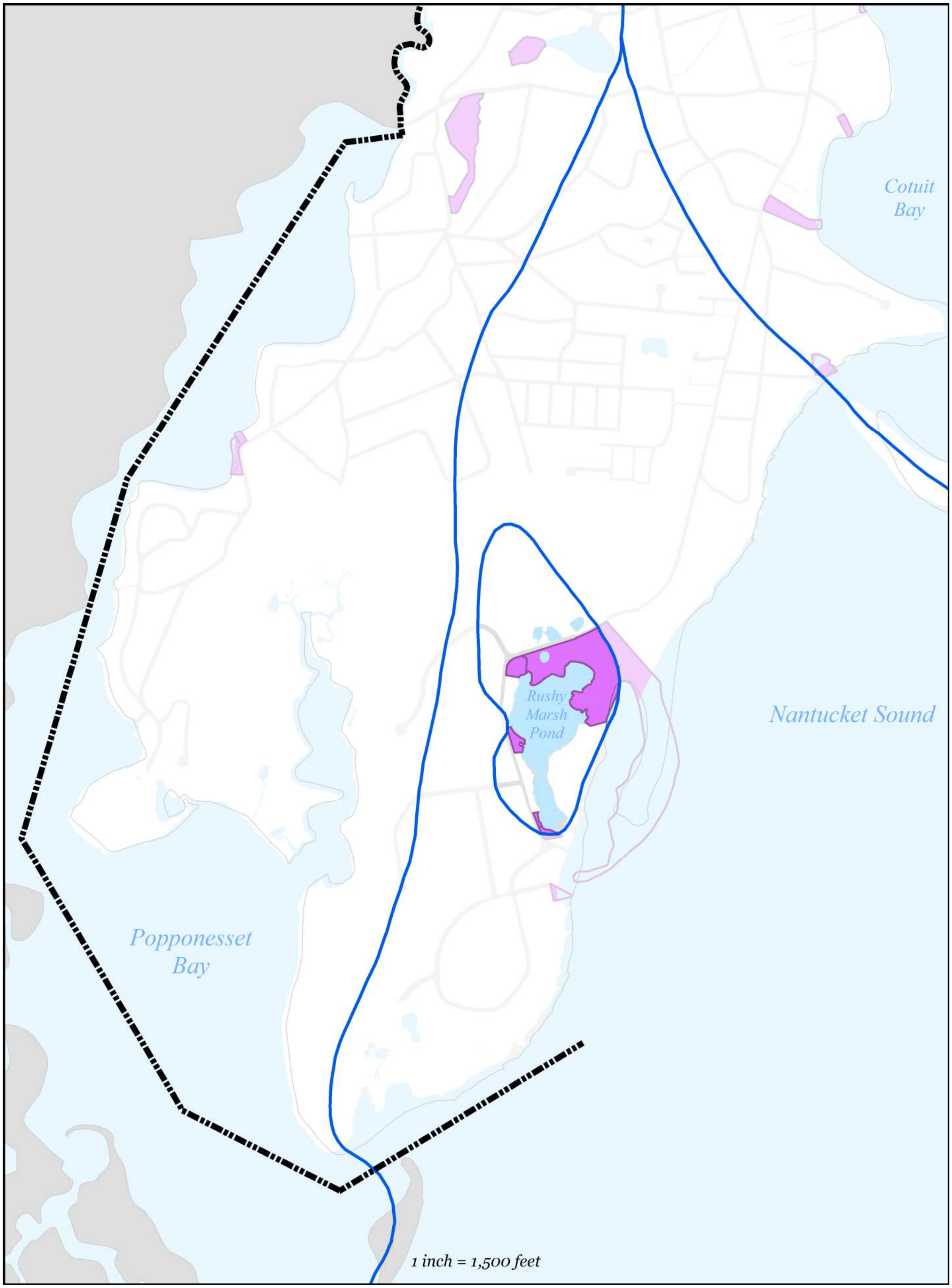

Figure 5-54: Parcels with Less than 4 feet Depth to Groundwater in Watershed

5.2.6 POPPONESSET BAY WATERSHED

The Popponesset Bay system is located within the Towns of Mashpee (north & west) and Barnstable (east), with a southern shore bounded by water from Nantucket Sound. The Bay is separated from Nantucket Sound by a barrier spit (Popponesset Beach), which grew from the southwestern shore. The Bay exchanges tidal water with Nantucket Sound through a single maintained inlet. Refer to Figure 5-55 for a figure showing the Popponesset Bay system. For a detailed description of the embayment system, refer to the 2004 MEP Report for the Popponesset Bay Embayment (Appendix T).

The source water for the Popponesset Bay Embayment System is the Popponesset Bay Watershed. The Popponesset Bay Watershed is approximately 13,082 acres and is distributed among the Towns of Mashpee, Barnstable and Sandwich (see Figure 5-55). Within the watershed there are 40 identified surface waters including 13 named freshwater ponds (including No Bottom Pond, Lewis Pond, Naomi Pond which are located in the Town of Barnstable) and 2 significant freshwater stream outlets (Mashpee River and Santuit River). The Cotuit Water District operates one public drinking water well located within the watershed within the limits of the Town of Barnstable.

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Popponesset Bay Watershed, including nutrient removal, pond protection, flood zone considerations and economic development, via sewer expansion into the Popponesset Bay Watershed.

5.2.6.1 SUMMARY OF NEEDS

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Popponesset Bay Watershed, including nutrient removal, pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the Popponesset Bay Watershed.

5.2.6.1.1 Nutrient Removal

The 2004 MEP technical report for the Popponesset Bay system indicates that the system exceeds its critical threshold for nitrogen, resulting in impaired water quality. Based upon the findings of the MEP technical report, a TMDL for nitrogen has been developed and approved.

As previously discussed in Section 2.3.1.1, the Town executed an IMA with its western neighbors (Mashpee and Sandwich) relative to addressing nitrogen removal (via nitrogen sharing or other similar methods) in the Popponesset Bay Watershed. Key components of the IMA include:

- The Towns agreed that it was in their best interests to apply jointly for a Watershed Permit.
- That each Town would develop and implement its own MassDEP approved CWMP or Targeted Watershed Management Plan, and the capital projects undertaken by the Town as a result of those plans will be the sole responsibility of that Town.
- The Town of Mashpee would serve as the fiscal agent under the IMA and, as such, will receive, hold, and expend any funds appropriated by the Parties for joint actions required in the implementation of the IMA, as well as any grant funds awarded to the Parties for the purpose of pursuing, securing, and implementing a Permit.
- The Towns would establish a Popponesset Bay Watershed Work Group, which would be comprised of three members from each Town (Town Manager, Selectman/Town Councilor, and a technical representative), and which will:
  - Administer this IMA and any amendments to it;
  - Administer the application and implementation of a Watershed Permit; but
  - The Work Group has no authority to bind one or more of the parties.
- The Towns established a nitrogen allocation formula for the purpose of assigning costs (see Table 5-9). They further agreed that the costs should be allocated on the basis of unattenuated and attenuated nitrogen loadings.
  - The unattenuated loads for tracking and accounting of nitrogen reductions which result from implemented measures.
  - The attenuated loads to provide a benchmark for comparison of improvements to water quality based on implemented measures. Attenuated load is what is received in the estuary.

Table 5-9: Nitrogen Allocation from Popponesset Bay Watershed IMA

	Unattenuated	Attenuated
Barnstable	12.6%	16.0%
Mashpee	65.4%	74.5%
Sandwich	22.0%	9.5%
Total	*100%*	*100%*

- The Towns agreed to develop a fair and practical methodology for nitrogen trading mechanism.
- The Towns agreed to work together to adopt a fair and practical methodology for monitoring the water quality of the watershed, and funding said effort.

However, since the development of the IMA, concerns have been raised by the community that nitrogen trading would not adequately address deteriorating water quality in portions on the watershed, specifically Shoestring Bay. Once a potential western wastewater treatment and disposal option presented itself (JBCC), the Town decided to fund the evaluation and preliminary design of a traditional solution in the Town's portion of the Popponesset Bay Watershed. As a result, the Town developed three "stages" of traditional sewer expansion in Cotuit which was designed to address the septic load removal requirements in the Town's portion of the watershed by traditional methods.

The Town's wastewater plan has been designed to exceed the septic load removals suggested in the 2004 MEP Report's threshold loading scenarios. The threshold septic loading scenario calls for a 61% reduction in total septic load within the watershed, which is further broken out into required septic load removals of the sub-watersheds that make up the total watershed. Portions of three of the sub-watershed areas are located within the Town: Santuit River requires 35% septic load removal (4.1 kg/day-N), Shoestring Bay requires 100% septic load removal (6.9 kg/day-N) and Pinquickset Cove requires 0% septic load removal. The aforementioned staging developed by the Town was designed to meet or exceed these percentages within the Town and removes the following total septic load:

- Santuit River sub-watershed: 44%, (4.1 kg/day-N)
- Shoestring Bay sub-watershed: 100% (3.4 kg/day-N)
- Pinquickset Cove sub-watershed: 30% (0.6 kg/day-N)

It is important to note that the proposed staging sewer expansion plan as designed exceeds the threshold septic load to be removed within the Santuit River sub-watershed (4.1 kg/day-N) even though the Town makes up approximately half of the total sub-watershed area.

Note: Nitrogen removal data reported above is from the Town of Barnstable's wastewater planning GIS tool and reflects calculated existing nitrogen loading on a parcel by parcel basis based upon existing water use data.

5.2.6.1.2 Wastewater Needs (Other Needs)

Title 5 Issues

If the Town pursues the sewer expansion "stages" within the watershed, the plan will address traditional Title 5 concerns via traditional sewer expansion. Utilizing the Town's wastewater planning GIS tool allowed Town staff to spatially map traditional Title 5 concerns such as small lot size, depth to groundwater, existing septic variances, existing known failed septic systems, and systems within Zone IIs. Parcels with area less than 0.25 acres were flagged because of they were considered difficult to site a traditional septic system, likely to need septic variances, and increased density leading to increased nutrient loading. Parcels with an average depth of groundwater of less than four feet were flagged as likely to require raised systems which are

costly and less desirable for community aesthetics. Existing septic variances and existing known failed septic systems were also mapped.
The tool allows the Town to overlay these layers to identify the “hot-spots” for traditional Title 5 concerns. These areas were then incorporated into the plan where practical. Many of these “hot-spots” overlaid other needs such as nutrients and pond protection. The Plan for the Popponesset Bay Watershed significantly address traditional Title 5 concerns as shown in the data presented below which was calculated using the Town’s wastewater planning GIS tool:

- Total parcels located within the Popponesset Bay Watershed in the Town = 943
- Parcels with total area less than 0.25 acres = 92
    - 5 (5%) will be addressed with a traditional solution in the Staging Plan
- Parcels with average depth to groundwater less than four feet = 10
    - 5 (50%) will be addressed with a traditional solution in the Staging Plan
- Parcels with septic system variances = 6
    - 5 (83%) will be addressed with a traditional solution in the Staging Plan
- Parcels with known failed septic systems = 0
- Parcels located within a Zone II = 412
    - 219 (53%) will be addressed with a traditional solution in the Staging Plan

Flood Zones

Low lying areas adjacent to Shoestring Bay, Pinquickset Cove and Popponesset Bay proper have been identified as needs areas for sewer expansion due to being within the 100 year floodplain and/or the velocity zone, and generally having shallow depth to groundwater. As a result of these conditions, traditional title 5 septic systems are difficult and costly to site in these areas.

- Total parcels within the Popponesset Bay Watershed = 943
- Parcels within 100 year flood plain and/or velocity zone = 175
    - 114 (65%) will be addressed with a traditional solution in the Staging Plan

Contaminants of Emerging Concern (CEC’s)

Contaminants of emerging concern (CECs) are increasingly being detected in surface water. (CECs) are made up of three general groups, endocrine disrupting compounds, pharmaceuticals, and personal care products. These compounds and potential contaminants are not currently regulated by the federal government because their toxicity is not well understood. Collecting wastewater with sewers and treating at a centralized treatment location allows the opportunity to treat wastewater for CEC’s as they are better understood and future treatment technologies are developed.

5.2.6.1.3 Pond Protection

The Town's wastewater planning has included detailed studies of ponds 3 acres or larger throughout the Town. Through those studies, there is extensive water data for 1 pond in the Popponesset Bay Watershed. Pond classification of these ponds is shown in in Table 5-10.

Table 5-10:Popponesset Bay Watershed Pond classification

	Ultra-Shallow 0 to 2.1m	Shallow 2.1 to 8.6m	Deep >8.6
Oligotrophic Total P<0-12 (ug/l)			
Mesotrophic Total P<12-24 (ug/l)		No Bottom	
Eutrophic Total P<24-96 (ug/l)			
Hypereutrophic			

5.2.6.1.4 Economic Development

Within the Popponesset Bay Watershed, the Route 28 corridor has also been identified by the Town as an area where a traditional solution is desired for economic development. Development within this corridor has historically been restricted by wastewater requirements (i.e. Title 5) and the Town's Salt Water Estuary's Regulation. The Town's wastewater plan has included sewer expansion along the entire Route 28 corridor to accommodate these goals.

5.2.6.2 PROPOSED SOLUTIONS

The plan addresses the needs areas using the following techniques:

- Sewer expansion
  - 524 of the 943 parcels (56%) located in the watershed in the Town are included in the sewer expansion plan
  - Removal of 52% (8.4 kg/day-N) of total watershed septic load within the Town.

- Stormwater upgrades
  - The Town's MS4 program will identify and provide solutions to existing stormwater outfalls.

        - 1 of the Town's 207 identified stormwater outfalls is located in the Popponesset Bay Watershed.
    - The Town's Public Road program invests on average $750,000 a year in stormwater improvements in the Town's public roads. These improvements generally include replacement of failed catch basins and leaching structures.
        - As part of a project that, partnering with the Town of Mashpee, will replace the culvert which conveys Santuit River (a significant freshwater tributary to Popponesset Bay Watershed) under Old Kings Road, the Town will be installing new stormwater infrastructure which will address stormwater runoff that is discharging directly into the river. This new stormwater system will include deep sump catch basins and infiltration structures which will reduce total suspended solids, bacteria and to a lesser extent nutrients directly discharging to the River.

- Dredging
    - The Town is not proposing any dredging within the Town's portion of the Popponesset Bay embayment. The majority of the navigational channels within Popponesset are located within the Town of Mashpee's jurisdiction. The Town of Mashpee performs on-going maintenance dredging within the embayment. The 2004 MEP report modeled a dredging alternative within the embayment which showed negligible impacts on nutrients in the embayment.

- Fertilizer Regulation
    - In 2014 the Town adopted a Fertilizer Nitrogen and Phosphorus Control Regulation (see Appendix PP). The regulations includes the following:
        - Provides Best Management Practices and performance standards for noncertified fertilizer applicators.
        - Outlines education, certification, enforcement and penalties.
- Watershed Permit
    - As stated in the executed IMA, Barnstable will work with the two other communities that make up the Popponesset Bay Watershed (Mashpee and Sandwich) in the pursuit of a Watershed Permit.

5.2.6.3 FUTURE CONDITIONS

The plan accommodates future growth conditions as follows:

- The majority of the watershed is significantly built-out.
- Projected growth within the watershed.

    - The projected growth within the watershed is focused on the Route 28 corridor which will be addressed with traditional solutions (i.e. sewer expansion). Projected growth in these areas will be considered when sizing sewer infrastructure (pipes, pump stations, force mains, etc.).
    - New developments within the watershed would be required to connect to sewer.
- The sewer expansion staging plan removes more septic load than required within the watershed, specifically within the Santuit River sub-watershed and the Pinquickset Cove sub-watershed to substantially address any additional development that may be experienced in the watershed.
- Adaptive management and monitoring
    - The Town will continue to monitor the embayment, review the Plan and provide formal updates as required.
    - Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.

