COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN/ENVIRONMENTAL IMPACT REPORT PHASE I EXISTING CONDITIONS, FUTURE REQUIREMENTS AND PROBLEMS IDENTIFICATION (DEFINITION OF NEEDS)

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EXECUTIVE SUMMARY

The Town of Acton filed an Environmental Notification Form (ENF) in October 1998 for the Middle Fort Pond Brook Sewer Project. The ENF requested a "Special Procedure" under the Massachusetts Environmental Policy Act (MEPA) to phase the overall environmental analyses, regulatory review and approval, and engineering design of a town-wide wastewater collection and treatment management plan to address the immediate and long-term growth needs of the Town.

The Secretary of Environmental Affairs issued a Certificate for the project on December 1, 1998. The MEPA Certificate (EOEA No. 11781) established a Special Procedure for the preparation and review of an EIR for town-wide wastewater facilities planning and development. This allowed the Town to proceed with design and construction of an advanced wastewater treatment facility on Adams Street and approximately 10 miles of collection system outside of the MEPA review process. A Special Procedure was established to address the remaining town-wide wastewater facilities planning and assessment requirements under a comprehensive, phased set of reports for long-range planning.

The Comprehensive Water Resources Management Plan / Environmental Impact Report (CWRMP/EIR) for the Town of Acton consists of four phases. The first phase, of which this report presents the findings and conclusions, includes an assessment of the current environmental conditions in and around Acton. Water demand projections are estimated for the 20-year study period and impacts to the present and future water supply are reviewed. Current storm water systems and programs are reviewed. Current wastewater management systems are discussed, followed by a determination of wastewater needs. Finally, potential locations for satellite wastewater treatment facilities are presented.

The Town of Acton recognizes the need to look at water resources in a comprehensive manner. This includes soliciting and incorporating resident and other stakeholder input. This study includes public outreach in the form of three Citizen Advisory Committee (CAC) meetings. The CAC communicated issues of importance to the residents of Acton and provided valuable insight, historical and anecdotal information, and direction to the project team.

The Town recently built a state-of-the-art treatment facility and groundwater discharge system with aggressive phosphorus removal. The Town has conducted surface and ground water sampling for several years and has developed an extensive database of fecal coliform levels throughout the Town's surface waters. The Town proactively engaged in stormwater planning, not only with the recent EPA Phase II requirements, but also by winning a 319 grant in 2001 to implement stormwater best management practices to reduce phosphorus loading in local waterways. The Town works closely with the Acton Water District, which has recently updated its master plan and conducted an assessment of land use risks to its wells. This first phase of the CWRMP/EIR compiles and synthesizes elements of all these projects into a comprehensive evaluation of Acton's water resources.

The Town of Acton is a residential community located approximately 25 miles northwest of Boston, MA. The Town has a proactive municipal staff that is actively engaged in finding solutions to wastewater issues and water quality problems. The Town's Board of Selectmen currently acts as the Sewer Commissioners. Several active environmental organizations are located in Acton and the surrounding Sudbury-Assabet-Concord (SuAsCo) Rivers Watershed.

Acton's most current census population is approximately 20,000. The Town's Master Plan projects the ultimate buildout population to be approximately 29,200, which will be reached in 40 years. Acton's estimated maximum residential buildout is approximately 10,600 dwelling units (defined as the residence of one family), a net increase of about 3,400 units over the 1998 housing stock of 7,200 units. About 68% of this net increase is attributed to further development of existing developed parcels. Non-

residential buildout is estimated to come through greenfield development (40%) and expansion and conversion of existing developed parcels (60%).

The entire Town lies within the drainage basin of the Assabet River. The two principal streams in Acton are Nashoba Brook and Fort Pond Brook. The Assabet River has been identified as receiving excessive levels of nutrients, particularly phosphorus. The sources identified as the leading cause of nutrient impairment in the Assabet River are the publicly-owned wastewater treatment facilities located upstream of Acton. During summer months, under low flow conditions, wastewater treatment facility effluent accounts for approximately 80% of the total river flow.

The topography of Acton is characterized by gently rolling hills and some small peaks. Elevation gradually increases from the southeast to the northwest. Acton's surficial geology is predominated by sand/gravel and till/bedrock deposits. Generally, the sand and gravel deposits occur in the narrow and constrained valley aquifers along the principal streams of the Town, and run in north-south lines. A large strip of till/bedrock separates the two sand/gravel areas. These aquifers are the only source of public drinking water in Town.

Approximately 95% of Acton's population is served by the Acton Water Supply District (the District). The District withdraws drinking water from five locations in these areas of sand and gravel. Drinking water sources consist of eleven wells and wellfields, nine of which are treated by packed tower aeration (PAC), granular activated carbon (GAC), or a combination of the two technologies. The District regularly enacts water use restrictions and is proactive in public education of water issues, especially promoting conservation measures.

The District is permitted to withdraw up to 1.93 MGD on average over a calendar year. In 2002 the District's average daily withdrawal was 1.86 MGD, with a maximum demand day of 2.90 MGD. The Acton Water District exceeded its permitted average daily withdrawal capacity only once, in 2001, when unaccounted water reached 19% of water withdrawn primarily due to an open valve that allowed unmetered water to flow from Acton's distribution system into Maynard.

With the exception of 2001, the District's average daily use has remained at approximately 1.85 MGD since 1997 even though Acton's population as grown by about 10 percent during that period. The District's Master Plan predicts an average daily demand of 2.24 MGD by 2011, with a maximum day demand of 3.68 MGD by 2011.

Much of the Town's drainage system was constructed in the 1930's through the programs of the Works Progress Administration. At that time, little consideration was given to controlling the quantity or quality of stormwater entering natural water bodies. Since approximately 1980, the Town's Subdivision Rules and Regulations require new commercial and residential developments in Acton to collect and convey runoff into a vegetated detention basin. In addition to these rules, developers of subdivisions containing five or more lots must adhere to Stormwater Management Standards set forth by MADEP.

The geography of Acton is not conducive to non-point source (NPS) controls having a direct benefit on the Assabet River. The only section of Acton that discharges directly to the river is the southeastern corner of Town. All of Acton streams flow through local water bodies to Warner Pond in Concord prior to entering the Assabet River.

In conjunction with the recent construction of the wastewater collection and treatment system, the Town has undertaken several projects to address stormwater issues. Acton is conducting a Watershed Trading Study aimed at reducing phosphorus loading on local waterways. The project (MADEP Project 00-07/319) is funded by an EPA 319 grant. According to the USEPA grant scope, "The project is intended

to pilot watershed trading programs that will become increasingly important and common in the coming years…" Acton will construct two structural best management practices (BMPs), a wetland to reduce phosphorus in the local swimming pond, and undertake several nonstructural measures to improve regulations and inform and involve the general public. The grant work is being undertaken in conjunction with this CWRMP/EIR and the recently completed Stormwater Management Plan required by EPA under the Phase II program.