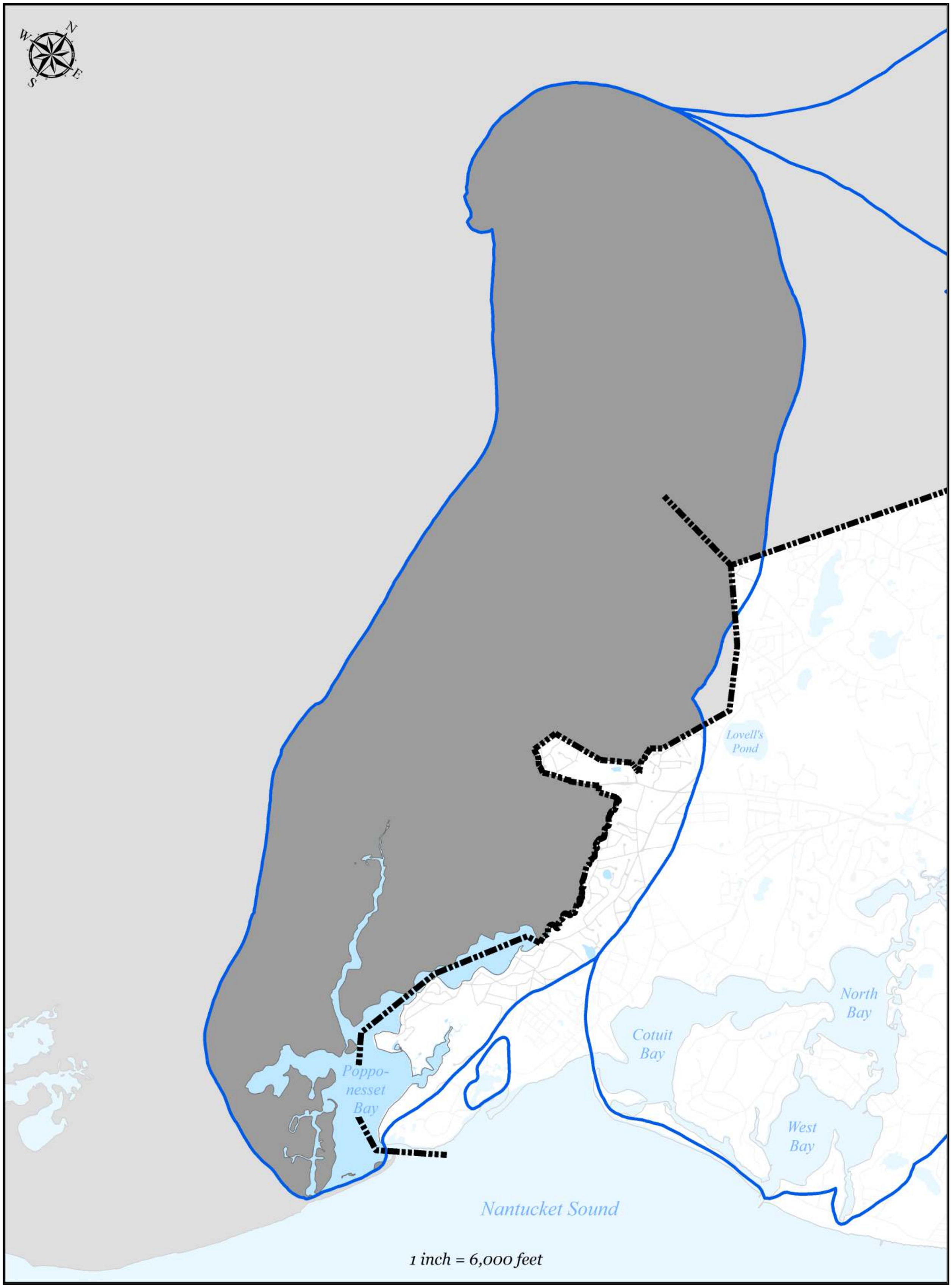

Figure 5-55: Popponesset Bay Watershed Boundary

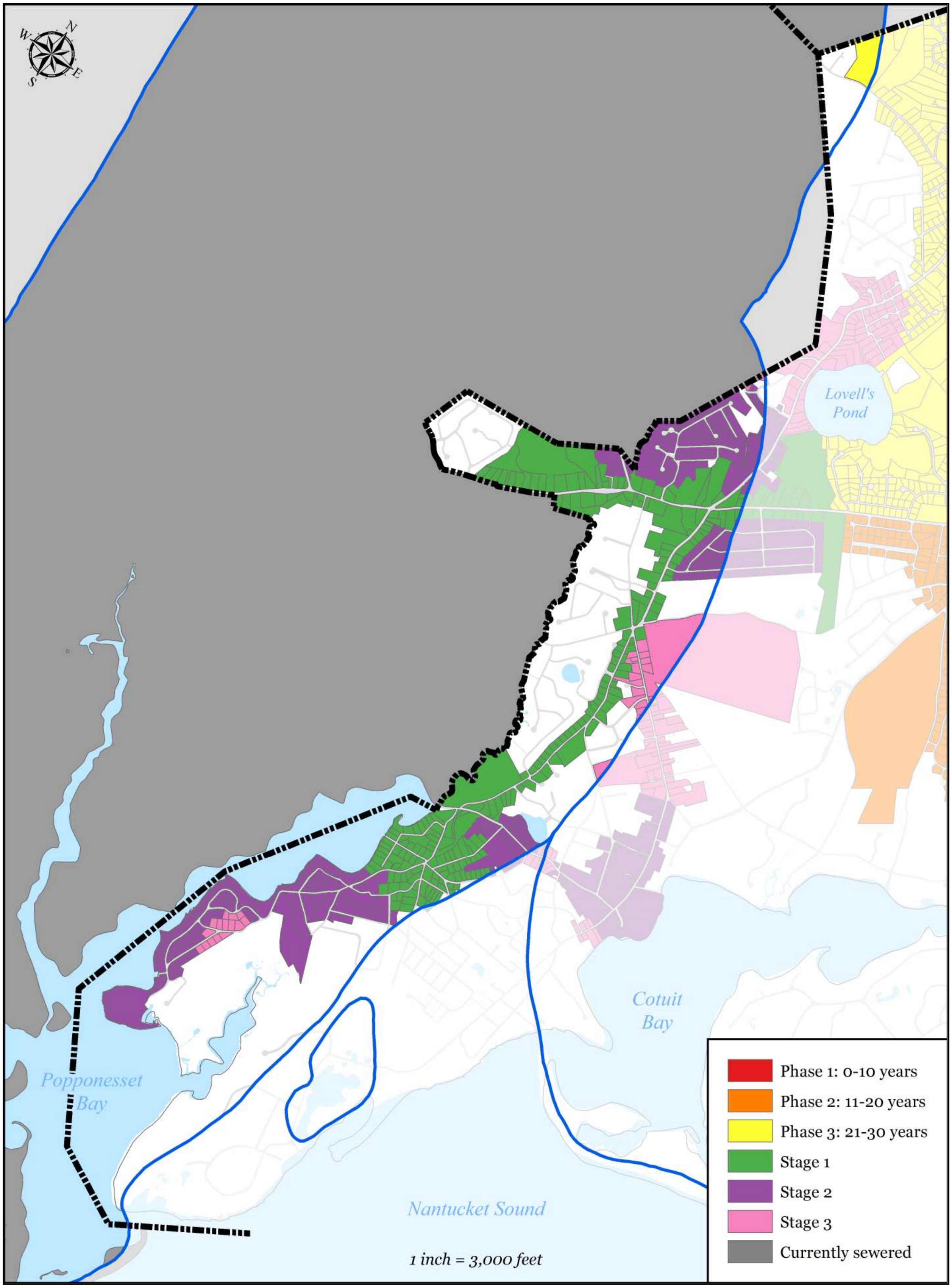

Figure 5-56: Sewer Expansion Plan in Popponesset Bay Watershed

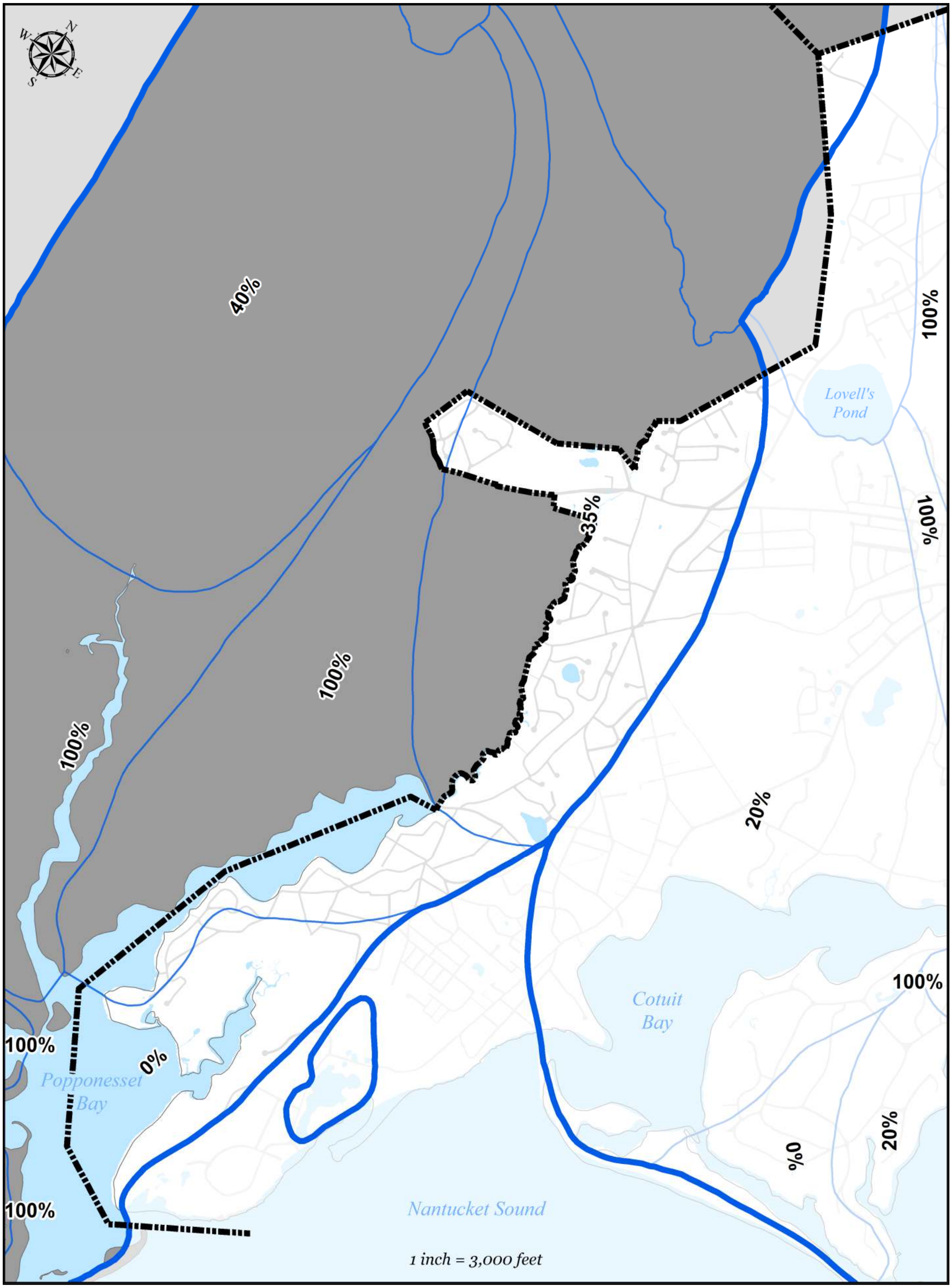

Figure 5-57: MEP-modeled Existing Septic Removal in Watershed

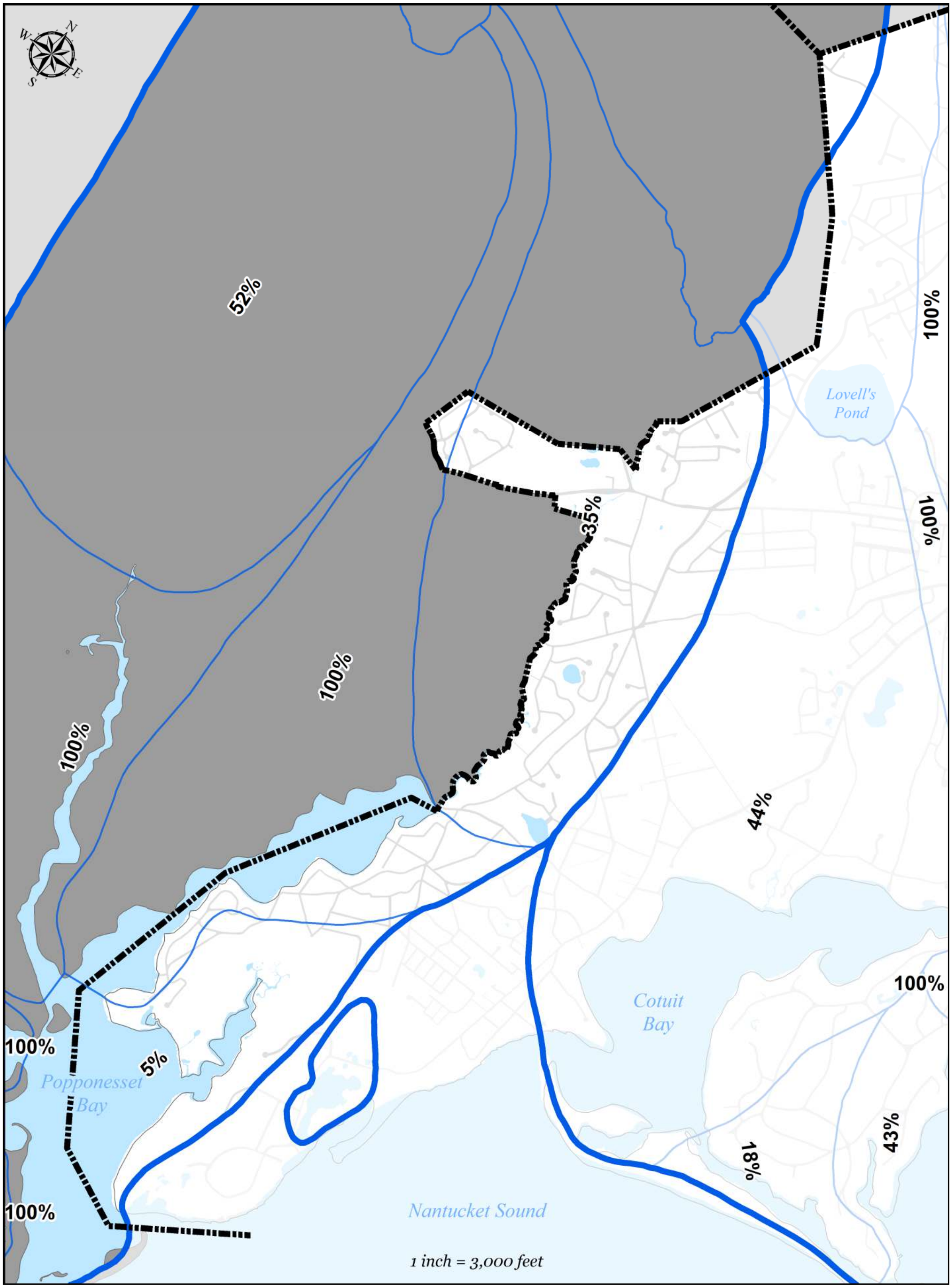

Figure 5-58: MEP-modeled Future Septic Removal in Watershed

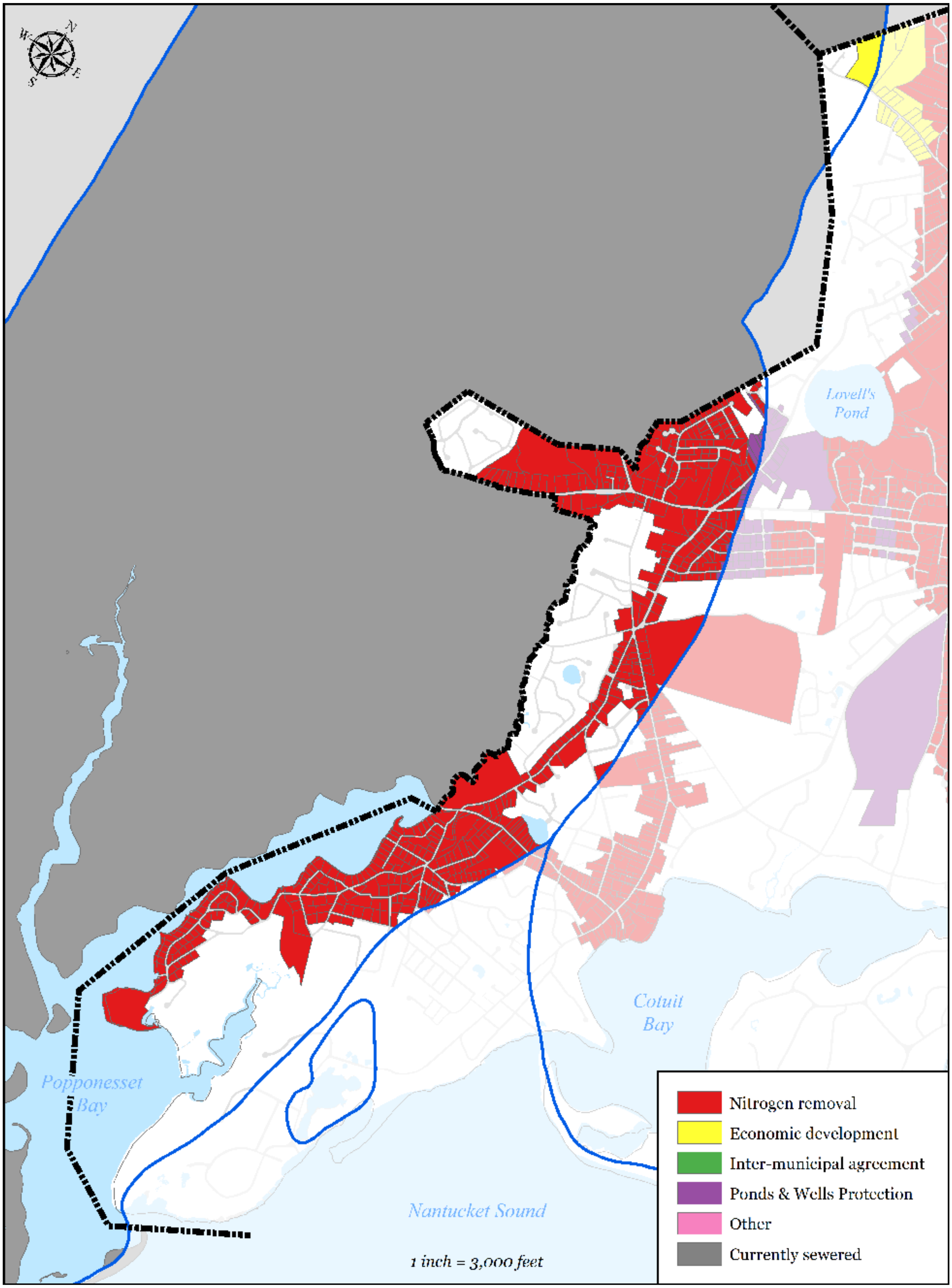

Figure 5-59: Needs Areas in Popponesset Bay Watershed

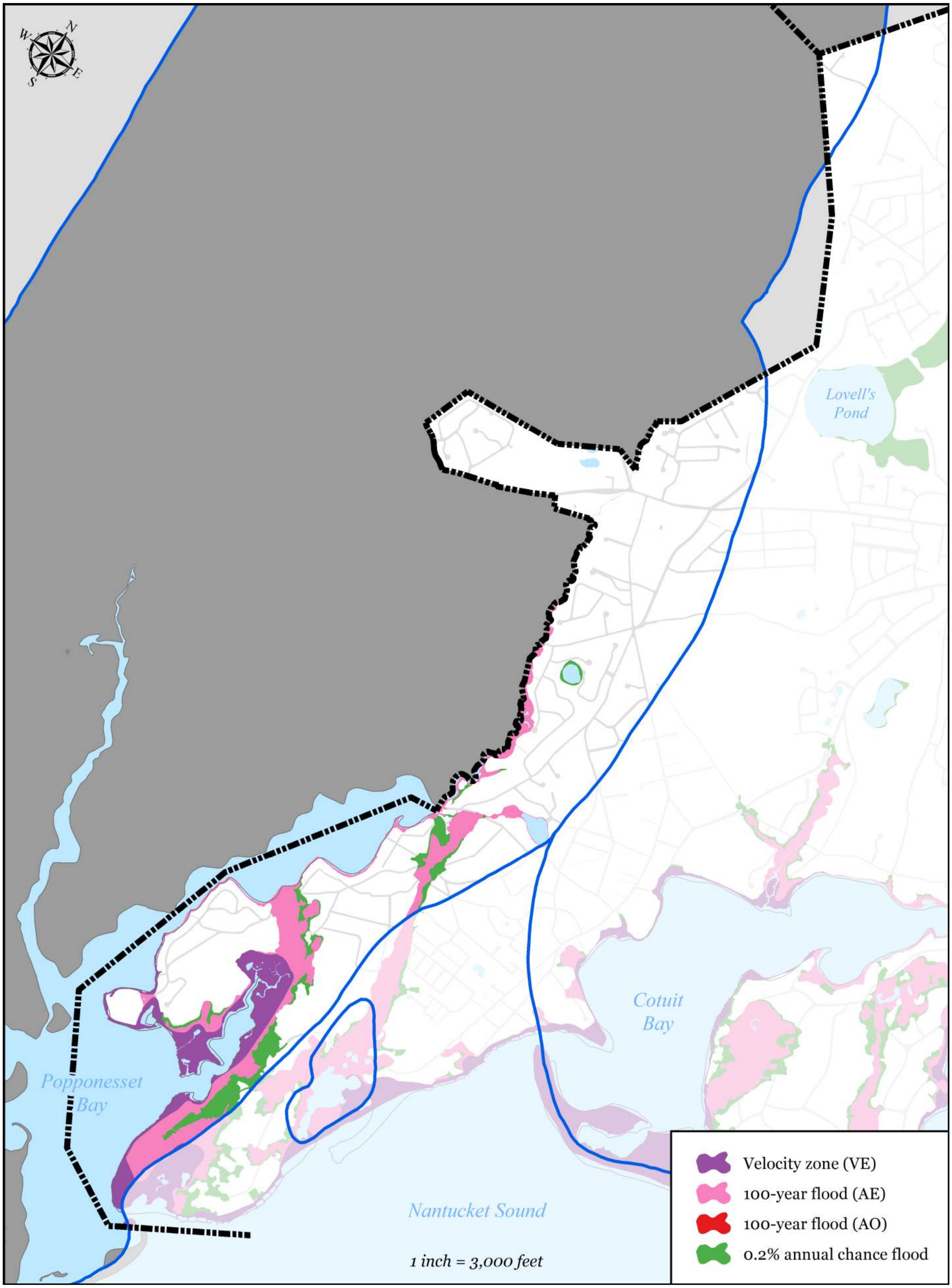

Figure 5-60: FEMA Flood Zones (2014) in Popponesset Bay Watershed

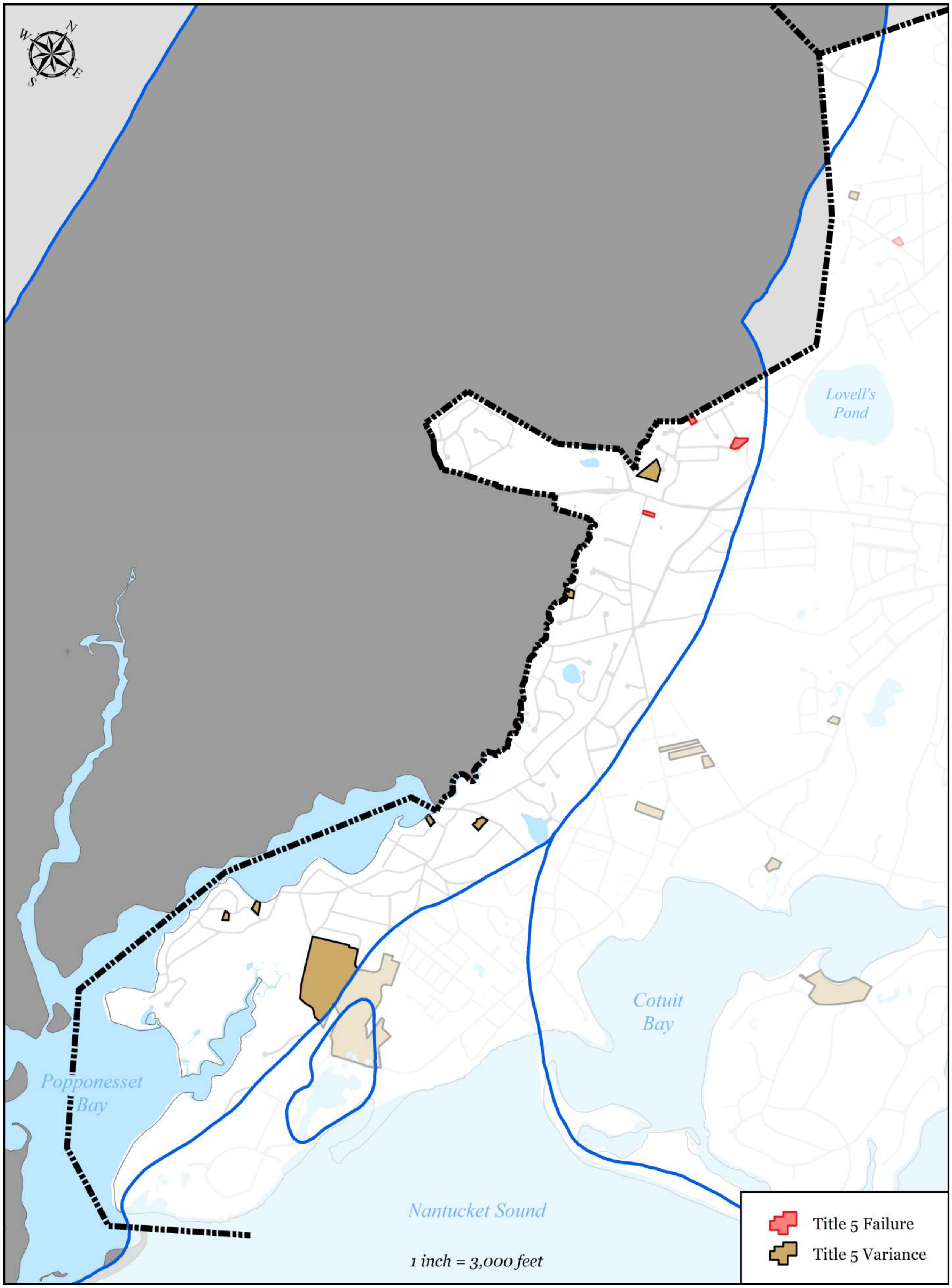

Figure 5-61: Parcels with Title 5 Septic Failures and Variances in Watershed

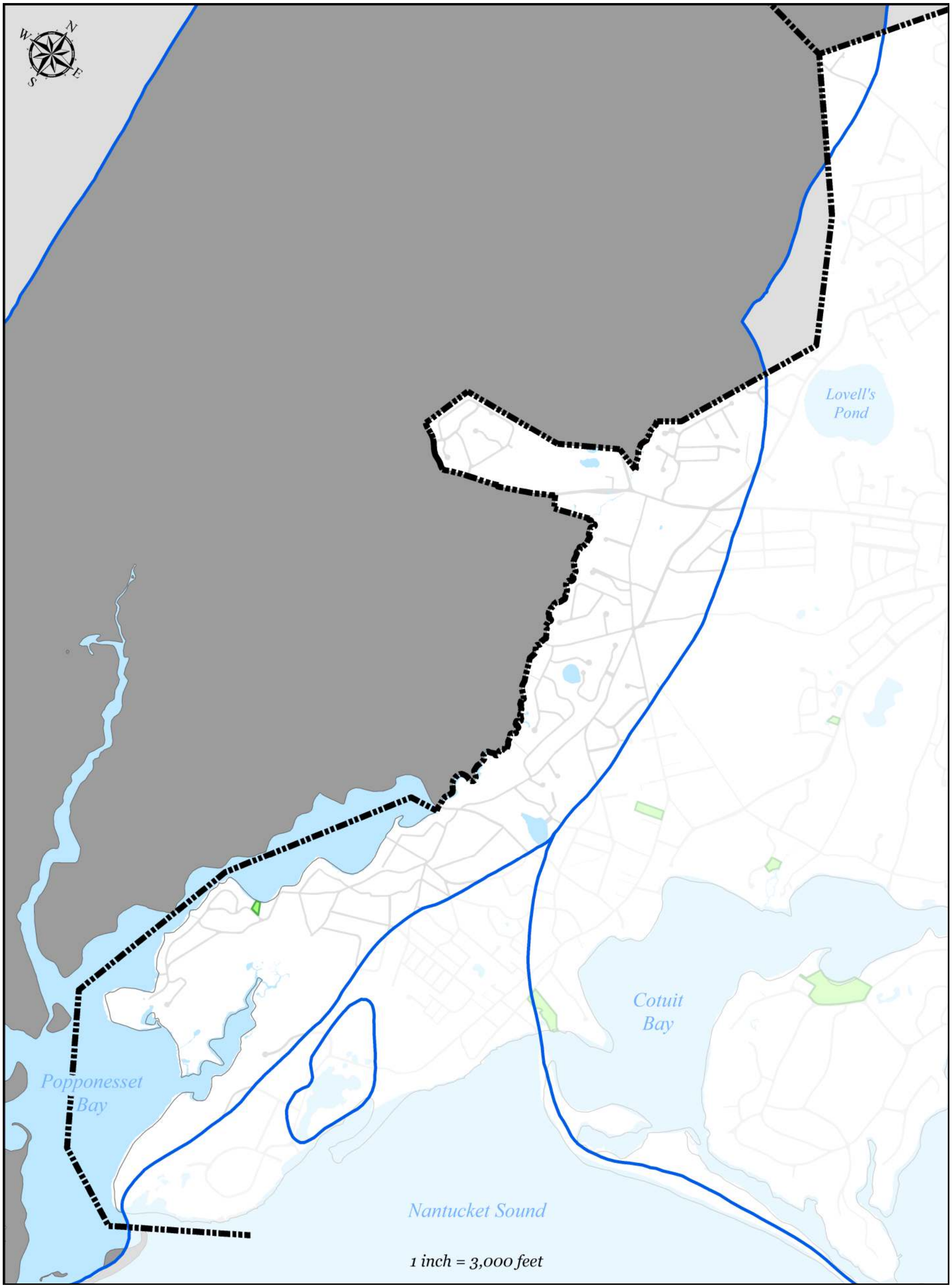

Figure 5-62: Parcels with I/A Septic Systems in Popponesset Bay Watershed

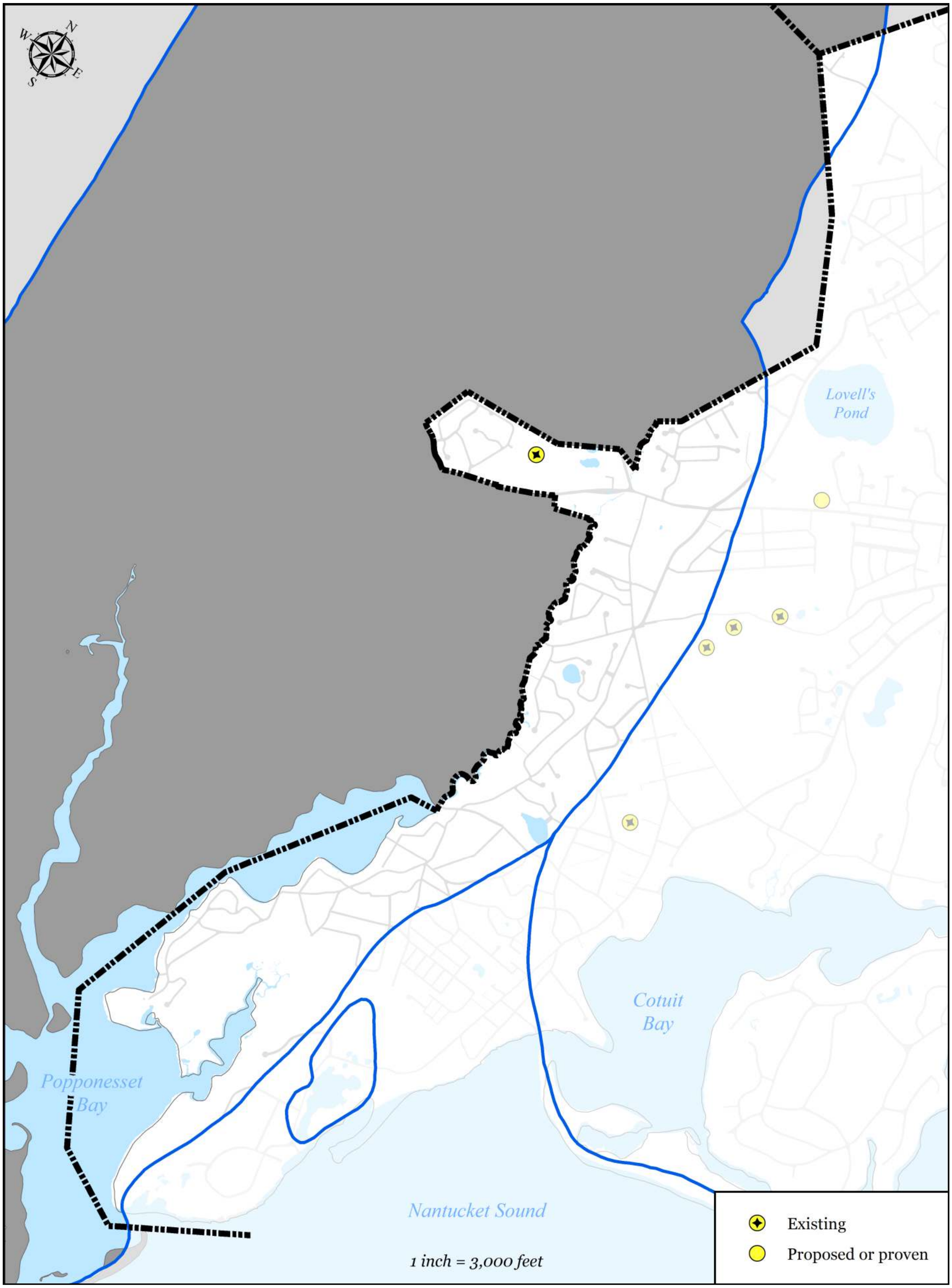

Figure 5-63: Public Water Supply Wells in Popponesset Bay Watershed