The Middle Fort Pond Brook Sewer System, which includes an advanced wastewater treatment facility (WWTF) with 10 miles of gravity sewer and ten pumping stations, has been on line since February 2002. The sewer system serves approximately 700 total parcels. The WWTF is permitted for 250,000 gpd with an effluent phosphorus limit of 0.2 milligrams per liter (mg/l). The facility discharges to rapid infiltration beds (RIBs) on the bank of the Assabet River.

The town is served by ten privately owned and operated cluster wastewater systems that are permitted to collect, treat and discharge approximately 450,000 gpd. Eleven small-medium cluster systems contribute a total of approximately 90,000 gpd of wastewater treatment and disposal capacity. These facilities discharge to subsurface disposal systems.

Approximately 84% of the town's developed parcels use on-site wastewater disposal systems. The Acton Board of Health (BOH) maintains a complete set of records for all septic systems in Acton. The BOH file system includes permit lists, Title 5 inspection lists, variance list (1995-2001), Geographic Information System (GIS) database, design data list, and non-electronic files (paper and microfiche) containing design and permit details.

To determine areas in need of wastewater disposal solutions, specific data were evaluated, including system age, repair history, septage pumping records, inspection data, variances, private wells location, parcel size, depth to groundwater and bedrock, and percolation rate. The files and database form the basis for the wastewater needs analysis. Key design data recorded in existing non-electronic files were digitized for this project and merged with existing BOH electronic information into a comprehensive GIS database. Soils parameters available through standard Natural Resources Conservation Service (NRCS) mapping were adjusted based on BOH records.

The analysis was applied town-wide, incorporating an improved and more detailed approach to identifying areas in need of wastewater solutions on a lot-be-lot basis. This process evaluates wastewater needs without presumptions or unintended bias inherent in preconfigured study areas.

Over 90% of the existing septic systems can remain as on-site systems for the planning period, with approximately 3.5% of these lots requiring innovative/alternative (I/A) technology and/or mounded systems. Lots identified as requiring offsite solutions to wastewater disposal problems are dispersed throughout the community.

Attempting to service only the dispersed lots with off-site solutions would be technically impractical and cost prohibitive. The lots identified as needing off-site solutions could be joined by adjacent lots to create independent service areas that may be more economically feasible to address. These needs areas will be further reviewed by the project team, with input from DEP, Town staff, CAC and general public as part of the forthcoming phases.

The range of wastewater flows projected to be collected treated and dispersed from the proposed needs/service areas is between 110,000 gpd and 265,000 gpd. Potential solutions to locating facilities and selecting appropriate technology for offsite solutions, whether decentralized/cluster facilities or expansion/extension of the existing wastewater collection and treatment system, will be further evaluated

in forthcoming phases of the study. A critical component of this evaluation is the determination of potential locations for wastewater effluent disposal within Acton.

The principal tool used in identifying areas of interest (AOI's) with potential for wastewater disposal has been the GIS databases derived from the Town of Acton's GIS system and MassGIS. These databases provide information on soil type characteristics, depth to seasonal high groundwater, depth to bedrock, level of development, and location of sensitive receptors. Preliminary analysis of selection criteria concludes that approximately 620 acres are available within Acton for locating wastewater treatment and disposal facilities. Additional parcels identified by the town and CAC input may provide effective alternatives to the lots selected from the analysis.

The Town is currently comparing actual flows at the central WWTF to the design flows to maximize the facility's effectiveness and optimize the potential solutions to wastewater needs. Pending this analysis, the first needs area under consideration for extension of the existing wastewater collection system is the Powdermill Plaza area, currently served by an older treatment facility that discharges directly to the Assabet River.

Phase II of the CWRMP/EIR includes pairing of the needs areas with potential disposal locations, including subsurface investigations if needed. Collection and treatment technologies will be evaluated for each needs/service area.

1. INTRODUCTION

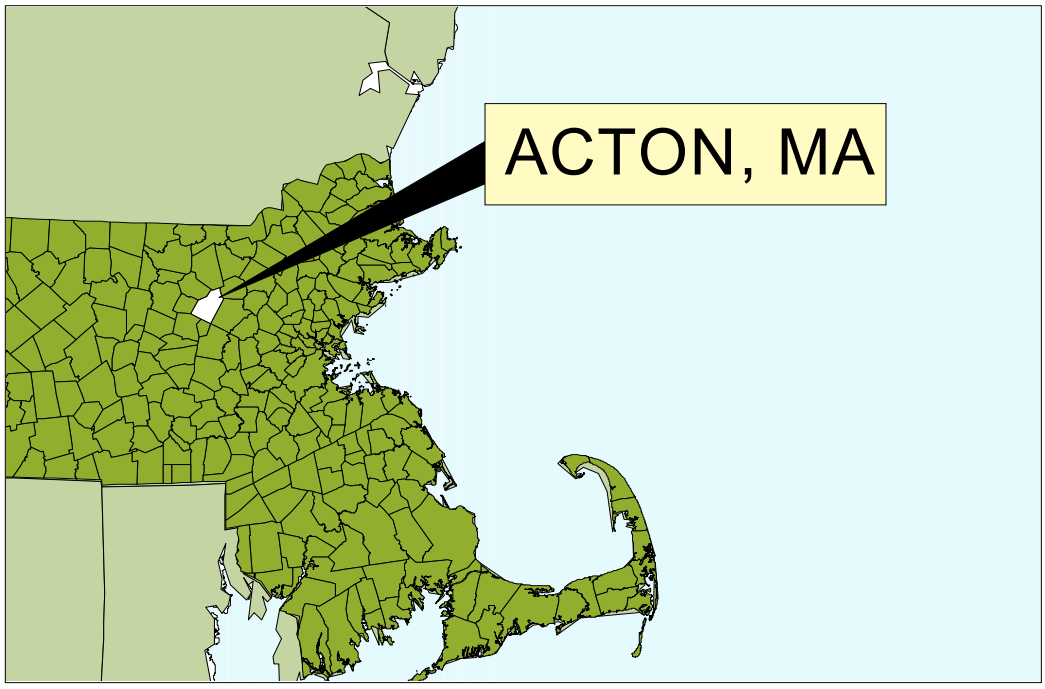
1.1 PURPOSE AND SCOPE OF THE CWRMP/EIR

Acton is located approximately 25 miles northwest of Boston, MA. The Town is located between the two circumferential beltways that surround Boston, the inner I-95/Route 128 corridor and the outer I-495 corridor. Route 2, a radial corridor serving the greater Boston area, passes through the Town, and is a major commuting route for residents of Acton and outlying communities.