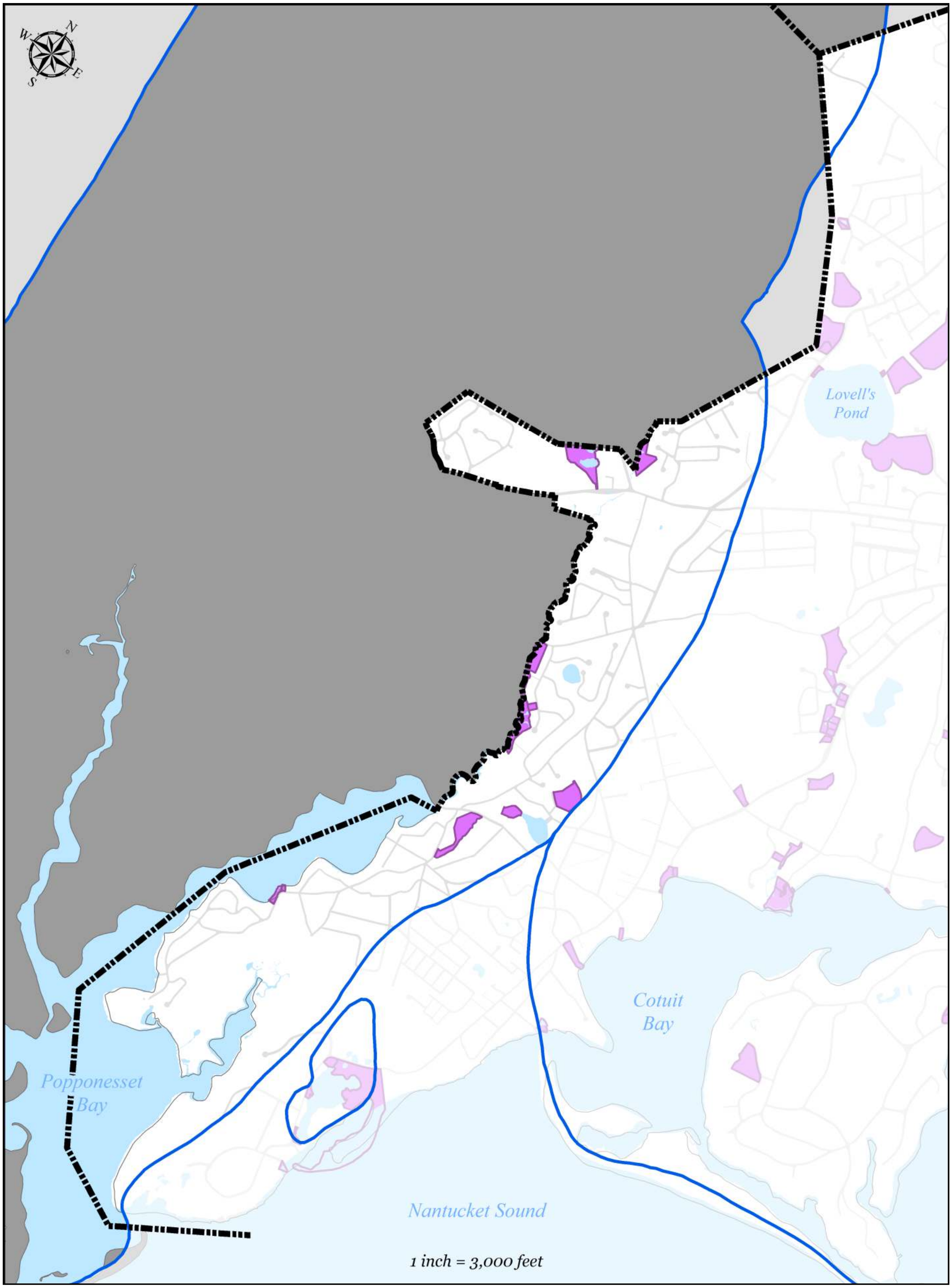

Figure 5-64: Parcels with Less than 4 feet Depth to Groundwater in Watershed

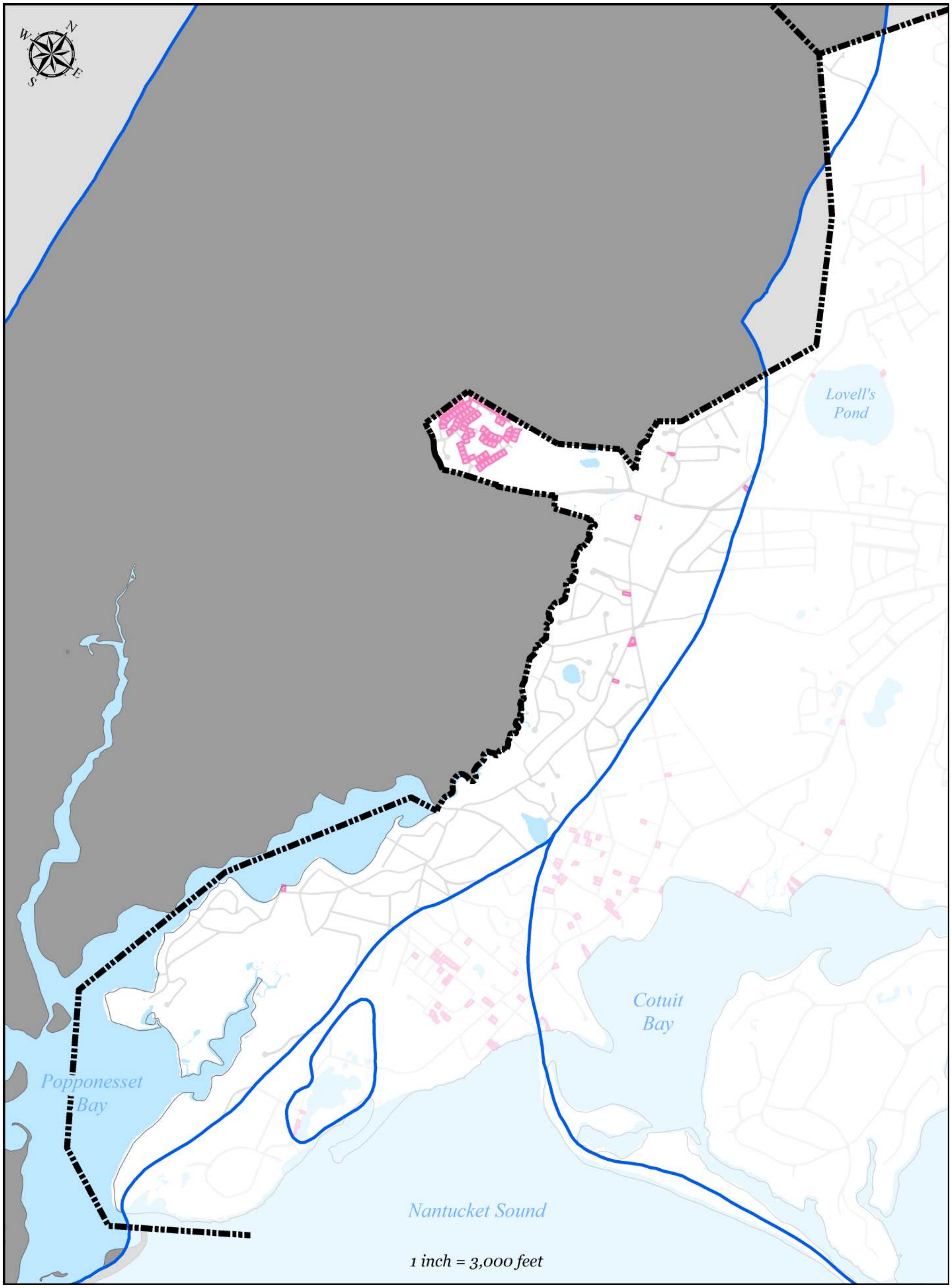

Figure 5-65: Parcels with Less than 0.25 acres in Popponesset Bay Watershed

5.2.7 BARNSTABLE HARBOR WATERSHED

The Barnstable Harbor Embayment System (also referred to as the Barnstable Great Marsh System) is located on the north side of the Town of Barnstable and extends into the towns of Yarmouth and Dennis. The system has a northern shore bounded by a narrow barrier beach, known as Sandy Neck, which separates the Harbor from Cape Cod Bay, with which it exchanges tidal waters. Due to the large tidal flow experienced in Barnstable Harbor, the embayment has been determined to have assimilative capacity with respect to nitrogen, except for the Millway sub-embayment (located in Barnstable Village). For a detailed description of the embayment system, refer to the 2017 Draft MEP Report (Appendix CC).