The Town is approximately 20.25 square miles in area and has a year 2000 population of approximately 20,331. Figure 1-1 depicts the geographical location of the Town.

This Comprehensive Wastewater Resources Management Plan/Environmental Impact Report (CWRMP/EIR) will evaluate issues of regional consequence within the Town of Acton and evaluate a number of alternatives to provide a 20-year plan and solutions to the water reuse and wastewater collection, treatment and disposal needs of the Town. Included within the CWRMP will be an assessment of Acton's wastewater disposal needs and an evaluation of the potential collection systems, transmission systems, required treatment levels and technologies for a range of on-site, localized, centralized and decentralized alternative treatment facilities, effluent disposal options, residuals handling and disposal options, and facilities siting solutions that will best serve the needs of the Town.

FIGURE 1-1: LOCATION MAP FOR ACTON, MA



1.1.1 Overview of the CWRMP/EIR Process

Preparation of the CWRMP will consist of four phases. The intent of the phased approach is to organize the project tasks into groups with increasing complexity and reliance upon information gathered in previous phases leading to informed and effective decisions. Each phase will have a review period for public and agency comments and will result in finalizing the specific scope of services for the next phase. A brief description of each phase follows:

Existing Conditions, Future Requirements and Problems Identification (Definition of Needs)

The first phase, of which this report presents the findings and conclusions, will include an assessment of the current environmental conditions in and around Acton. Water demand projections will be estimated for the study period and impacts to present and future water supply will be reviewed. Current stormwater systems and programs will be reviewed. Current wastewater management systems and a determination of wastewater needs will be calculated in this phase of the project. A summation of the conclusions reached will become a deliverable for this phase. The development of a water balance model to assess issues such as inter-basin transfers will also be conducted. The final task will be the determination of potential site locations for satellite treatment facilities.

An expanded ENF will also be prepared and submitted to MEPA. This ENF will determine whether and what degree of EIR coverage is called for.

Review and Iteration of Management Techniques and Technologies Screening, and Potential Satellite Facility Site Selection

The second phase of the project will conduct further refinement of the potential site locations initially identified in Phase I and alternative wastewater treatment solutions across the Town. Candidate wastewater and stormwater management technologies and general screening criteria will be reviewed and established. This will encompass on-site solutions, potential satellite solutions and centralized solutions. A description of watershed-based non-sewage stormwater management techniques will also be developed. The actual screening process will also be accomplished under this phase of work.

Preparation of Draft EIR and Detailed Assessment of Management Options and Recommendation of Management Plan

The third phase will be conducted to define and assess the environmental impacts of the viable options for on-site wastewater treatment technologies, satellite technologies and centralized options.

The Draft EIR (DEIR) will examine all of the alternatives considered under the CWRMP facilities planning. It will assess the natural and man-made environment, engineering options for onsite, collection, treatment and discharge, as well as stormwater management as part of the comprehensive town-wide solutions being considered. Based on the DEIR comparative measures evaluated, a recommended plan and wastewater solutions will be selected.

An environmental fate and transport analysis of satellite technologies and sites will be conducted. This phase includes the preparation of conceptual design plans, sufficient to allow siting and operational impacts to be assessed, and will result in a recommended town-wide wastewater management plan.

Final CWRMP/EIR Preparation

The final phase of planning will integrate the previous three submittals into a unified CWRMP and a Final EIR. Upon the completion of each phase, a variety of comments will have been generated from agency reviewers, the public, area watershed and resource protection and other interested groups. The responses to the DEIR and any remaining comments on the previous phase reports will be addressed and responded to in the Phase IV submittal of the Final EIR (FEIR). An executive summary including the conclusions and recommendations will be added to the report.

1.1.2 Planning Area and Period

The planning area proposed for this Scope of Work includes the entire Town of Acton. The planning period will be 20 years, with a design year of 2025.

1.1.3 The MEPA Process

This section addresses the requirements under the Massachusetts Environmental Policy Act (MEPA) state law in accordance with the regulations contained in 301 CMR 11.00 of the Code of Massachusetts Regulations (CMR).

The Town of Acton, working in conjunction with its consultants Woodard & Curran, Inc., prepared and filed an Environmental Notification Form (ENF) in October 1998 for the Middle Fort Pond Brook Sewer Project. The ENF summarized the project's parameters and requested a "Special Procedure" under the MEPA regulations in order to phase the overall environmental analyses, regulatory review and approval, and engineering design of a town-wide wastewater collection and treatment management plan to address the immediate and long-term growth needs of the town.

This assessment was also in conjunction with the guidelines issued at that time by the Massachusetts Department of Environmental Protection (DEP) regarding comprehensive water resources management planning (see Section 1.1.4 below) to address other factors that also are key in establishing an effective town-wide wastewater management plan, such as stormwater management, groundwater recharge, natural resources protection, and surface water quality.

A key element of the ENF and the approach that Acton was taking was to accelerate the engineering design of a new advanced wastewater treatment plant (WWTP) proposed to be built on a 35-acre town-owned parcel of land at Adams Street, in the southeastern area of town. The wastewater treatment facility would treat up to 250,000 gallons per day (gpd) of waste and discharge treated effluent to a groundwater discharge system also located at the Adams Street site. The Assabet River flows adjacent to the site. A chief reason for this accelerated WWTP design and construction and phased approach to town-wide facilities and water resources planning was the serious impact to public health and water quality from older under-designed and failing onsite septic systems in several sections of Acton.

The Secretary of Environmental Affairs issued a Certificate for the project on December 1, 1998. The MEPA Certificate (EOEA No. 11781) established a Special Procedure for the preparation and review of an EIR for town-wide wastewater facilities planning and development. Among the key provisions established by the Secretary were the following:

- An EIR is required for town-wide wastewater facilities planning.
- The Adams Street WWTP and its associated approximately 10 miles of collection sewers are allowed to proceed to final design and permitting outside of the MEPA review process.
- A Special Procedure is established to address the remaining town-wide wastewater facilities planning and assessment requirements under a comprehensive, phased set of reports to be prepared that analyze major elements of town-wide, long-range wastewater planning.
- Based on the findings and conclusions of these sequential reports, as well as the filing of another Expanded ENF document, the Secretary will determine whether an EIR is required, and if required whether a Single EIR is appropriate or whether a full Draft and Final EIR is required.

The sequence of phased reports to be prepared starts with this Phase I report. This will be followed by a Phase II – Alternatives Analysis Report and Expanded ENF that summarizes and screens the following topics: Results of the Phase I report relative to the extent of wastewater problems and need for corrective measures, as well as growth management strategies; alternatives available to correct the problems and the broadly defined engineering solutions, environmental affects and economic ranking of each alternative. Depending on the problems, solutions and their relative impacts and rankings presented in the Phase II report and Expanded ENF, the Secretary will make a decision on the next steps in the process and whether an EIR is required. If an EIR is required, it will be prepared following the Phase II results.

1.1.4 Other Regulatory Requirements

This section describes the range of regulatory and permitting requirements that the town will address as part of the CWRMP/EIR process and to achieve project permit approvals.

1.1.4.1 DEP Wastewater Facilities Planning Guidance

The DEP prepared a guidance document titled "Guide to Comprehensive Wastewater Management Planning", dated January 1996, that outlined the approach and steps to wastewater facilities planning for municipalities. This document presents guidelines for communities to follow in preparing local Comprehensive Water Resources Management Plans (CWRMP) that address wastewater facilities planning and community growth and resources protection issues in a comprehensive and integrated way. This Phase I report follows the CWRMP process outlined by the state. It is the first of a phased analysis of Acton's town-wide wastewater facilities needs and water resources management approaches to achieve long-term managed community growth with natural resource protection and community values maintained.

1.1.4.2 DEP Groundwater Discharge Permit

Acton's wastewater treatment plant located on Adams Street was completed and operations commenced in February 2002. A groundwater discharge permit (No. 0-656) was issued by DEP on January 7, 2000. Operations of the WWTP are currently serving connected users, with additional connections continuing to be made. The highly treated effluent is discharged to infiltration beds located at the site.

1.1.4.3 Massachusetts State Revolving Loan Program (SRF)

The Town of Acton is financing this project under the state's SRF loan program pursuant to Chapters 21 and 29C of the General Laws of the Commonwealth. The loan is from funds established through bonding authority of the Massachusetts Water Pollution Abatement Trust and administered by the DEP. Regulations governing and defining project eligibility, performance criteria, evaluation criteria, affirmative action and MBE/WBE requirements, and terms and conditions of the loan agreement are specified in 310 CMR 44.00.

1.1.4.4 Assabet River Consortium

The Assabet River Consortium is comprised of six communities all operating wastewater treatment facilities that discharge their effluent to the Assabet River. The communities in the consortium are Hudson, Marlborough, Maynard, Northborough, Shrewsbury and Westborough, all upstream of Acton. These communities and the consortium that they make up are preparing a Comprehensive Wastewater Management Plan and Environmental Impact Report (CWMP/EIR) to study regional wastewater treatment issues that affect the communities and the Assabet River. The result of the CWMP/EIR will be

a plan outlining how each of the six communities will manage and treat sanitary sewage for the next 20 years.

Although not a member of the Assabet River Consortium, Acton is actively monitoring and coordinating the preparation of its own CWRMP/EIR to that of the Assabet River Consortium communities. All reports prepared as part of Acton's process will be available to the Assabet River Consortium for their review and use.

1.1.4.4.1 Other Permits and Agency Approvals

The agencies having regulatory review and approval and/or permit authority over the construction and operation of the various alternative wastewater solutions that may be implemented include local, state and federal departments and agencies. Actual jurisdiction over the projects will be determined at the conclusion of this process based on the final plans and facilities recommended and the outcome of the MEPA and DEP processes.

The following agencies and departments are those that are expected to be involved in the MEPA process and in subsequent project reviews and approvals for the CWRMP/EIR.

Local Authorities

- Board of Health
- Acton Water District
- Sewer Commission/Board of Selectmen
- Conservation Commission/Natural Resources Department
- Building Department
- Historic Commission

State Agencies

- Massachusetts Environmental Policy Act Office (MEPA)
- Massachusetts Department of Environmental Protection (DEP).
  - DEP Division of Water Pollution Control (DWPC)
  - DEP Division of Wetlands and Waterways (DWW)
  - DEP Division of Air Quality Control (DAQC)
  - DEP Division of Water Resources (DWR)
- Massachusetts Historical Commission (MHC)
- Massachusetts Department of Environmental Management (DEM)
- Massachusetts Water Resources Commission (WRC)
- Massachusetts Highway Department (MHD)

Federal Agencies

- U.S. Army Corps of Engineers (ACOE)
- U.S. Environmental Protection Agency (EPA)

1.2 PUBLIC PARTICIPATION PROCESS

1.2.1 Organization of CAC

J. Lastovica Co. Consulting Engineering was hired as a sub-contractor to help organize, prepare and facilitate meetings of the Acton Citizens Advisory Committee (CAC). The CAC consists of seventeen stakeholders representing members of various town boards, the Acton Water District, several local businesses and the general resident populace. The mission of the CAC is to:

- Serve as a representative Acton forum to offer views, comments and opinions about the CWRMP/EIR to the Town and consultant team;
- Help the Town and consultant team identify all relevant issues, topics and concerns about the CWRMP/EIR by offering ideas and constructive comments;
- Demonstrate to MEPA and DEP by its periodic meetings and discussions that the diverse views of the community have been considered in the process; and
- Provide outreach to Acton residents and the community at large to communicate the process and results of the CWRMP/EIR and, hopefully, help to build a consensus for the water resources management plan that emerges from this process.

1.2.2 Summary of CAC Meetings

Three CAC Meetings have been held during the Phase I process.

CAC Meeting No. 1

The first CAC meeting was held on December 12, 2001. The objective of the initial CAC meeting was to give the citizens' committee a general overview of the project scope, schedule, and CWRMP/EIR regulatory process and elicit general feedback regarding comments, questions or concerns about both the project and the methods of committee involvement.

The meeting began with presentation of the project overview and the regulatory process. A general discussion of issues followed, including:

- If there is inadequate public input, public relations will fail;
- How will public issues be "ferreted" out;
- How "sunshine/public" can our discussions be;
- How will the public have a say in the study;
- Include the CAC Mission with the next agenda;
- Publicize public meetings via "Town Meeting" banners; and
- Learn from successful consensus and public processes used for other projects.

Additional issues were noted and maintained by the facilitator. The CAC members in attendance were then randomly divided into three groups and asked to discuss and list their issues and concerns based on the project description and regulatory process, as well as their stakeholder positions.

The objective and goals of the next meeting were described. The CAC was scheduled to meet again in October 2002 after the completion of the effort to digitize Board of Health records.

CAC Meeting No. 2

The second CAC meeting was held on October 22, 2002. The objectives of the meeting were to

- Confirm each study area and establish the level of effort to characterize each area through field investigations, especially for non-wastewater concerns such as neighborhood character, historical significance, natural features, etc.
- Establish the objective criteria by which each area's wastewater needs will be assessed and the relative ranking of the criteria.