The Barnstable Harbor Watershed is the source water for the Barnstable Harbor Embayment System. The Barnstable Harbor Watershed is predominantly located within the Town of Barnstable but also extends into the towns of Yarmouth, Dennis and Sandwich (see Figure 5-66). Within the total watershed there are 63 identified surface waters including 18 named freshwater ponds and 3 significant freshwater stream outlets. The 2 significant freshwater stream outlets in the Barnstable Harbor Watershed that are located in the Town of Barnstable are: Bridge Creek and Brickyard Creek. There are 3 public drinking water wells operated by Barnstable Water District located within the watershed within the limits of the Town of Barnstable. Additionally, the Village of West Barnstable is located within the watershed and is predominantly serviced by private on-site drinking water wells. There are no municipally operated wastewater treatment facilities within the watershed.

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Barnstable Harbor Watershed, including nutrient removal, pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the watershed.

5.2.7.1 SUMMARY OF NEEDS

The Town of Barnstable's wastewater plan has been designed to address multiple needs areas within the Barnstable Harbor Watershed, including nutrient removal, pond protection, water supply protection, flood zone considerations and economic development, via sewer expansion within the Barnstable Harbor Watershed.

5.2.7.1.1 Nutrient Removal

As of the writing of this report, the MEP technical report for the Barnstable Harbor system is in draft form and there is no approved nitrogen TMDL for the Barnstable Harbor system. The 2017 draft MEP technical report for the Barnstable Harbor system indicates that the system is not severely overloaded with respect to nitrogen and the majority of sub-embayments have assimilative capacity to accept more nitrogen. The one exception is the Millway sub-embayment which the modeling indicates is overloaded with respect to nitrogen and requires a 65% (4.7 kg/day-N) reduction in nitrogen septic load. The Town's wastewater plan has been designed to exceed the required septic load removal within the Millway sub-embayment by sewer expansion within the Millway sub-watersheds (Millway LT10, Millway GT10, and Maraspin Creek sub-watersheds). Utilizing the Town's wastewater planning GIS tool, the Town modeled the septic loading within the Millway sub-watersheds and developed a sewer expansion plan to reduce the septic loading to the Millway sub-embayment. The plan will extend sewer to 370 parcels within the Millway sub-watersheds which will result in a calculated septic load removal of 5.3 kg/day-N, which exceeds the MEP required reduction of 4.7 kg/day-N.

5.2.7.1.2 Wastewater Needs (Other Needs)

Title 5 Issues

Integral to the planning process was the Town's development a wastewater planning GIS tool which allowed Town staff to spatially map traditional Title 5 concerns such as small lot size, depth to groundwater, existing septic variances, existing known failed septic systems, and systems within Zone IIs. Parcels with area less than 0.25 acres were flagged because they were considered difficult to site a traditional septic system, likely to need septic variances, and increased density leading to increased nutrient loading. Parcels with an average depth of groundwater of less than four feet were flagged as likely to require raised systems which are costly and less desirable for community aesthetics. Existing septic variances and existing known failed septic systems were also mapped.

The tool allows the Town to overlay these layers to identify the "hot-spots" for traditional Title 5 concerns. These areas were then incorporated into the plan where practical. Many of these "hot-spots" overlaid other needs such as nutrients and pond protection. The Plan for the Barnstable Harbor Watershed addresses traditional Title 5 concerns as shown in the data presented below which was calculated using the Town's wastewater planning GIS tool:

- Total parcels within the Town of Barnstable within the Barnstable Harbor Watershed = 4,656
- Total parcels connected to municipal existing sewer = 452 (10%)
- Parcels with total area less than 0.25 acres = 335 (7%)
    - 139 (41%) already served by municipal sewer
    - 38 (11%) additional to be addressed with a traditional solution in the Plan
    - Total = 177 (52%)
- Parcels with average depth to groundwater less than four feet = 267 (6%)

    - 29 (11%) already served by municipal sewer
    - 36 (13%) additional to be addressed with a traditional solution in the Plan
    - Total = 65 (24%)
- Parcels with septic system variances = 26 (0.6%)
    - 5 (19%) will be addressed with a traditional solution in the Plan
- Parcels with known failed septic systems = 2 (0.04%)
    - 1 (50%) will be addressed with a traditional solution in the Plan
- Parcels located within a Zone II = 669 (14%)
    - 40 (6%) already served by municipal sewer
    - 382 (57%) additional to be addressed with a traditional solution in the Plan
    - Total = 422 (63%)

Flood Zones

- Total parcels within the Barnstable Harbor Watershed = 5,220
- Parcels within FEMA mapped 100-year flood zone (AE/AO) or velocity zone (VE) = 833
    - 179 (21%) already served by municipal sewer
    - 24 (3%) that will be addressed with a traditional solution in the Plan
    - Total = 203 (24%)

Contaminants of Emerging Concern (CEC's)

Contaminants of emerging concern (CECs) are increasingly being detected in surface water. (CECs) are made up of three general groups, endocrine disrupting compounds, pharmaceuticals, and personal care products. These compounds and potential contaminants are not currently regulated by the federal government because their toxicity is not well understood. Collecting wastewater with sewers and treating at a centralized treatment location allows the opportunity to treat wastewater for CEC's as they are better understood and future treatment technologies are developed.

5.2.7.1.3 Pond Protection

The Town's wastewater planning has included detailed studies of ponds 3 acres or larger throughout the Town. Through those studies, there is extensive water data for 5 ponds in the Barnstable Harbor Watershed. Pond classification of these ponds is shown in Table 5-11. Two ponds within the watershed have been identified as impaired; Flax Pond, and Mill Pond.

Table 5-11: Barnstable Harbor Watershed Pond Classification

	Ultra-Shallow 0 to 2.1m	Shallow 2.1 to 8.6m	Deep >8.6m
Oligotrophic Total P<0-12 (ug/l)	Hathaway's Pond (South)	Garrett's Pond	Hathaway's Pond (North)
Mesotrophic Total P<12-24 (ug/l)			
Eutrophic Total P<24-96 (ug/l)	Flax Pond Mill Pond		
Hypereutrophic			

5.2.7.1.4 Economic Development

The Town's Planning and Development Department (P&D) identified a number of areas within the Barnstable Watershed as needs areas for sewer expansion to promote economic development. These areas include:

- Properties along Route 132 from Attucks Lane to Phinney's Lane.
- Properties along Attucks lane
- Properties along the west side of Phinney's Lane between Route 132 and the Mid-Cape Highway (Route 6).
- The Kidd's Hill Area (referred to in previous sections as the "Lorusso property").
- Properties in the "Independence Park" area that have not been connected to municipal sewer to date or have not been developed to date.

5.2.7.2 PROPOSED SOLUTIONS

The plan addresses the needs areas using the following techniques:

- Sewer Expansion
    - 452 of the 4,656 parcels (10%) in the watershed within the Town of Barnstable are connected to municipal sewer
    - 370 parcels in the Millway sub-watersheds will be are included in the proposed sewer expansion plan. The calculated septic load removal is 5.3 kg/day-N, which exceeds the MEP required reduction of 4.7 kg/day-N.

- Stormwater upgrades
    - The Town's MS4 program will identify and provide solutions to existing stormwater outfalls.
        - 54 of the Town's 207 identified stormwater outfalls are located in the Barnstable Harbor Watershed.
    - The Town's Public Road program invests on average $750,000 a year in stormwater improvements in the Town's public roads. These improvements generally include replacement of failed catch basins and leaching structures.
    - In the Fall of 2019 and the Spring of 2020, the Town will be completing a streetscape project on Route 6A the center of Barnstable Village and on Mill Way which includes an upgrade to the stormwater management systems of these roadways. These upgrades will improve the water quality of the stormwater runoff generated on these roadways and collected in the stormwater system.

- Fertilizer Regulation
    - In 2014 the Town adopted a Fertilizer Nitrogen and Phosphorus Control Regulation (see Appendix PP). The regulations includes the following:
        - Provides Best Management Practices and performance standards for noncertified fertilizer applicators.
        - Outlines education, certification, enforcement and penalties.

5.2.7.3 FUTURE CONDITIONS

The plan accommodates future growth conditions as follows:

- The Millway sub-watershed is significantly developed with predominantly residential uses. It is not anticipated that there will be substantial growth within this sub-watershed. However, sewer expansion within this sub-watershed has been designed to remove 113% of the required septic load to accommodate any unanticipated growth within this area. Sewer expansion projects will be designed to accommodate growth within the expansion areas (increased pipe sizes, appropriate pump station sizing, etc.).
- Downtown Barnstable Village is a densely developed business center and is also home to the Barnstable County complex. This area has been served by municipal sewer since the late 1970s.
    - The SewerCAD model indicates that the existing sewers in this area have sufficient capacity for existing and future conditions.
- Adaptive management and monitoring
    - The Town will continue to monitor the embayment, review the Plan and provide formal updates as required.

- Refer to Section 6.4 for the Adaptive Management Plan and Section 6.3 for the Monitoring Plan.