The first draft version of the CWRMP was made available to CAC members prior to the meeting. The initial findings and assessment of current environmental conditions in and around Acton were presented. Water demand, water supply, stormwater systems, and wastewater management and needs were reviewed. Fieldwork in the form of a "windshield survey" of significant Town natural resources and other special conditions will complete the initial assessment.

The concept of "study areas" was discussed, with the modified lot-by-lot assessment available through GIS presented to the CAC. Since the first CAC meeting, existing Board of Health records were converted in to GIS database for analysis of wastewater needs and used in conjunction with other Town reports and projects to provide the best available data for the wastewater needs analysis. Draft "Needs" areas developed through this modified approach were presented.

The CAC was divided into two breakout groups for further discussion of the study areas/proposed fieldwork and the needs criteria. Several comments were received and recorded in the meeting minutes for the project team to enhance the report and investigate for further report submittals. The objective criteria and relative ranking of criteria for wastewater needs were discussed and agreed upon. The Health Department surface water and groundwater sampling program was reviewed and discussed. Additional surface water and groundwater sampling is not needed to supplement the existing Health Department program. The project team will refine the analysis with comments and suggestions from the CAC and present findings at the next CAC meeting in January 2003.

CAC Meeting No. 3

The third CAC meeting was held on January 23, 2003. The objectives of the meeting were to:

- Establish the selection criteria for potential satellite treatment locations and review potential discharge/disposal locations.
- Discuss suggestions, comments and questions received at the October 22, 2002 CAC meeting.

Water demand, water supply, and wastewater disposal needs were reviewed. Based on the compilation of numerous reports and studies and Health Department records and field data, maps were developed to delineate areas most suitable for on-site solutions. Similarly, maps were also developed for areas requiring off-site solutions.

The evaluation process for selecting potential satellite treatment/disposal locations was reviewed. Existing cluster systems and disposal options were discussed. The CAC requested that the CWRMP include additional data and analysis on the impact the cluster wastewater systems and any potential expansion of the centralized collection system will have on "needs" areas.

Selection criteria on potential locations of satellite treatment and disposal facilities were discussed and CAC comments and suggestions were added to the selection process. The CAC suggested including lands by non-profit agencies and large lots that are not fully developed, as well as locations along the Route 2 corridor. The draft maps will be modified and final selections will be made available with the submittal of the CWRMP for DEP review and public review period.

2. EXISTING ENVIRONMENTAL CONDITIONS

2.1 INTRODUCTION

This section will discuss existing environmental conditions in Acton, the built and human environment and the natural environment. It will set the current baseline for the Town when measuring any impacts from future change within the planning period

2.2 THE BUILT AND HUMAN ENVIRONMENT

2.2.1 Town Population

Acton's historical population is provided in Table 2-1 and depicted graphically in Figure 2-1.

TABLE 2-1: HISTORICAL POPULATION OF ACTON

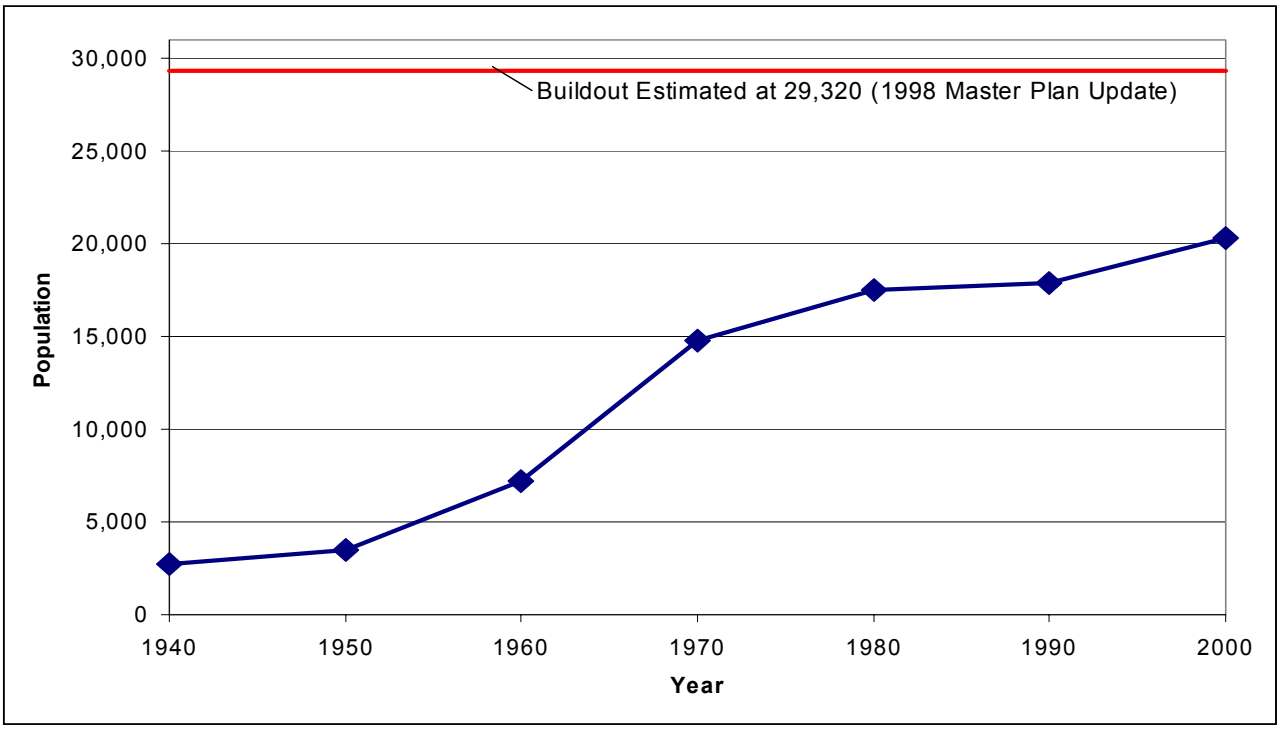
Year	Population	Percent Change	Annualized Percent Change	Internal Increase	% of Total Increase	Net Migration	% of Total Increase
1940	2,701	--	--	--	--	--	--
1950	3,510	30%	2.7%	275	34%	534	66%
1960	7,238	106%	7.5%	937	25%	2791	75%
1970	14,770	104%	7.4%	1673	22%	5859	78%
1980	17,544	19%	1.7%	1792	65%	982	35%
1990	17,872	2%	0.2%	1064	100%	-736	NA
2000	20,331	14%	1.3%	NA	NA	NA	NA

1940 – 1990 Data from 1998 Update to Town Master Plan; 2000 Data from 2000 U.S. Census.

According to the Town's 1998 Master Plan Update, Acton experienced its greatest growth between 1950 and 1970. Population quadrupled from 3,510 to 14,770. While many communities in the western Boston metropolitan area experienced unprecedented population growth in the 1970s and 1980s, Acton's slowed; after doubling during the 1960s, the Town's population increased 18.7% between 1970 and 1980, and by only 2% between 1980 and 1990. The Town grew by 14% through the 1990s. The Town's buildout population is projected at 29,230. The 1998 Update to the Master Plan estimated that, at current long-term average growth rates, the Town may reach its buildout population in approximately 40 years *(1998 Update to Master Plan, pp 62)*.

According to the 2001 Acton Assessor's Database, the town's total valuation is approximately $2.55 billion. The mean residential home valuation is approximately $388,900. Total assessed value for residential parcels is approximately $1.7 billion.

FIGURE 2-1: HISTORICAL POPULATION OF ACTON, MA



2.2.1.1 Demographic Characteristics

2.2.1.1.1 Median Income Distribution

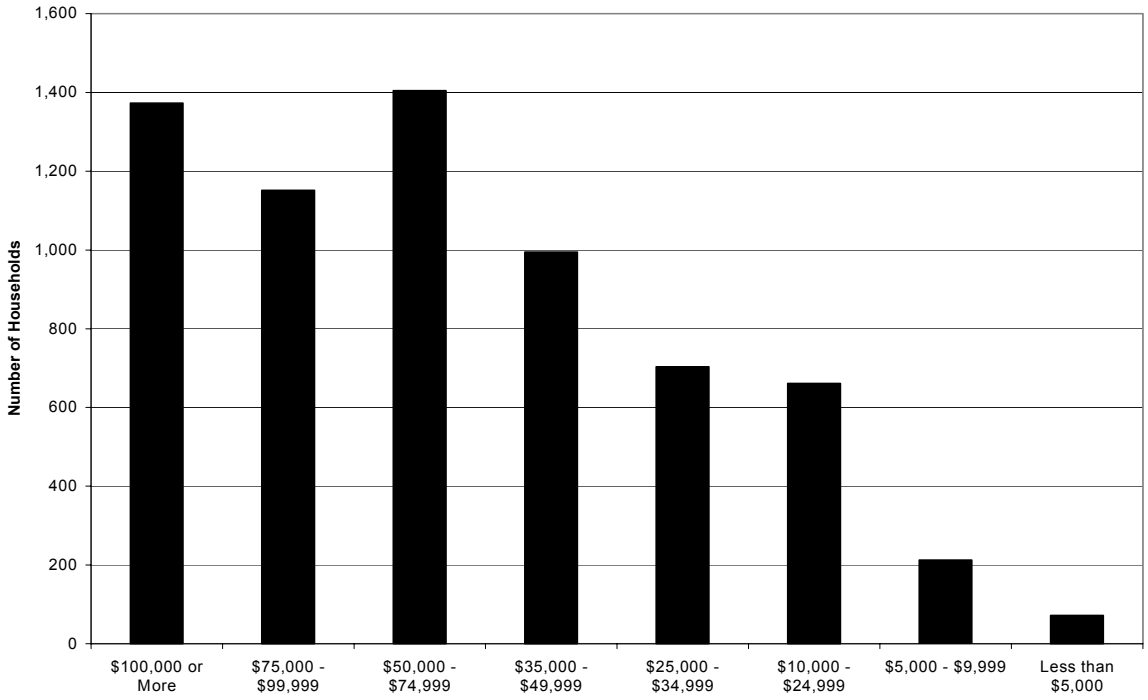
Acton's household income distribution, as reported by the 1990 U.S. Census, is presented in Table 2-2. The same information is presented graphically in Figure 2-2. According to the 1998 Master Plan Update, the median household income in Acton for 1990 was $61,394. According to the 2000 U.S. Census, the median household income in 1999 was $91,624.

TABLE 2-2: ACTON HOUSEHOLD INCOME DISTRIBUTION, 1990

Household Income	Number of Households	Percent of Total	Cumulative Percent
$100,000 or More	1,373	21%	21%
$75,000 - $99,999	1,152	18%	38%
$50,000 - $74,999	1,405	21%	60%
$35,000 - $49,999	995	15%	75%
$25,000 - $34,999	703	11%	86%
$10,000 - $24,999	661	10%	96%
$5,000 - $9,999	213	3%	99%
Less than $5,000	72	1%	100%
Total	**6,574**		

Data from 1998 Master Plan Update

FIGURE 2-2: ACTON HOUSEHOLD INCOME DISTRIBUTION, 1990



2.2.1.1.2 Age Distribution

Age distribution in Acton for 1990 and 2000 is presented in Table 2-3.

TABLE 2-3: ACTON AGE DISTRIBUTION

Age Range	1990		2000		
	Population	% of Population	Population	% of Population	
Under 5 years	1,240	6.9%	1,507	7.4%	7.4%
5 to 9 years	4,756	26.6%	1,784	8.8%	26.4%
10 to 14 years			1,831	9%	
15 to 19 years			1,155	5.7%	
20 to 24 years			593	2.9%	
25 to 34 years	6,583	36.8%	2,222	10.9%	31.4%
35 to 44 years			4,173	20.5%	
45 to 54 years	2,570	14.4%	3,581	17.6%	17.6%
55 to 59 years	868	4.9%	1,087	5.3%	5.3%
60 to 64 years	669	3.7%	697	3.4%	3.4%
65 to 74 years	682	3.8%	997	4.9%	4.9%
75 to 84 years	348	1.9%	515	2.5%	2.5%
85 years and over	156	0.9%	189	0.9%	0.9%
TOTAL POPULATION	**17,872**		**20,331**		
Median age (years)	--		37.9		

Data from 1990 and 2000 U.S. Census. 1990 age ranges differed from 2000

2.2.2 Land Use

Table 2-4 presents general land use in Acton, summarized by number of parcels with each land use designation. Table 2-5 presents land use by acreage.

TABLE 2-4: CURRENT LAND USE IN ACTON (BY PARCEL)

Status	Commercial Institutional	Industrial	Open Agricultural Recreational	Residential	Town/State Owned Land	No Land Use Data	Total # of Parcels	Percent of Parcels
Developed Parcels	265	43	1	5,258	54	100	**5,721**	85%
Undeveloped Parcels	57	50	46	542	273	11	**979**	15%
Total Number of Parcels	**322**	**93**	**47**	**5,800**	**327**	**111**	**6,700**	100%
Percent of Parcels	5%	1%	1%	87%	5%	2%		

Data Compiled from 2001 Acton Assessor's Database & BOH records.