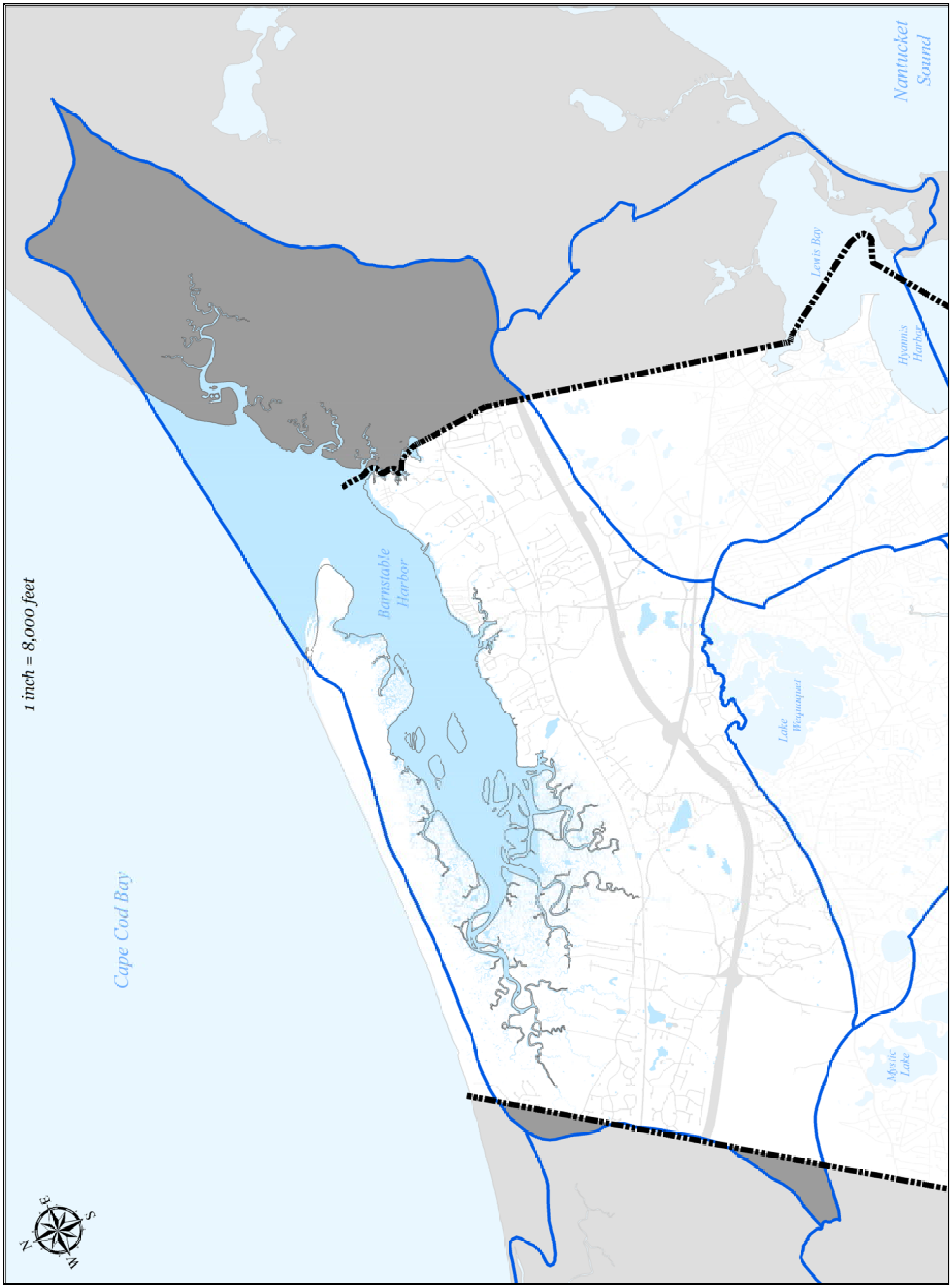

Figure 5-66: Barnstable Harbor Watershed

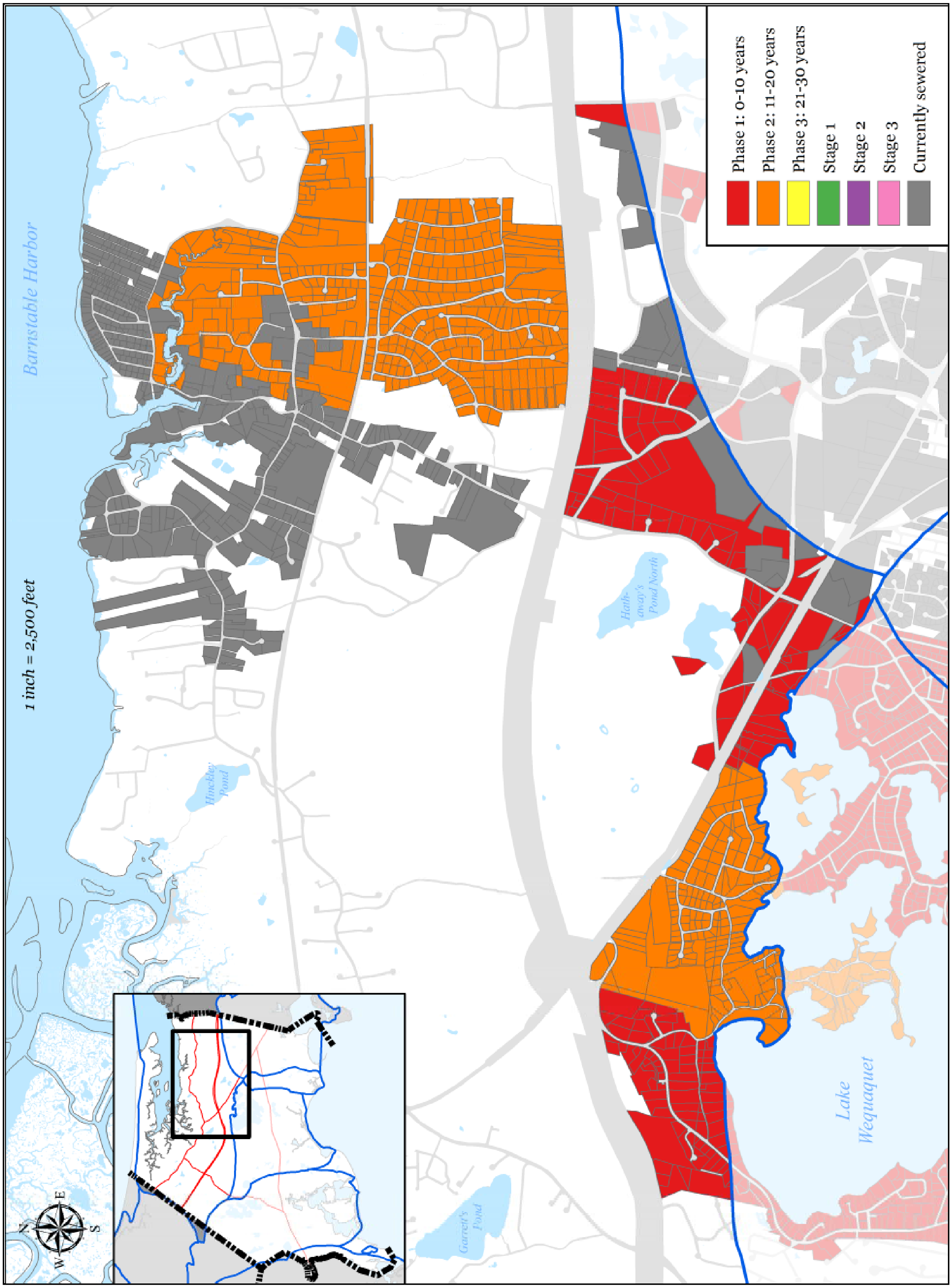

Figure 5-67: Sewer Expansion Plan in Barnstable Harbor Watershed

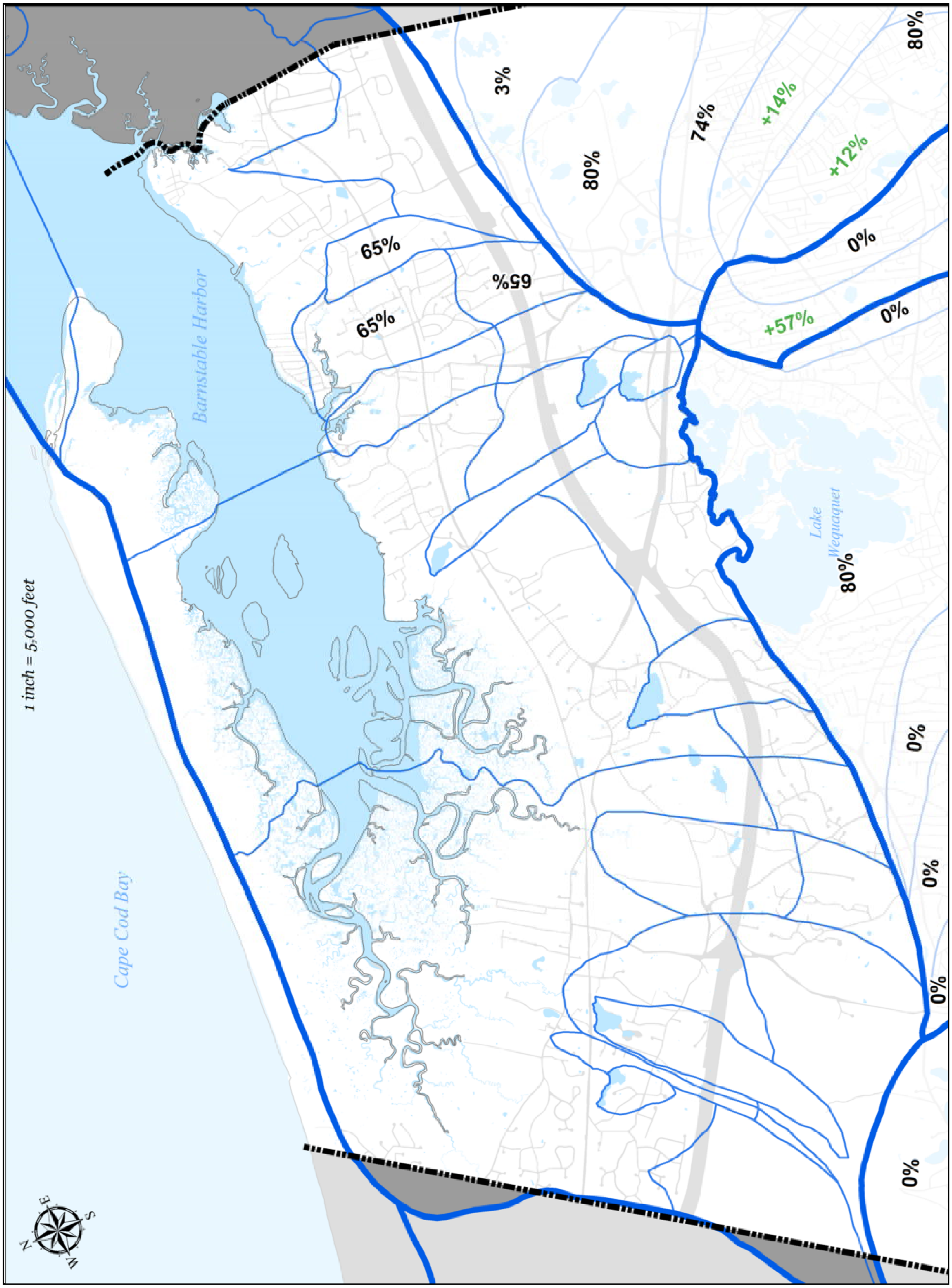

Figure 5-68: MEP-modeled Existing Septic Removal in Watershed

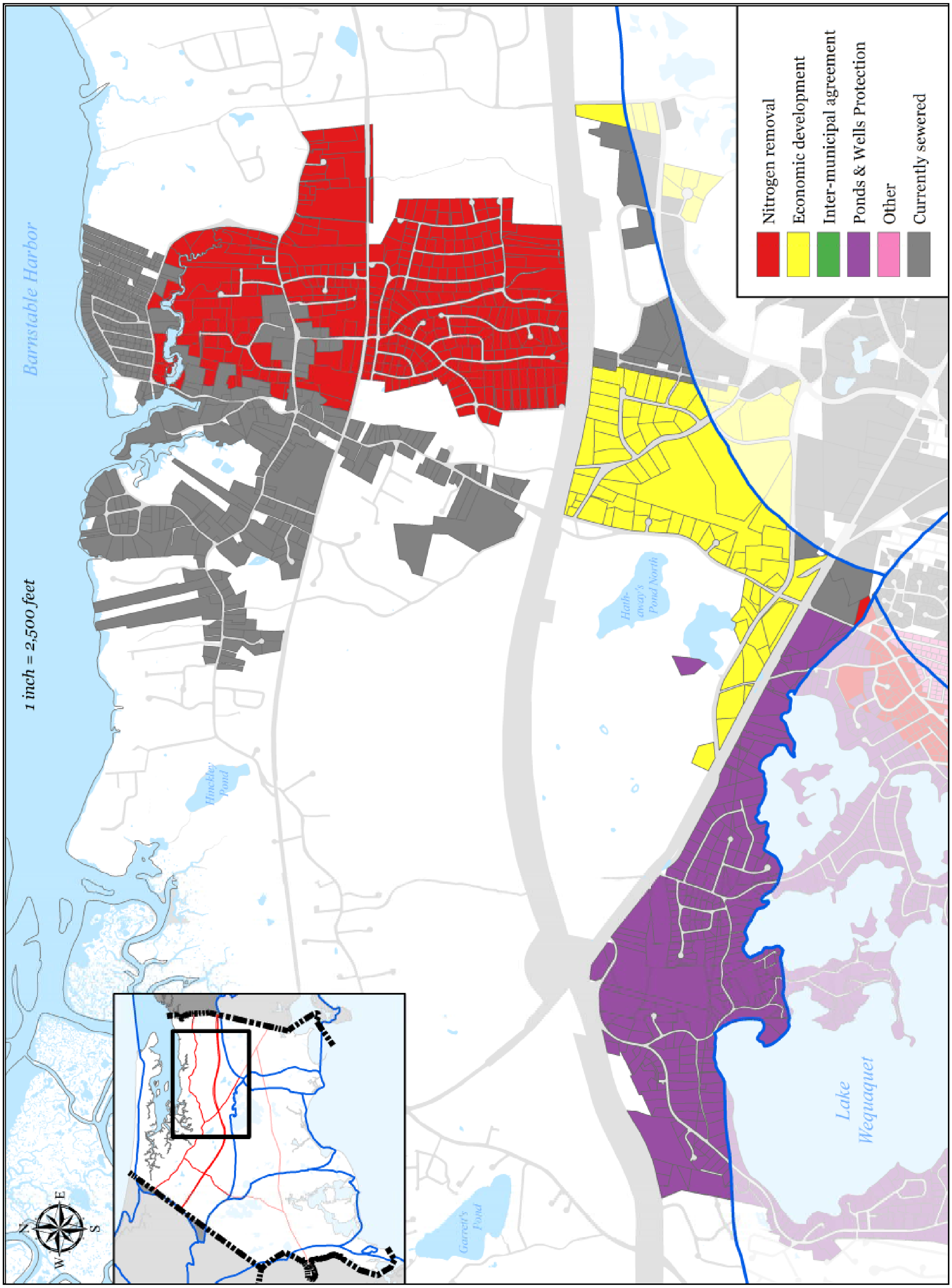

Figure 5-69: Needs Areas in Barnstable Harbor Watershed

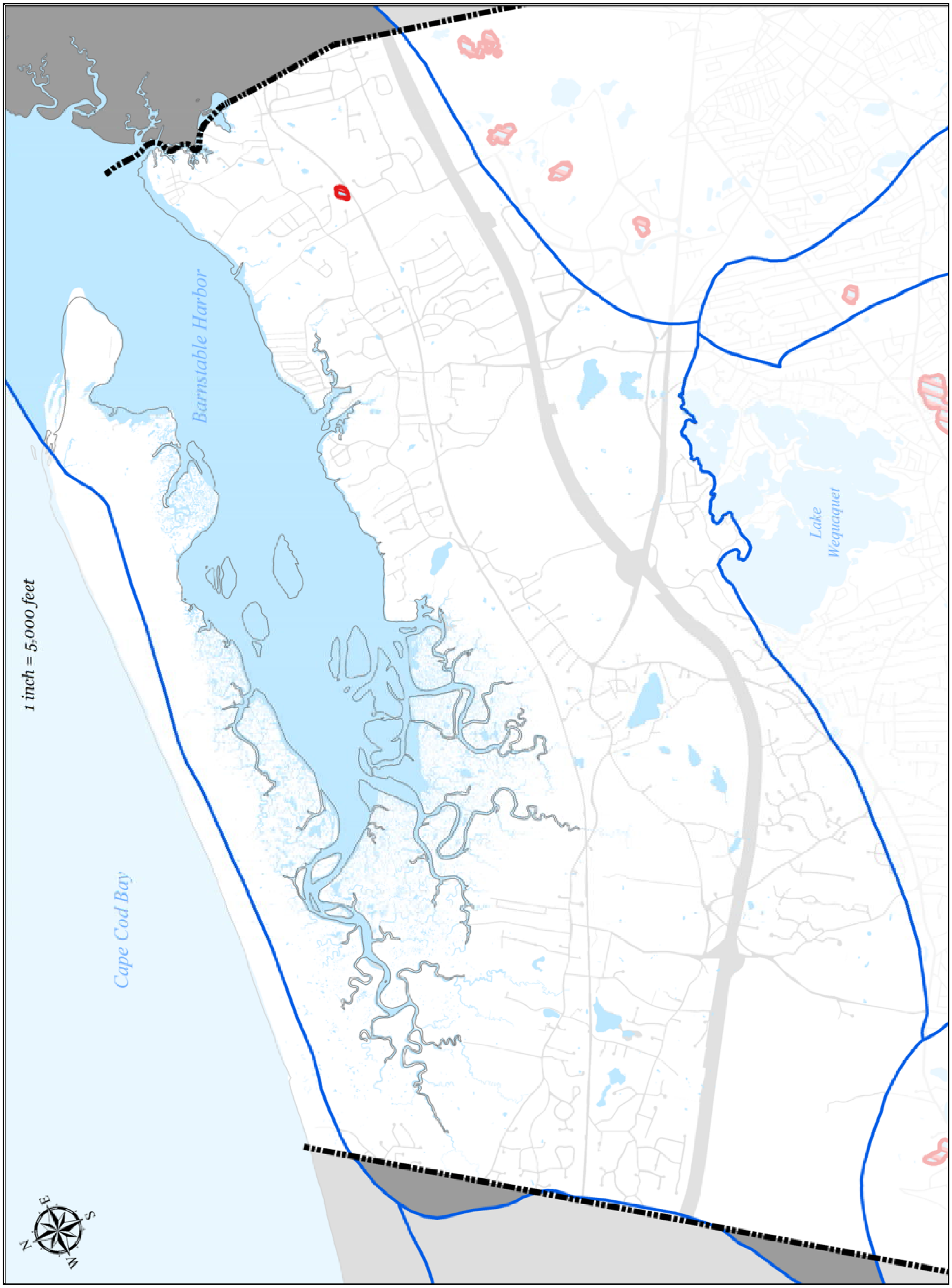

Figure 5-70: Impaired Ponds in Barnstable Harbor Watershed

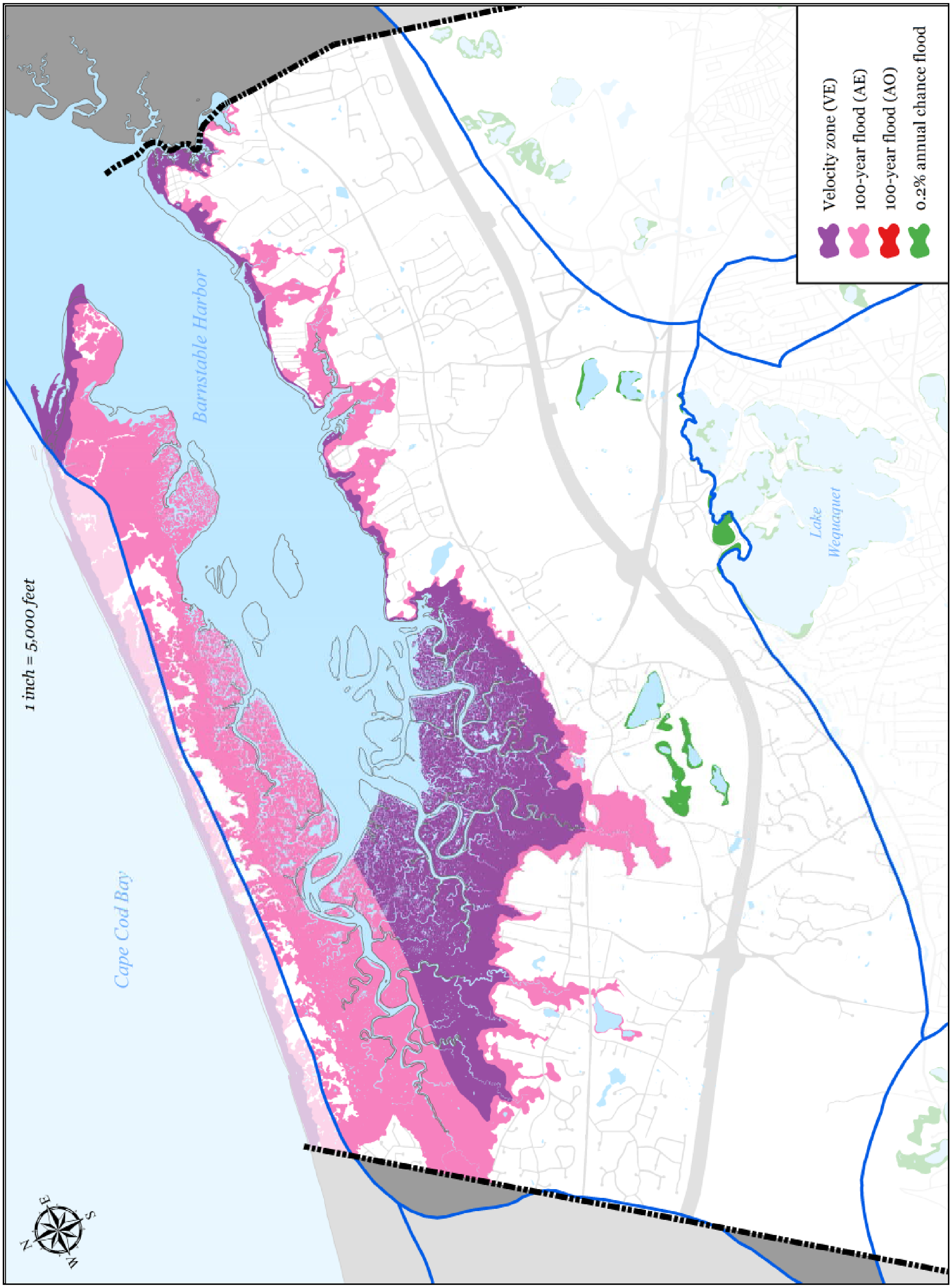

Figure 5-71: FEMA Flood Zones (2014) in Barnstable Harbor Watershed

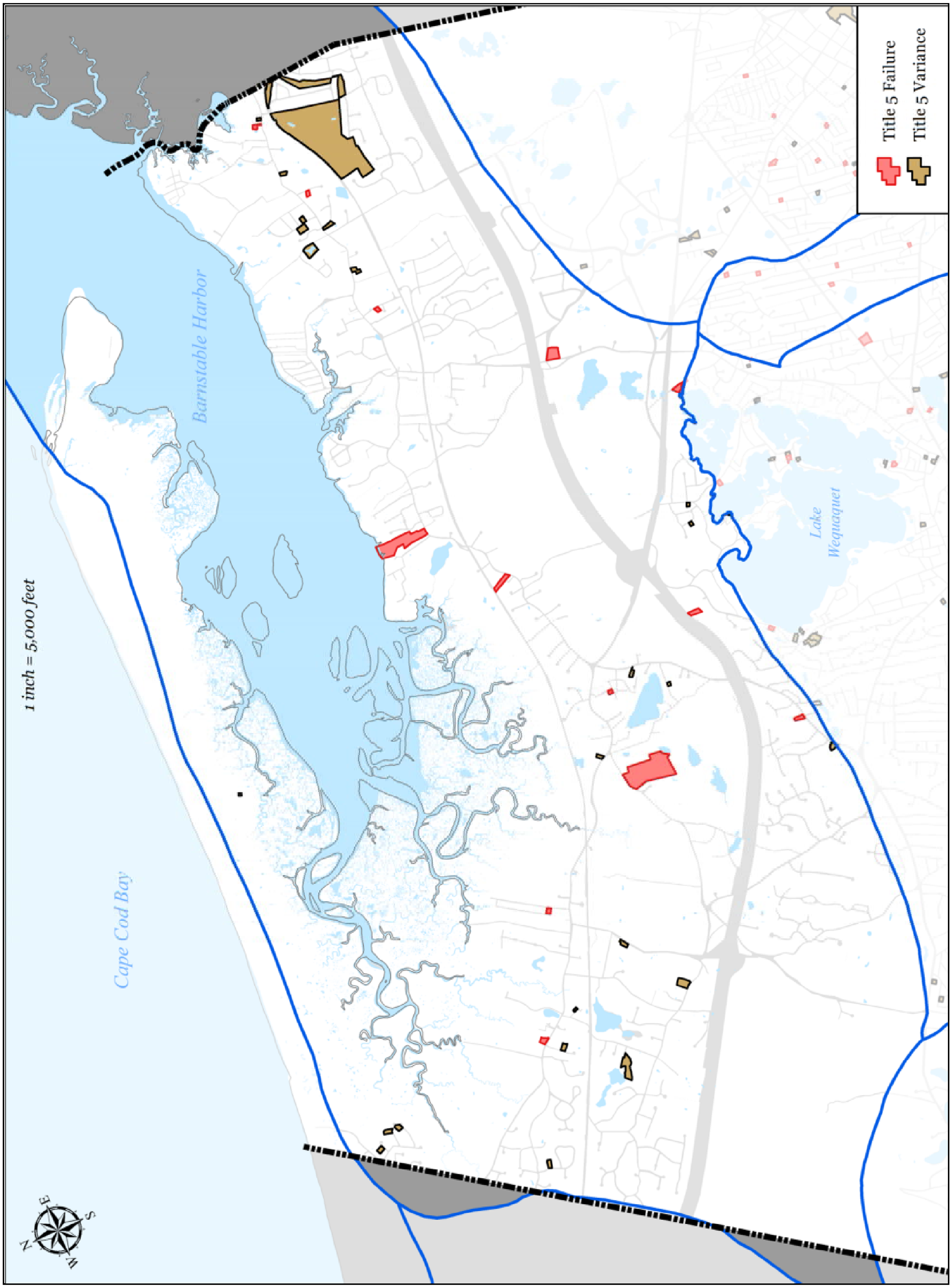

Figure 5-72: Parcels with Title 5 Septic Failures and Variances in Watershed

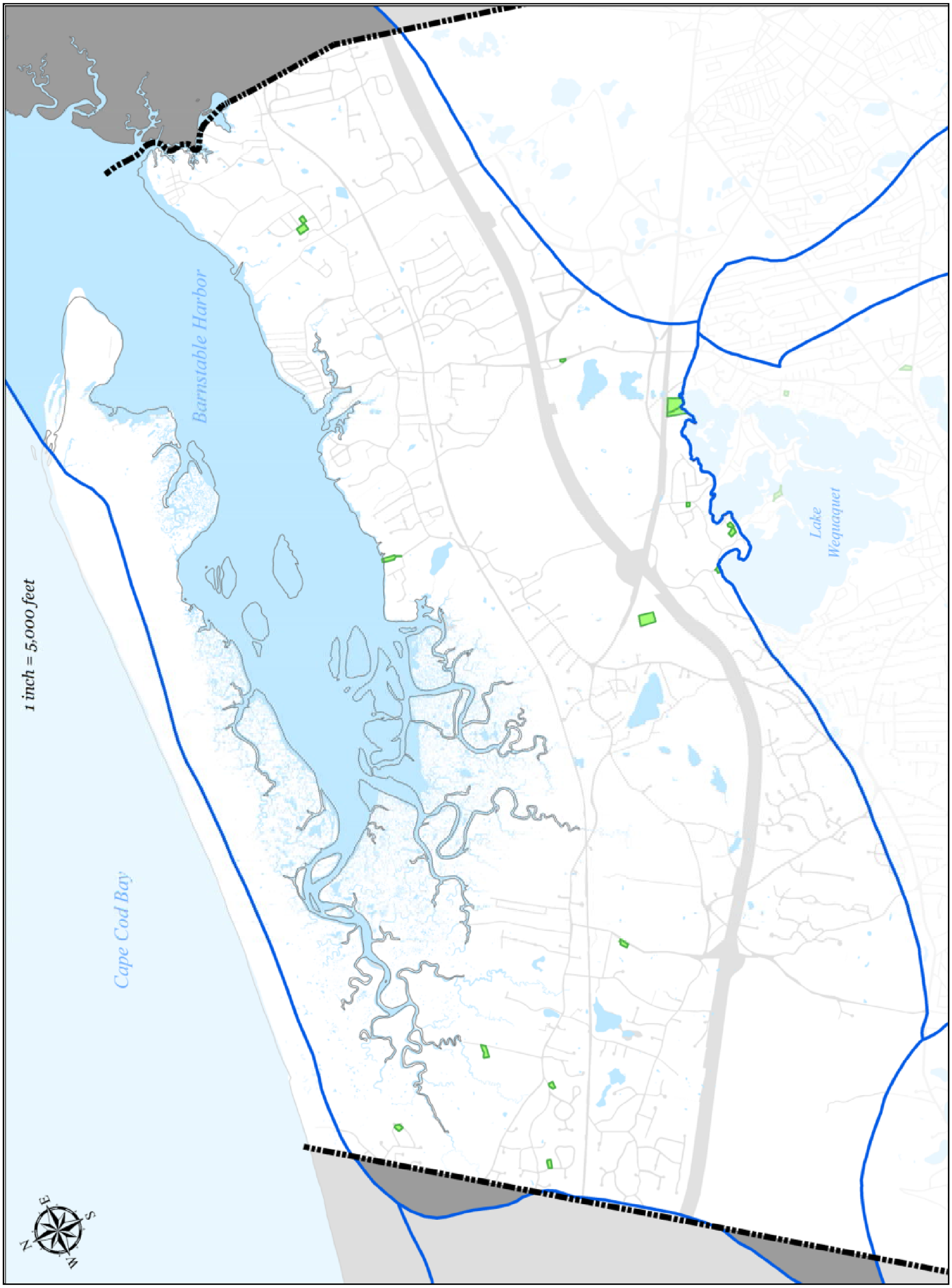

Figure 5-73: Parcels with I/A Septic Systems in Barnstable Harbor Watershed

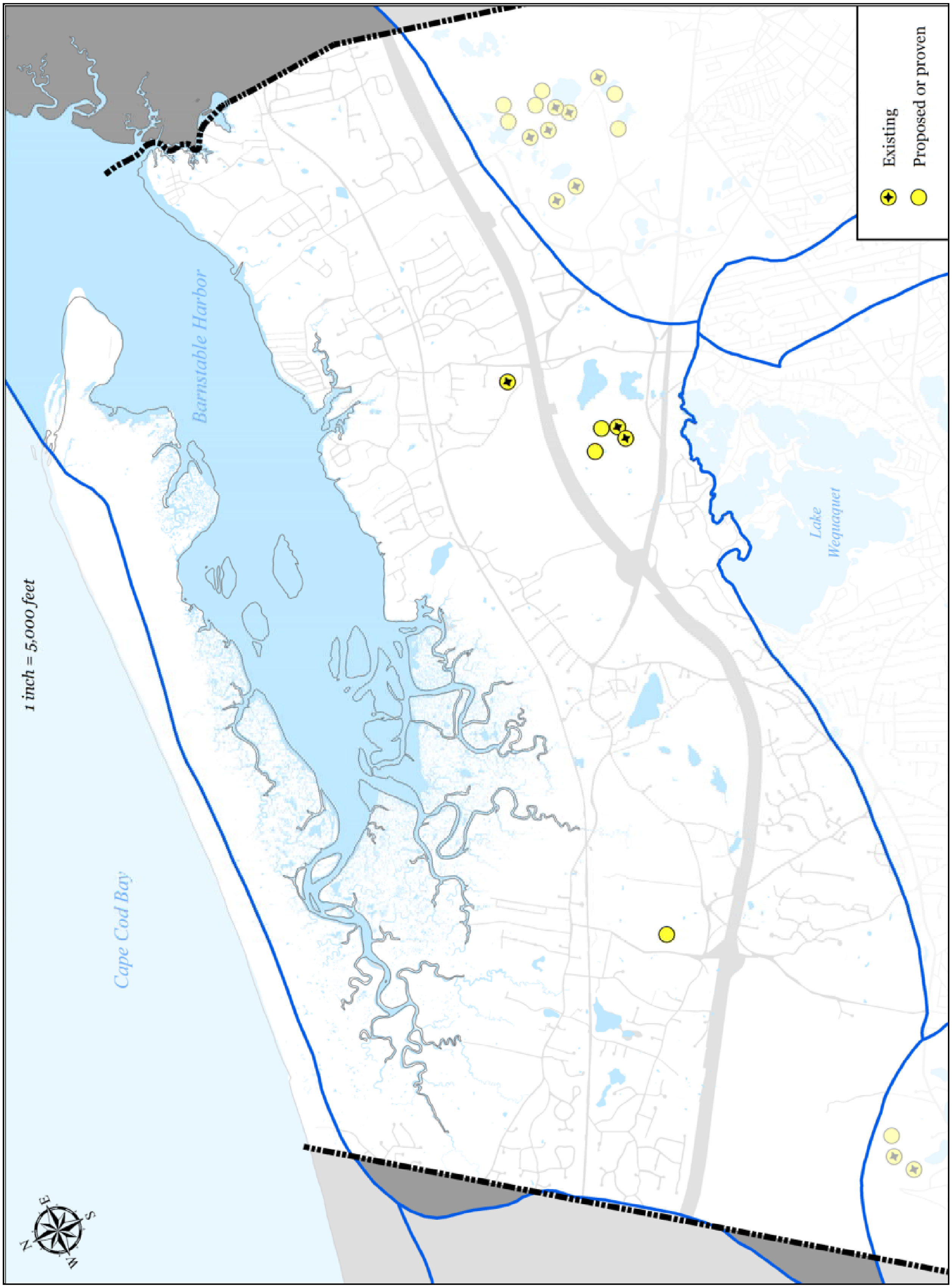

Figure 5-74: Public Water Supply Wells in Barnstable Harbor Watershed

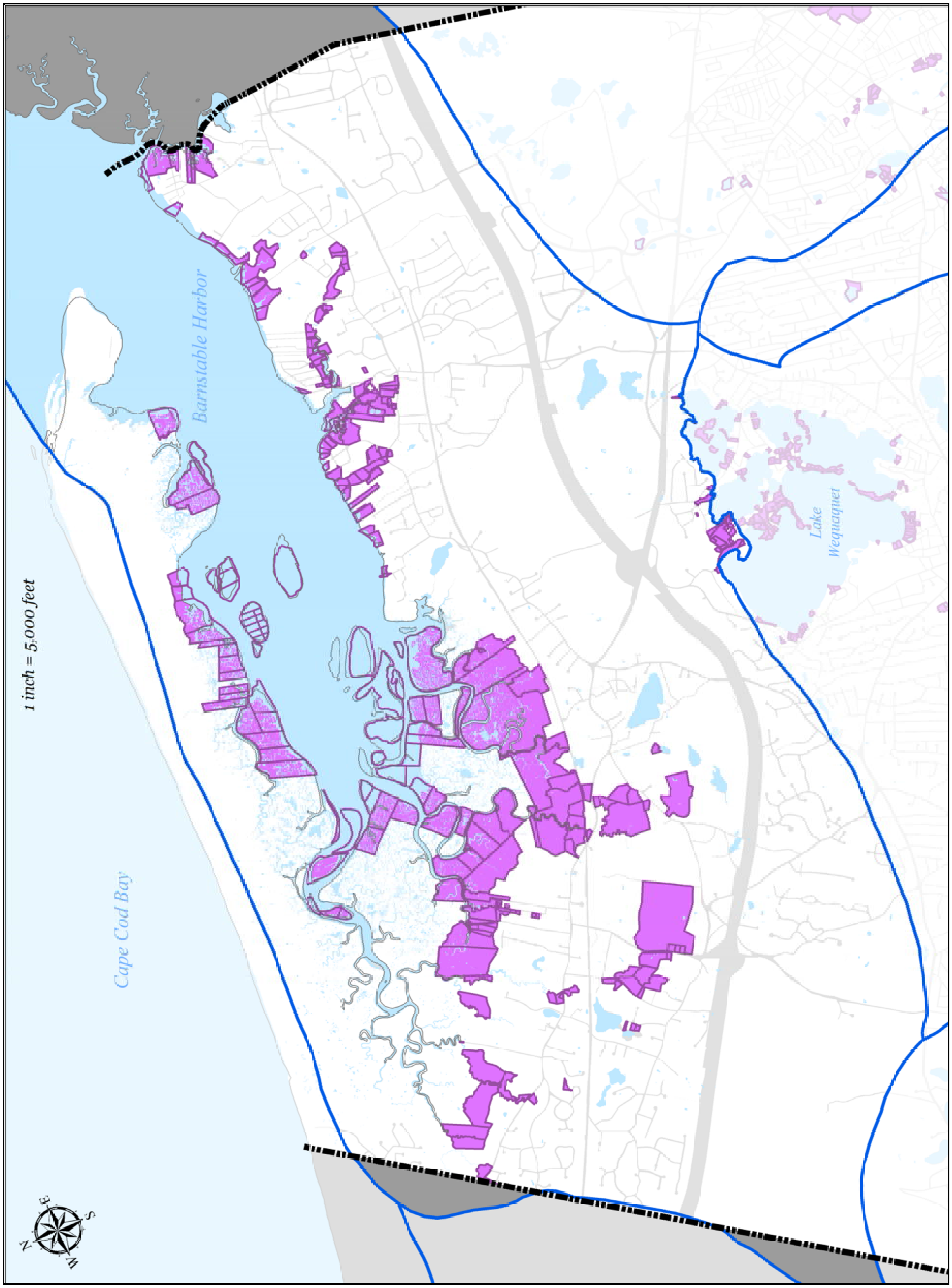

Figure 5-75: Parcels with Less than 4 feet Depth to Groundwater in Watershed

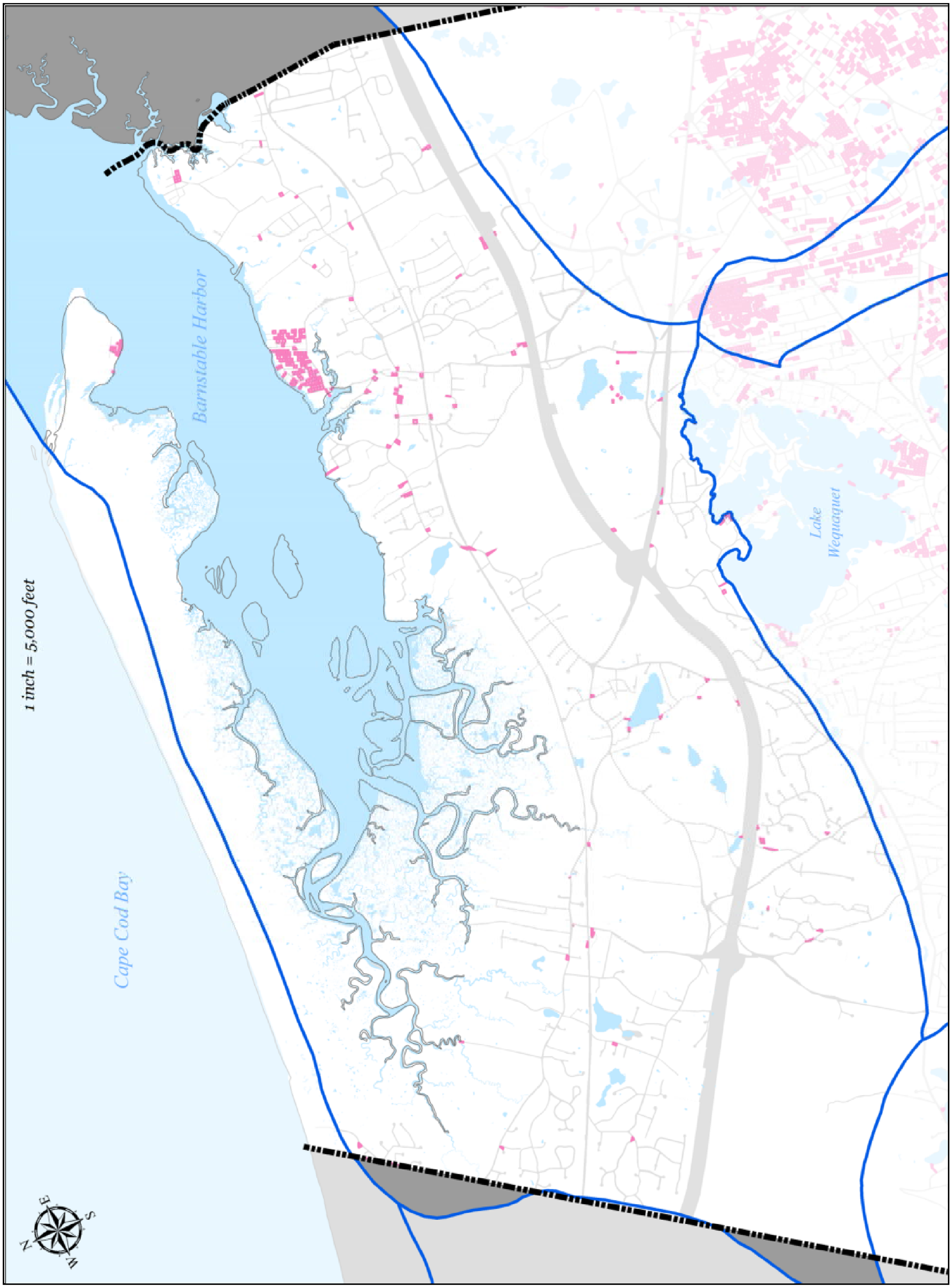

Figure 5-76: Parcels with Less than 0.25 acres in Barnstable Harbor Watershed

5.3 TREATMENT AND EFFLUENT DISPOSAL

To accommodate the proposed sewer expansion, aspects of the wastewater treatment facility will need to be upgraded. Additionally, as discussed in previous sections, effluent disposal options will have to be identified. The following two sections briefly discuss those requirements.

5.3.1 WATER POLLUTION CONTROL FACILITY

The Barnstable Water Pollution Control Facility was initially constructed in 1935, though the majority of the plant as presently constituted was installed in 1980. The Town has been upgrading individual pieces of equipment at the facility as it has approached the end of its design life ever since. The majority of the additional flows and loads associated with sewer expansion will need to be treated at the plant which will require changes to the facility. These are discussed below. The timing and costs of these upgrades can be found in Table 6-3 in Section 6.