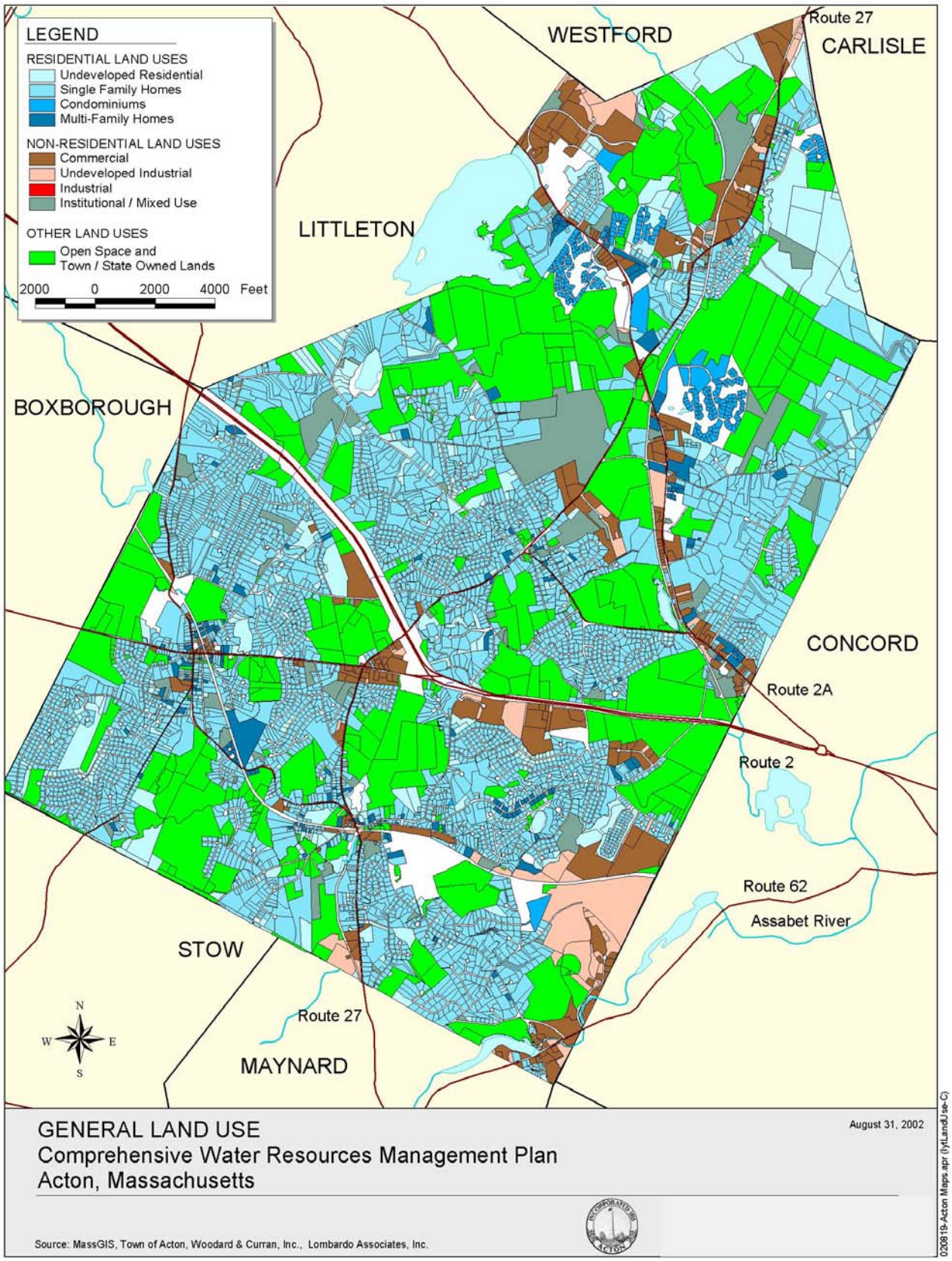
TABLE 2-5: CURRENT LAND USE IN ACTON (BY ACREAGE)

Status	Commercial Institutional	Industrial	Open Agricultural Recreational	Residential	Town/State Owned Land	No Land Use Data	Grand Total (Acres)	% of Town Land Area
Developed	607	251	20	5,732	665	292	**7,566**	64%
Undeveloped	106	242	578	1,008	2,316	62	**4,313**	36%
Total Land Acreage	**714**	**492**	**598**	**6,740**	**2,981**	**354**	**11,879**[1]	100%
Percent of Town Land	6%	4%	5%	57%	25%	3%		

[1]Total differs from other tables (11,879 acres vs. 12,358 acres) due to spatial distortions between the different Town GIS coverages.

Land use information based upon the 2001 assessor's database is presented in Figure 2-3, Acton General Land Use.

FIGURE 2-3: ACTON GENERAL LAND USE



2.2.3 Planning

The Town of Acton has developed a growth management strategy through master planning and related planning efforts such as the Open Space and Recreation Plan. The Town's 1991 Master Plan was followed by the 1994 West Acton Village Plan, and supplemented by the 1998 Master Plan Update and the recent addition of the 2004 East Acton Village Plan.

In summary, the Master Plan establishes goals and objectives for

- Land use;
- Housing;
- Economic development;
- Natural, cultural, and historic resources;
- Open space and recreation;
- Services and facilities; and
- Transportation and circulation

Central to the Master Plan is the concept of village centers. The Master Plan's Land Use Plan was designed to focus development into compact villages to restrict strip commercial development and preserve open space crucial to Acton's rural character. While village centers are important to economic development, the Master Plan promotes small scale mixed use to maintain the character of the village centers themselves. In addition to village centers the Master Plan recommends establishing business and industrial zoning districts to concentrate economic development within specific areas.

The Town's master planning follows the guidelines of Executive Order #385, which requires proactive and coordinated planning for sustainable economic development and resource protection. Furthermore, the Master Plan aligns with #385 by establishing areas for denser development to maintain open space and preserve natural resources. According to the Master Plan, "The 1998 Master Plan Update reflects a shift to a proactive stance regarding business development so as to take advantage of benefits that can be gained from business activity, while still protecting natural resources and mitigating adverse impacts." The CWRMP/EIR follows #385 by determining areas of wastewater disposal need and identifying solutions.

2.2.4 Zoning

The location and extent of the Town's general zoning districts are described below. More detailed zoning district information is available from the Town's zoning map and zoning ordinance. Acton general zoning districts are presented in Figure 2-4.

Residential

As indicated in Table 2-6, the majority of the Town is zoned for residential use. Residential districts are located throughout Acton, with higher density districts (10,000 – 40,000 square foot minimum lot size) generally located in the southern half of the Town and lower density districts (40,000 – 100,000 square foot minimum lot size) generally located in the northern half of Town. Most condominium clusters are located in the northern half of Town. A corridor of higher density residential zoning extends along Route 27 into North Acton.

Commercial

Commercial districts comprise approximately 4% of the Town's total area, and are generally located along the major transportation corridors, such as Route 2 and Route 119.