- Solids Handling Facility - The solids handling facility processes the residuals from septage receiving and the primary (two of them) and secondary (three of them) clarifiers. The residuals are thickened via two, 2-meter, gravity belt thickeners to approximately 5-6% solids, and trucked off Cape Cod to an incineration disposal facility. This system is nearing the end of its design life, and the additional flow from new sewers will further tax this equipment and necessitate expansion. This project is currently being designed and is expected to be constructed in FY21-23.
- Aeration Tanks/System – The aeration tanks are where biological activity reduces the organic carbon components of the wastewater. Properly configured, they can also reduce some of the nitrogen load as well. There are three parallel reactor trains, each with a volume of 170,000 cubic feet. The system was originally designed to treat 4.2 MGD for Biological Oxygen Demand (BOD) removal (without nitrogen removal). To achieve nitrogen removal tank volume is required for the nitrification and denitrification process, thus reducing the rated capacity of the aeration tanks. Based on treatment plant operation during July and August, and results of computer modeling, the estimated maximum month capacity of the aeration tanks is less than 2.5 MGD. Expansion of the aeration system to accommodate the new flows will be required within the first 3-5 years of the plan.
- Nutrient Removal Technologies – The existing facility reduces nitrogen concentrations to an annual average of approximately 6 mg/l of Total N. Though a relatively low concentration, in combination with the amount of flow being treated this can still equate to a significant nitrogen load entering the environment. The Town is limited to an annual mass nitrogen load limit of 49,315 pounds per year. Reducing the nitrogen concentration from 6 mg/l to 3mg/l in the effluent would remove 18.9 kg/day-N of existing nitrogen load from the watershed (approximately 35% of the total attenuated load to be removed per the Cape Cod Commission 208 Watershed Report), and would enable additional

effluent discharge in the Town of Yarmouth if the Town elected to utilize that option (see Section 2.3.1.2). This evaluation, design and construction is expected to occur in years 1-5 of the plan.

- Headworks Facilities – The headworks is the portion of the plant that receives all the flows from the collections system and provides pretreatment of the wastewater. Pretreatment removes larger items for the wastewater and grit via a manual bar screen, an automated mechanically cleaned climber screen, and an aerated grit chamber. Though the headworks facilities are adequately sized for the projected flows from the sewer expansion, they do not have space to receive the new sewer piping, and the equipment is generally very dated technology that is beyond its design life. The evaluation, design and construction/upgrade of this facility is expected in years 3-8.
- Backup Power – With the expansion of the plant, there will be a need for additional backup power on site. As such the Town will need to design and install a second emergency backup generator in order to handle the increased electrical loads placed on the facility. The evaluation, design and construction/upgrade of this facility is expected in years 4-5.
- Secondary Clarifiers – Secondary clarifiers are the tanks that follow the aeration system, where the biological process ("bugs") are settled out from the wastewater prior to the treated water being disposed of. The Town currently has three secondary clarifiers (two are 70-foot diameter and one is 85-foot diameter). Between them is the capacity to treat up to 4.7 MGD (max day). To accommodate the full sewer expansion, additional secondary clarifier capacity will be needed. As such the Town will evaluate, design, and construct improvements to the secondary clarifiers at the BWPFC in order to increase treatment capacity. The evaluation, design and construction/upgrade of this facility is expected to occur at the end of Phase I and the beginning of Phase II.

5.3.2 EFFLUENT DISPOSAL

The Town is currently in the process of evaluating the effluent disposal capacity at the BWPCF in order to determine exactly how much treated effluent can be discharged on-site. Once this study is complete, a summary report will be submitted to the Massachusetts Department of Environmental Protection for review and approval and the permitted disposal capacity for the facility will be confirmed or adjusted. If it is determined that the effluent volume is not adequate for the full sewer expansion, mitigation measure will be modeled, pursued and implemented to address the remaining effluent.

5.4 STATEMENT OF CONSISTENCY WITH 208

Waste Treatment Management Agency (WMA) assumes responsibility for controllable nitrogen for any part of the watershed within its jurisdiction.

In the Comprehensive Water Management Plan (CWMP), the Town Barnstable commits to responsibility for its share of controllable nitrogen load in all of the watersheds within the Town's jurisdiction.

Future Action: Nitrogen loading information should be revisited during development of annual updates and adaptive management reports, using up-to-date population and water use data.

Plan meets applicable nutrient targets.

The CWMP is designed to reduce nutrient loads to meet the nutrient targets (TMDL's or otherwise), within the jurisdictional limits of the Town of Barnstable.

Planning occurs at a watershed level with consideration of a hybrid approach.

The CWMP is designed to meet the nutrient targets developed for each of the watersheds addressed in the plan with traditional solutions. However, the plan includes a hybrid approach by also utilizing non-traditional solutions such as dredging, aquaculture, alternative septic systems, and storm water treatment.

Future Action: The Town will continue to progress towards required nitrogen reductions, using tradition and non-traditional solutions.

Public was engaged to gain plan consensus.

The Town has involved the public during the process of drafting the CWMP, with a committee named the WRAC, which was staffed by eight citizens and three Town Councilors. Their meetings and workshops were conducted in the Town Council Meeting room and televised for the general public to be able to witness what was occurring. Public engagement in the planning process is discussed further in Section 4.

Future Action: The Town will continue to involve the public in the process of finalizing the plan and pursuing its implementation.

Plan includes proposed strategies to manage nitrogen loading from new growth.

The CWMP includes addresses future development and its wastewater flows and nitrogen loads. Please refer to Sections 2.2.6 for discussion of future conditions in the Town and Section 5.3 for discussion relative to how the plan addresses future conditions on a watershed by watershed basis.

Future Action: The Town of Barnstable will continue to progress with future growth conditions. The town will continue creating updates to the plan every five years to accommodate future growth.

Plan includes adaptive management approach

Refer to the adaptive management plan in Section 6.4.

Plan included pre- and post- implementation monitoring program

The town has completed 20+ seasons of embayment monitoring, with monitoring locations selected and approved under a MassDEP to track compliance with total maximum daily load. Refer to Section 6.3 for further discussion of the Town's monitoring plan.

Future Action:

The Town will continue to perform embayment monitoring, to comply with the MassDEP standards. As well as continue private monitoring of the Marstons Mills River carried out by the Barnstable Clean Water Coalition.

Plan includes a description and assessment of the towns proposed funding strategy

Refer to Section 7 of the CWMP for the Town's financial strategy.

WMA commits to regular 208 Plan update consistency reviews until water quality goals are achieved, generally to occur at least every five years

The Town of Barnstable plans to formally review the CWMP every five years.

In shared watersheds, WMA seeking 208 Consistency Review collaborates with neighboring WMA(s) on nitrogen allocation, shared solutions, and cost saving measures

Refer to Section 2.3.1 for discussion relative to the Town's collaborative work with neighboring communities relative to nitrogen allocation, shared solutions and cost saving measures.

6 IMPLEMENTATION PLAN/SCHEDULE

6.1 PROPOSED IMPLEMENTATION PLAN AND RECOMMENDED CAPITAL IMPROVEMENT SCHEDULE

The Plan includes an aggressive 30-year plan focused on traditional solutions that will be performed in three 10-year phases. The Town has developed a recommended implementation plan for the first 10-year phase (Phase 1) of the plan. Future updates to the CWMP will include similar detailed implementation plans for the remaining phases. The followings table and figures graphically show the effectiveness of the Phase 1 Implementation Plan.

Table 6-1: Phase 1 Traditional Project Statistics

Project	Number of Parcels Connected	Wastewater Captured (gpd)	Total N Removed (kg/day)	% of Total N Removed in Phase 1
Merchants Way	7	0	4.7	6.0%
Strawberry Hill Road	240	47,066	0.9	1.2%
Route 28 East	49	9,440	11.4	14.7%
Old Yarmouth Road	131	22,603	0.6	0.7%
Phinneys Lane	653	94,200	7.9	10.1%
Long Beach	203	37,647	3.6	4.7%
Route 28 Centerville	41	5,534	4.1	5.3%
Huckins Neck	148	21,506	3.3	4.2%
Long Pond Area	606	114,599	5.9	7.6%
Great Marsh Road	406	79,299	5.3	6.8%
Old Craigville Road	397	41,512	2.4	3.1%
Route 28 Marstons Mills	157	36,429	3.3	4.2%
Osterville Woods	328	59,571	5.2	6.7%
Shootflying Hill Road	348	52,306	1.7	2.2%
Lumbert Mill	357	53,221	9.4	12.0%
Osterville-West Barnstable Road & South County Road	153	32,787	3.7	4.8%
Marstons Mills Main Street	144	24,123	2.1	2.8%
Prince Cove	158	32,972	0.0	0.0%
Attucks Lane / Kidds Hill Area	87	16,893	2.2	2.9%
Total	**4,613**	**781,708**	**77.7**	**100.0%**[1]

1. Phase 1 is 44% of the Plan.

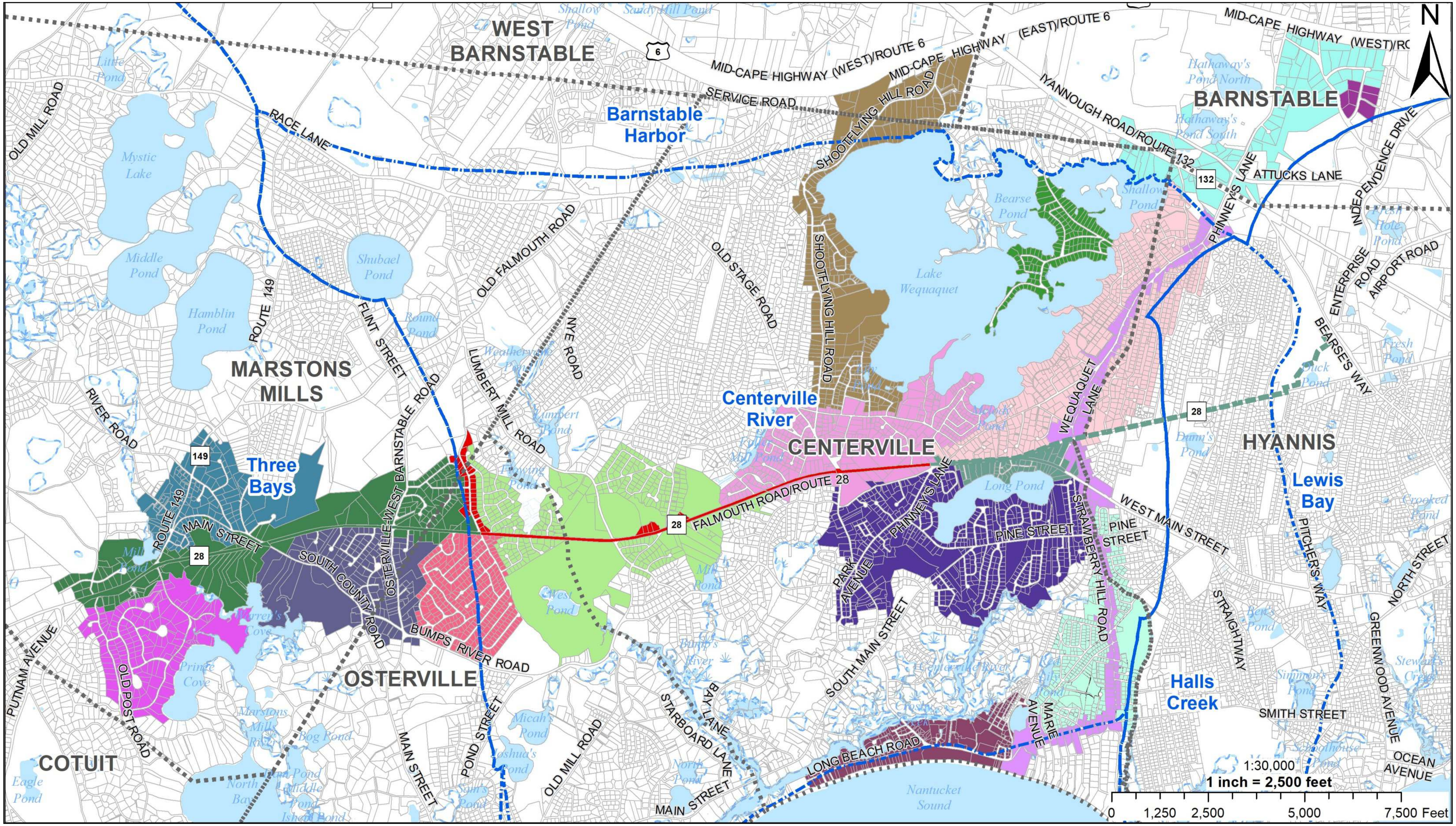

Figure 6-1: Phase 1 Implementation Plan
(Old Yarmouth Road Sewer Expansion Project not shown)

Table 6-2: Phase 1 Sewer Collection System Expansion CIP Schedule

			Phase 1											
Project	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**	***TOTAL***
Merchants Way	***$50,000***	***$550,000***												**$600,000**
Strawberry Hill Road		***$835,000***	***$8,500,000***											**$9,335,000**
Route 28 East		***$800,000***		$12,000,000										**$12,800,000**
Old Yarmouth Road		***$750,000***	$600,000		$6,000,000									**$7,350,000**
Phinneys Lane	***$315,000***	***$735,000***			$20,000,000									**$21,050,000**
Long Beach				$300,000	$750,000		$7,500,000							**$8,550,000**
Route 28 Centerville		***$612,000***	$1,300,000			$14,000,000								**$15,912,000**
Huckins Neck					$250,000	$600,000		$5,000,000						**$5,850,000**
Long Pond Area	***$402,000***	***$938,000***					$28,000,000							**$29,340,000**
Great Marsh Road				$550,000		$1,250,000		$15,500,000						**$17,300,000**
Old Craigville Road					$500,000		$1,000,000		$15,000,000					**$16,500,000**
Route 28 Marstons Mills			$1,800,000						$13,500,000					**$15,300,000**
Osterville Woods							$450,000	$1,050,000		$13,500,000				**$15,000,000**
Shootflying Hill Road						$600,000		$1,350,000		$17,500,000				**$19,450,000**
Lumbert Mill								$450,000	$1,050,000		$13,500,000			**$15,000,000**
Osterville-West Barnstable Road & South County Road									$300,000	$675,000		$8,700,000		**$9,675,000**
Marstons Mills Main Street								$300,000		$650,000		$6,000,000		**$6,950,000**
Prince Cove									$350,000		$650,000		$8,000,000	**$9,000,000**
Attucks Lane / Kidds Hill Area	***$100,000***									$300,000	$650,000		$8,500,000	**$9,550,000**
TOTAL COSTS - COLLECTION SYSTEM	**$867,000**	**$5,220,000**	**$12,200,000**	**$12,850,000**	**$27,500,000**	**$16,450,000**	**$36,950,000**	**$23,650,000**	**$30,200,000**	**$32,625,000**	**$14,800,000**	**$14,700,000**	**$16,500,000**	**$244,512,000**
NEW PARCELS CONNECTED	**0**	**7**	**0**	**240**	**0**	**180**	**856**	**41**	**754**	**803**	**833**	**357**	**542**	**4,613**
COMBINED FLOW (GPD)	**1,670,000**	**1,670,000**	**1,670,000**	**1,717,000**	**1,717,000**	**1,749,000**	**1,881,000**	**1,887,000**	**2,023,000**	**2,144,000**	**2,292,000**	**2,345,000**	**2,452,000**	**782,000**

Legend	
Evaluation and/or Preliminary Design	(yellow)
Final Design	(blue)
Construction	(pink)
Currently Funded Project	***$400,000***
Currently Unfunded Project	$500,000

Table 6-3: Phase 1 Treatment Plant Upgrades CIP Schedule

			Phase 1											
Project	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**	**TOTAL**
Aeration Upgrades			$200,000		$5,500,000									**$5,700,000**
Effluent Flow Meter (Permit Requirement)		***$600,000***												**$600,000**
Denitrification		***$15,000***	$200,000		$600,000		$5,500,000							**$6,315,000**
BWPCF Effluent Disposal Capacity	***$195,000***													**$195,000**
Effluent Disposal Location	***$150,000***		$1,000,000		$3,500,000			$35,000,000						**$39,650,000**
Future Pipes for Potential Yarmouth Connection		***$1,300,000***												**$1,300,000**
Solids Handling			$8,000,000											**$8,000,000**
BWPCF Facility Study (Permit Requirement)				$150,000										**$150,000**
Headworks Modifications					$250,000									**$250,000**
Main Switch B Generator						$550,000								**$550,000**
Secondary Clarifier Upgrades											$300,000		$800,000	**$1,100,000**
TOTAL COSTS - WPCF UPGRADES	**$345,000**	**$1,915,000**	**$9,400,000**	**$150,000**	**$9,850,000**	**$550,000**	**$5,500,000**	**$35,000,000**	**$0**	**$0**	**$300,000**	**$0**	**$800,000**	**$61,550,000**

Legend	
Evaluation and/or Preliminary Design	
Final Design	
Construction	
Currently Funded Project	***$400,000***
Currently Unfunded Project	$500,000

6.2 COORDINATION WITH NEIGHBORING COMMUNITIES

Barnstable shares MEP watersheds with the towns of Mashpee, Sandwich, and Yarmouth. The Town has continued to work with neighboring communities to address the needs for each watershed.

6.2.1 MASHPEE

Barnstable and Mashpee currently share the Popponesset Bay Watershed. Barnstable has worked with Mashpee and Sandwich in developing an inter-municipal agreement (IMA) regarding nutrient management in Popponesset Bay. Please refer to Section 2.3.1.1 for more detail about this IMA agreement.

JBCC – The towns of Bourne, Falmouth, Mashpee, and Sandwich have discussed the possibility of utilizing the waste water treatment facility on JBCC as a regional facility. During the winter of 2018/2019 Barnstable was invited to join the four towns. Barnstable joined and contracted a consultant to study the feasibility of further expanding the Joint Base Cape Cod wastewater treatment facility, to accommodate additional flows from the western portion of the Town. The results of the consultant’s efforts can be found in Appendices KK to NN.

6.2.2 SANDWICH

Sandwich and Barnstable currently share Popponesset and Three Bays Watershed.

As discussed, Barnstable and Mashpee currently share the Popponesset Bay Watershed. Barnstable has worked with Sandwich and Mashpee in developing an inter-municipal agreement (IMA) regarding nutrient management in Popponesset Bay. Please refer to Section 2.3.1.1 for more detail about this IMA agreement.

Three Bays Watershed – Coordination meetings and discussions were held with Sandwich. Each community is addressing its respective need for this watershed via their own CWMP.

As discussed the towns of Bourne, Falmouth, Mashpee, and Sandwich have discussed the possibility of utilizing the waste water treatment facility on JBCC as a regional facility. During the winter of 2018/2019 Barnstable was invited to join the four towns. Barnstable joined and contracted a consultant to study the feasibility of further expanding the Joint Base Cape Cod wastewater treatment facility to accommodate additional flows from the western portion of the Town. The results of the consultant’s efforts can be found in Appendices KK to NN.

6.2.3 YARMOUTH

Yarmouth and Barnstable share the Lewis Bay and Barnstable Harbor watershed. After discussion of treatment options a study was conducted to better understand the opportunities related to having an exchange with Yarmouth. The basis of that exchange would be that Yarmouth would send its collected sewage to Barnstable for treatment, and Barnstable would send that effluent, plus additional effluent back to Yarmouth for disposal. Barnstable and Yarmouth are currently still discussing treatment options during the writing of the CWMP. The study that was conducted can be found in Appendix JJ.

6.3 MONITORING PLAN

The following sections describe the Town's approach to monitoring the effectiveness of the plan.

6.3.1 EMBAYMENT MONITORING

The Town of Barnstable will continue its yearly embayment monitoring. This will include monitoring of water quality, eel grass coverage, and benthic infauna habitat, to verify that the sewer extension and nitrogen remediation efforts are effective.

The embayment monitoring will be a long-term effort and will need to be a team effort between the communities within the embayment watersheds and the Town.

The embayment monitoring program is divided into 5 sample events per summer season (2 in July, 2 in August, and 1 in September), at 2 to 8 sample locations per estuary, for the following parameters:

− Particulate Organic Nitrogen (PON)

− Dissolved Organic Nitrogen (DON)

− Dissolved Inorganic Nitrogen (DIN)

− Dissolved Oxygen (DO)

− Chlorophyll a

− Secchi Depth

− Salinity

− Total Suspended Solids (TSS)

6.3.2 NON-TRADITIONAL SOLUTIONS MONITORING

Monitoring plans for non-traditional solutions will be developed in consultation with DEP during the permitting phase of each project.

6.4 ADAPTIVE MANAGEMENT PLAN

The Town of Barnstable's plan is to implement a sewering approach composing of three phases occurring over 30 years. The adaptive management approach allows for modifications to the plan after evaluation of the result from the earlier phases. The Town will continue revisiting the recommended plan every five years and will be re-evaluating each phase prior to design and construction.

7 FINANCIAL PLAN

7.1 TIMEFRAME

- Projects commence in fiscal year 2020.
- Projects end in fiscal year 2049.
- Duration of project design and construction is 30 years.

7.2 ESTIMATED PROGRAM COSTS

- Collection system costs - $640 million; including $122 million for cost escalation
- Treatment system costs - $224 million; including $78 million for cost escalation
- Project management costs - $30 million
- Finance charge on bond issues - $168 million
- Total estimated costs - $1.062 billion

7.3 BOND FINANCING SUMMARY

- Total project costs appropriated - $864 million
- Estimated Cape & Islands Water Protection Fund subsidies - $112 million (13%)
- Net amount financed - $752 million
- Bond amortization period – 20 years
- Bond amortization method – level payment
- Average interest rate on bonds – 2.0%
- Finance charge on bond issues - $168 million

7.4 TYPES OF PROJECT COSTS

Special Benefit Facilities (SBF) – This includes sewer mains to which a lateral line from an individual abutting property can be connected and pumping stations that are required to service a specific project area.

General Benefit Facilities (GBF) – This includes improvements such as pumping stations, trunk and force mains, lands, rights-of-way, and easements which will provide a benefit or advantage to an area exceeding that served by the special benefit facilities. Ordinarily general benefit facilities will serve a major part of a pumping district.

7.5 SEWER ASSESSMENTS

General Benefit Facility costs (GBF) are allocated 100% to all potential properties that could be serviced by the GBF using the unit method to arrive at a per unit assessment. Only those properties directly abutting the GBF will be assessed up to a maximum of $20,000 in year 1 (FY 2020); adjusted for inflation annually using the Construction Cost Index as calculated by ENR (Engineering News-Record) for the greater Boston area. The balance will be paid for by the town and not be carried forward for future assessment.

Special Benefit Facility (SBF) costs are allocated 100% to all properties included in the special benefit area using the unit method. The maximum assessment for SBF will be $20,000 in year 1 (FY 2020); adjusted for inflation annually using the Construction Cost Index as calculated by ENR (Engineering News-Record) for the greater Boston area. The balance will be paid for by the town and not be carried forward for future assessment.

Property owners will be allowed to apportion sewer assessments over future tax bills:

- The interest rate used on sewer assessments will be set a 2.5%
- The amortization period for sewer assessments will be 30 years
- The amortization method on sewer assessments will be level payment
- Property owners can pay off the balance of assessments early without penalty
- Assessments will be added to quarterly bills
- Plan assumes assessments will be paid off within 15 years due to property transfers and refinancing

7.6 COSTS TO PROPERTY OWNERS

Property owners will incur four types of costs:

1. An assessment for GBF and/or SBF up to a maximum of $20,000;
2. The connection cost for tying property into the sewer line in the street;
3. A Systems Development Charge of $2,000 upon connecting to the sewer line, and;
4. Once connected to the sewer they will receive quarterly sewer bill based on usage.

The town will consider ways it can assist homeowners with financing connection costs and SDC; possibly through creation of a loan revolving fund.

7.7 PROGRAM REVENUE SOURCES

1. Cape & Islands Water Protection Fund principal subsidies generated from 2.75% C&I rooms tax on all lodging establishments including short-term rentals.
2. Assessments on GBF and SBF to property abutters assuming an average assessment of $18,000.
3. Investment earnings on excess cash deposits in Sewer Construction & Private Way Maintenance & Improvement Fund.
4. General Fund contribution - $300,000 beginning in year 2022; increasing $300,000 per year until it reaches an annual amount of $3,000,000. Could be in the form of a property tax override, debt or capital exclusion override, reprioritizing existing tax levy and new tax growth, or a combination of all. Every $0.01 increase in the tax levy generates $140,000 of additional tax with an annual impact of $3.45 to the median residential property owner.
5. System Development Charge of $2,000 per property connecting to offset a portion of the investment made by the town in treatment system upgrades and GBFs.
6. User rate revenue generated from new connections using an average residential annual bill of $400.
7. Local meals tax revenue (rate = 0.75%) – 100% of revenue dedicated to this program.
8. Local rooms tax excise (rate = 6%) (Hotels/ Motels, B&B's) – 33% of revenue dedicated to this program.
9. Short-term rental tax (rate = 6%) – 100% of revenue dedicated to this program.

Funding Sources		
Estimated Principal Subsidies on Bond Issues	$112,229,437	11%
Sewer Assessments	$255,764,639	24%
Investment Earnings	$11,397,346	1%
General Fund Contribution	$70,500,000	7%
System Development Charges	$19,624,000	2%
User Rate Revenue	$128,524,045	12%
Rooms and Meals Taxes including STR	$463,211,220	44%
Total funding sources	**$1,061,250,687**	**100%**

7.8 FINANCIAL ASSUMPTIONS

INPUTS	
Program Implementation Year	**2020**
Program Ending Year	**2049**
Years to Implement	**30**
Average Principal Subsidy on Debt Issues	**13.00%**
Average Interest Rate on Bonds	**2.00%**
Collection System Bond Amortization Period in Years	**20**
Treatment System Bond Amortization Period in Years	**20**
Average Sewer Assessment Charge	**$18,000**
Inflation Factor on Sewer Assessment Charge	**2.00%**
Interest Rate on Sewer Assessments	**2.50%**
Sewer Assessment Amortization Period in Years	**30**
Sewer Assessments Maturity in Years	**15**
Growth Rate on Rooms Tax Revenue	**3.00%**
Growth Rate on Meals Tax Revenue	**4.00%**
Rate of Return on Investments	**1.50%**
Construction Cost Inflation Factor	**2.00%**
Project Management Inflation Factor	**4.00%**
New Short-term Rental Tax Revenue Estimate	**$2,250,000**
General Fund Contribution Ceiling	**$3,000,000**
Annual Growth in General Fund Contribution	**$300,000**
Fiscal Year General Fund Contribution Begins	**2022**
Fiscal Year General Fund Contribution Ends	**2056**
System Development Charge	**$2,000**
Average Residential Sewer Bill - Year 1	**$400**
Annual Increase in Sewer Rates	**3.00%**

COMPREHENSIVE WASTEWATER MANAGEMENT PLAN										
FUNDING PROFORMA										
Years	1	2	3	4	5	6	7	8	9	10
Fiscal Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Beginning Fund Balance	$ 17,647,010	$ 16,641,755	$ 19,163,139	$ 21,403,226	$ 24,973,883	$ 28,405,802	$ 30,533,731	$ 29,112,981	$ 29,817,415	$ 27,596,542
Resources:										
Hotel/Motel Rooms Tax 1/3	1,048,048	1,079,489	1,111,874	1,145,230	1,179,587	1,214,974	1,251,424	1,288,966	1,327,635	1,367,464
Meals Tax	1,685,556	1,752,978	1,823,097	1,896,021	1,971,862	2,050,737	2,132,766	2,218,077	2,306,800	2,399,072
Short-term Rental Tax	250,000	350,000	500,000	2,250,000	2,317,500	2,387,025	2,458,636	2,532,395	2,608,367	2,686,618
General Fund Contribution	-	-	300,000	600,000	900,000	1,200,000	1,500,000	1,800,000	2,100,000	2,400,000
Earnings on Investments	264,705	249,626	287,447	321,048	374,608	426,087	458,006	436,695	447,261	413,948
Existing Sewer Assessments	95,014	92,509	88,335	85,917	77,803	75,685	72,974	70,888	68,801	66,715
Assessments	-	-	-	-	355,889	355,889	633,590	1,980,622	2,046,431	3,280,888
User Charge Revenue	-	-	2,971	3,060	111,200	114,536	203,944	631,171	670,881	1,084,527
Systems Development Charge	-	-	14,000	-	480,000	-	360,000	1,712,000	82,000	1,508,000
Total Resources	3,343,323	3,524,603	4,127,723	6,301,276	7,768,450	7,824,934	9,071,339	12,670,814	11,658,177	15,207,233
Commitments:										
Staffing	200,000	208,000	316,320	428,973	446,132	463,977	582,536	605,838	630,071	655,274
Operating expenses	-	10,000	10,400	10,816	11,249	11,699	12,167	12,653	13,159	13,686
Other costs	-	-	100,000	104,000	108,160	112,486	116,986	121,665	126,532	131,593
Existing Debt Service Payments	501,578	501,926	502,283	502,647	503,019	503,400	503,788	504,185	504,591	505,006
Estimated Debt Service on Collection System	-	283,292	958,634	1,684,184	3,267,971	4,234,311	6,448,318	7,893,744	9,776,403	11,850,913
Estimated Debt Service on Treatment System	-	-	-	-	-	371,132	2,828,294	2,828,294	2,828,294	2,852,013
Other Cash Program Commitments	3,647,000	-	-	-	-	-	-	-	-	-
Total Current Year Commitments	4,348,578	1,003,218	1,887,637	2,730,620	4,336,530	5,697,005	10,492,089	11,966,380	13,879,050	16,008,484
Increase (Decrease) in Trust Fund Balance	(1,005,255)	2,521,384	2,240,087	3,570,657	3,431,919	2,127,929	(1,420,750)	704,434	(2,220,873)	(801,252)
Ending Trust Fund Balance	$ 16,641,755	$ 19,163,139	$ 21,403,226	$ 24,973,883	$ 28,405,802	$ 30,533,731	$ 29,112,981	$ 29,817,415	$ 27,596,542	$ 26,795,291
Project Costs	$7,316,766	$ 22,867,742	$ 13,805,447	$ 41,307,729	$ 18,832,576	$ 48,587,031	$ 73,348,173	$ 35,384,113	$ 38,989,895	$ 18,486,901
Cape cod & Islands Water Protection Fund subsidies	($951,180)	($2,972,806)	($1,794,708)	($5,370,005)	($2,448,235)	($6,316,314)	($9,535,262)	($4,599,935)	($5,068,686)	($2,403,297)
Net Bond Issue	$6,365,586	$19,894,936	$12,010,739	$35,937,724	$16,384,341	$42,270,717	$63,812,911	$30,784,178	$33,921,209	$16,083,604

COMPREHENSIVE WASTEWATER MANAGEMENT PLAN
FUNDING PROFORMA

Years	11	12	13	14	15	16	17	18	19	20
Fiscal Year	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Beginning Fund Balance	$ 26,795,291	$ 27,408,347	$ 29,479,965	$ 30,516,735	$ 32,084,590	$ 33,062,227	$ 33,663,186	$ 33,885,576	$ 33,727,974	$ 32,833,569
Resources:										
Hotel/Motel Rooms Tax 1/3	1,408,488	1,450,743	1,494,265	1,539,093	1,585,266	1,632,824	1,681,809	1,732,263	1,784,231	1,837,758
Meals Tax	2,495,035	2,594,836	2,698,630	2,806,575	2,918,838	3,035,591	3,157,015	3,283,296	3,414,627	3,551,212
Short-term Rental Tax	2,767,216	2,850,233	2,935,740	3,023,812	3,114,526	3,207,962	3,304,201	3,403,327	3,505,427	3,610,589
General Fund Contribution	2,700,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Earnings on Investments	401,929	411,125	442,199	457,751	481,269	495,933	504,948	508,284	505,920	492,504
Existing Sewer Assessments	64,628	62,542	62,542	62,542	-	-	-	-	-	-
Assessments	4,621,862	6,040,756	6,661,015	7,621,531	8,181,891	8,753,458	9,336,457	9,931,115	10,181,778	10,800,460
User Charge Revenue	1,548,729	2,056,418	2,321,709	2,709,738	2,978,592	3,261,137	3,557,955	3,869,647	4,196,838	4,540,178
Systems Development Charge	1,606,000	1,666,000	714,000	1,084,000	620,000	620,000	620,000	620,000	620,000	620,000
Total Resources	17,613,888	20,132,653	20,330,100	22,305,042	22,880,382	24,006,906	25,162,384	26,347,931	27,208,820	28,452,702
Commitments:										
Staffing	681,485	708,744	737,094	766,578	797,241	829,130	862,296	896,788	932,659	969,965
Operating expenses	14,233	14,802	15,395	16,010	16,651	17,317	18,009	18,730	19,479	20,258
Other costs	136,857	142,331	148,024	153,945	160,103	166,507	173,168	180,094	187,298	194,790
Existing Debt Service Payments	505,430	505,862	306,986	307,438	-	-	-	-	-	-
Estimated Debt Service on Collection System	12,810,815	13,783,299	14,896,694	16,015,276	17,156,229	18,320,001	19,507,049	20,717,838	21,952,843	23,212,548
Estimated Debt Service on Treatment System	2,852,013	2,905,996	3,189,137	3,477,941	3,772,520	4,072,992	4,379,473	4,692,083	5,010,946	5,336,186
Other Cash Program Commitments	-	-	-	-	-	-	-	-	-	-
Total Current Year Commitments	17,000,832	18,061,035	19,293,330	20,737,187	21,902,744	23,405,947	24,939,995	26,505,533	28,103,225	29,733,748
Increase (Decrease) in Trust Fund Balance	613,056	2,071,618	1,036,770	1,567,855	977,637	600,959	222,390	(157,602)	(894,405)	(1,281,046)
Ending Trust Fund Balance	$ 27,408,347	$ 29,479,965	$ 30,516,735	$ 32,084,590	$ 33,062,227	$ 33,663,186	$ 33,885,576	$ 33,727,974	$ 32,833,569	$ 31,552,523
Project Costs	$ 18,277,602	$ 21,940,583	$ 26,345,028	$ 26,871,929	$ 27,409,368	$ 27,957,555	$ 28,516,705	$ 29,087,039	$ 29,668,780	$ 30,262,156
Cape cod & Islands Water Protection Fund subsidies	($2,376,088)	($2,852,276)	($3,424,853)	($3,493,350)	($3,563,218)	($3,634,482)	($3,707,171)	($3,781,315)	($3,856,941)	($3,934,081)
Net Bond Issue	$15,901,514	$19,088,307	$22,920,175	$23,378,579	$23,846,150	$24,323,073	$24,809,534	$25,305,724	$25,811,839	$26,328,075

COMPREHENSIVE WASTEWATER MANAGEMENT PLAN										
FUNDING PROFORMA										
Years	21	22	23	24	25	26	27	28	29	30
Fiscal Year	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**
Beginning Fund Balance	$ 31,552,523	$ 29,607,235	$ 26,208,202	$ 22,940,314	$ 19,422,811	$ 15,930,608	$ 12,351,226	$ 12,829,787	$ 13,876,010	$ 16,351,435
Resources:										
Hotel/Motel Rooms Tax 1/3	1,892,891	1,949,677	2,008,168	2,068,413	2,130,465	2,194,379	2,260,210	2,328,017	2,397,857	2,469,793
Meals Tax	3,693,261	3,840,991	3,994,631	4,154,416	4,320,593	4,493,417	4,673,153	4,860,079	5,054,483	5,256,662
Short-term Rental Tax	3,718,907	3,830,474	3,945,389	4,063,750	4,185,663	4,311,233	4,440,570	4,573,787	4,711,000	4,852,330
General Fund Contribution	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Earnings on Investments	473,288	444,109	393,123	344,105	291,342	238,959	185,268	192,447	208,140	245,272
Existing Sewer Assessments	-	-	-	-	-	-	-	-	-	-
Assessments	11,153,816	10,450,461	11,041,203	10,474,268	9,596,023	8,649,112	8,510,276	8,040,812	7,981,324	7,920,647
User Charge Revenue	4,900,341	5,278,028	5,673,965	6,088,120	6,441,518	6,810,641	7,196,114	7,598,585	8,018,729	8,457,242
Systems Development Charge	620,000	620,000	620,000	618,000	420,000	420,000	420,000	420,000	420,000	420,000
Total Resources	29,452,504	29,413,741	30,676,479	30,811,072	30,385,604	30,117,741	30,685,592	31,013,727	31,791,533	32,621,946
Commitments:										
Staffing	1,008,764	1,049,115	1,091,079	1,134,722	1,180,111	1,227,316	1,276,408	1,327,465	1,380,563	1,435,786
Operating expenses	21,068	21,911	22,788	23,699	24,647	25,633	26,658	27,725	28,834	29,987
Other costs	202,582	210,685	219,112	227,877	236,992	246,472	256,330	266,584	277,247	288,337
Existing Debt Service Payments	-	-	-	-	-	-	-	-	-	-
Estimated Debt Service on Collection System	24,497,447	25,524,752	26,186,219	26,089,871	25,147,870	24,836,152	23,289,859	22,525,502	21,337,533	19,971,607
Estimated Debt Service on Treatment System	5,667,931	6,006,311	6,425,169	6,852,405	7,288,186	7,361,551	5,357,775	5,820,229	6,291,932	6,749,350
Other Cash Program Commitments	-	-	-	-	-	-	-	-	-	-
Total Current Year Commitments	31,397,792	32,812,773	33,944,368	34,328,575	33,877,806	33,697,123	30,207,031	29,967,503	29,316,109	28,475,067
Increase (Decrease) in Trust Fund Balance	(1,945,288)	(3,399,032)	(3,267,889)	(3,517,503)	(3,492,203)	(3,579,382)	478,561	1,046,223	2,475,425	4,146,879
Ending Trust Fund Balance	$ 29,607,235	$ 26,208,202	$ 22,940,314	$ 19,422,811	$ 15,930,608	$ 12,351,226	$ 12,829,787	$ 13,876,010	$ 16,351,435	$ 20,498,313
Project Costs	$ 30,867,399	$ 31,484,747	$ 19,698,047	$ 20,092,008	$ 20,493,848	$ 20,903,724	$ 21,321,799	$ 21,748,235	$ 22,183,200	$ 22,626,864
Cape cod & Islands Water Protection Fund subsidies	($4,012,762)	($4,093,017)	($2,560,746)	($2,611,961)	($2,664,200)	($2,717,484)	($2,771,834)	($2,827,271)	($2,883,816)	($2,941,492)
Net Bond Issue	$26,854,637	$27,391,730	$17,137,301	$17,480,047	$17,829,648	$18,186,240	$18,549,965	$18,920,964	$19,299,384	$19,685,372

8. ENVIRONMENTAL IMPACT STATEMENT