Industrial / Technology

Industrial and technology districts comprise approximately 5% of the Town's total land area, and are generally located along major transportation corridors. A significant portion of southeastern Acton is also zoned for industrial / technology uses.

TABLE 2-6: ACTON GENERAL ZONING DISTRICTS

General Zoning Districts[1]	Minimum Lot Size	Approximate Acreage	Percent of Total
Residential – R-AA	10,000 SF	13	0.1%
Residential – R2. VR	15 – 20,000 SF	4,532	36%
Residential – R4	40,000 SF	644	5.2%
Residential – R8, R8/4	80,000 SF	1,737	14%
Residential – R10, R10/8, RA	100,000 SF	1,996	16%
Commercial	--	550	4.4%
Industrial	--	675	5.4%
Village	--	121	1.0%
Open	--	2,228	18%
TOTAL	--	12,497	

[1]Multiple specific zoning districts have been aggregated in this table. Refer to the Zoning Bylaws and official Town Zoning Map for full information.

Village Districts

Acton contains 4 village districts. Each is located at a traditional downtown / crossroads area:

- North Acton (Center) Village District
- West Acton Village District
- East Acton Village District
- South Acton Village District

These districts are shown on Figure 2-4. The north (center), south and west village districts have been designated historical preservation districts.

Open Space

Approximately 18% of the Town's land area is zoned as open space. This includes agricultural, recreational and conservation areas (ARC), as well as the Planned Conservation Residential Community (PCRC) district. Open Space districts are distributed throughout the Town, generally away from established transportation corridors. Open space districts are shown on Figure 2-4. Acton's undevelopable and Government Owned Lands are presented in Figure 2-5.

Overlay Districts

The Town has 4 overlay districts:

1. Affordable Housing Overlay District
2. Floodplain Overlay District
3. Open Space Development Overlay District
4. Groundwater Protection Overlay District – this district includes four different levels of Groundwater protection described in greater detail below and shown in Figure 2-11:

   – Zone I – Wellhead protection Area
   – Zone II – Well Recharge Area
   – Zone III – Aquifer Recharge Area
   – Zone IV – Watershed Protection Area (Entire Town not in Zones I, II or III)

Schematic descriptions of the Groundwater Protection Districts, as presented in the Town's Zoning Bylaw, are:

> Zone I – The area from which groundwater will travel to a pumping municipal well within a one year time period, based on an average recharge conditions and anticipated pumping.
>
> Zone II – The are within which groundwater will move toward a pumping municipal well at the end of a 180 day period of no surficial recharge and full design capacity of the well.
>
> Zone III – The area of the Town underlain with the geologic formation of stratified drift, based on Soil Conservation Services (SCS) soil map.
>
> Zone IV – Consists of the entire Town including Zones I-III and separates the Town into watershed areas along the existing groundwater divides.

FIGURE 2-4: ACTON ZONING DISTRICTS

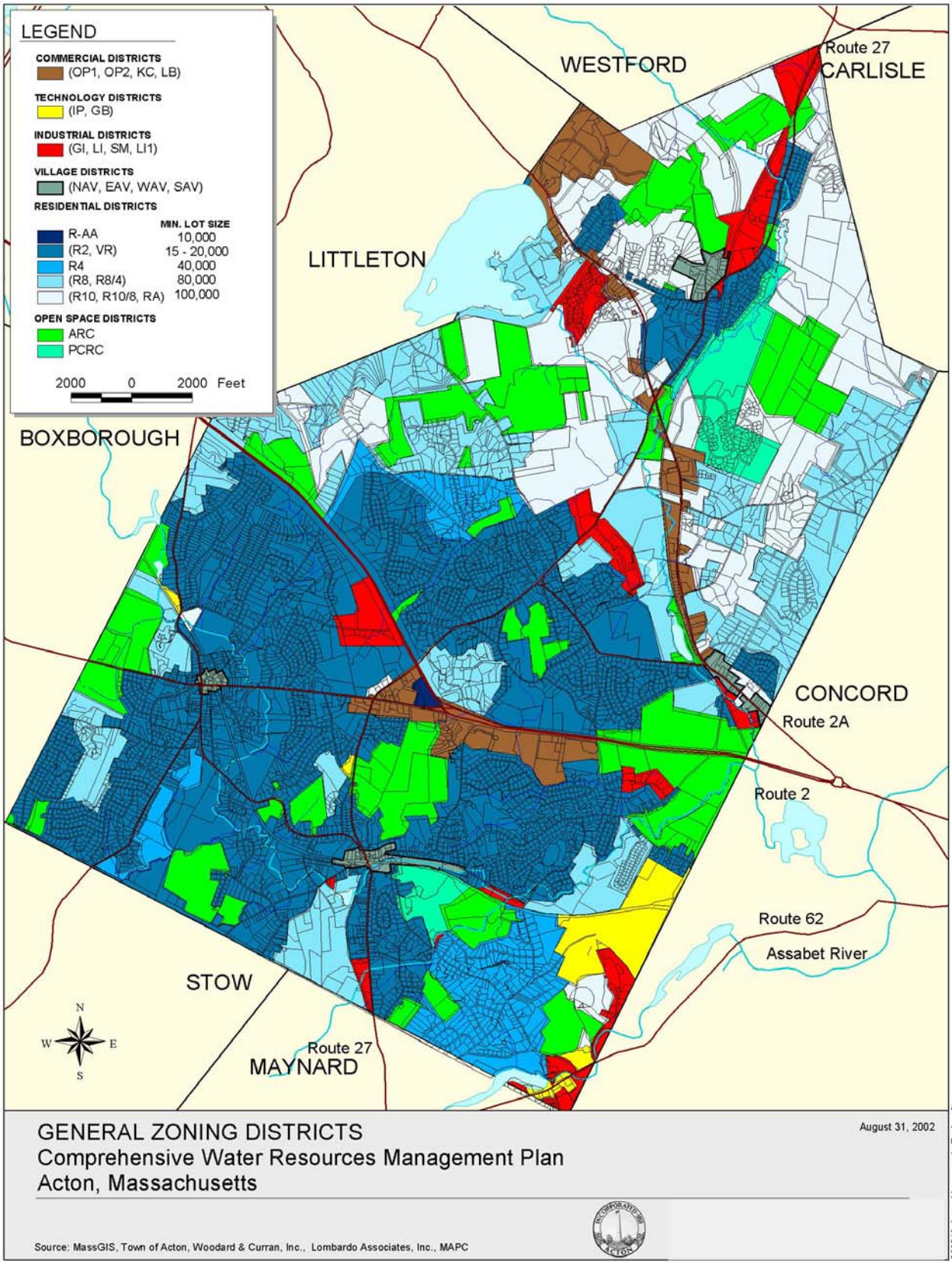
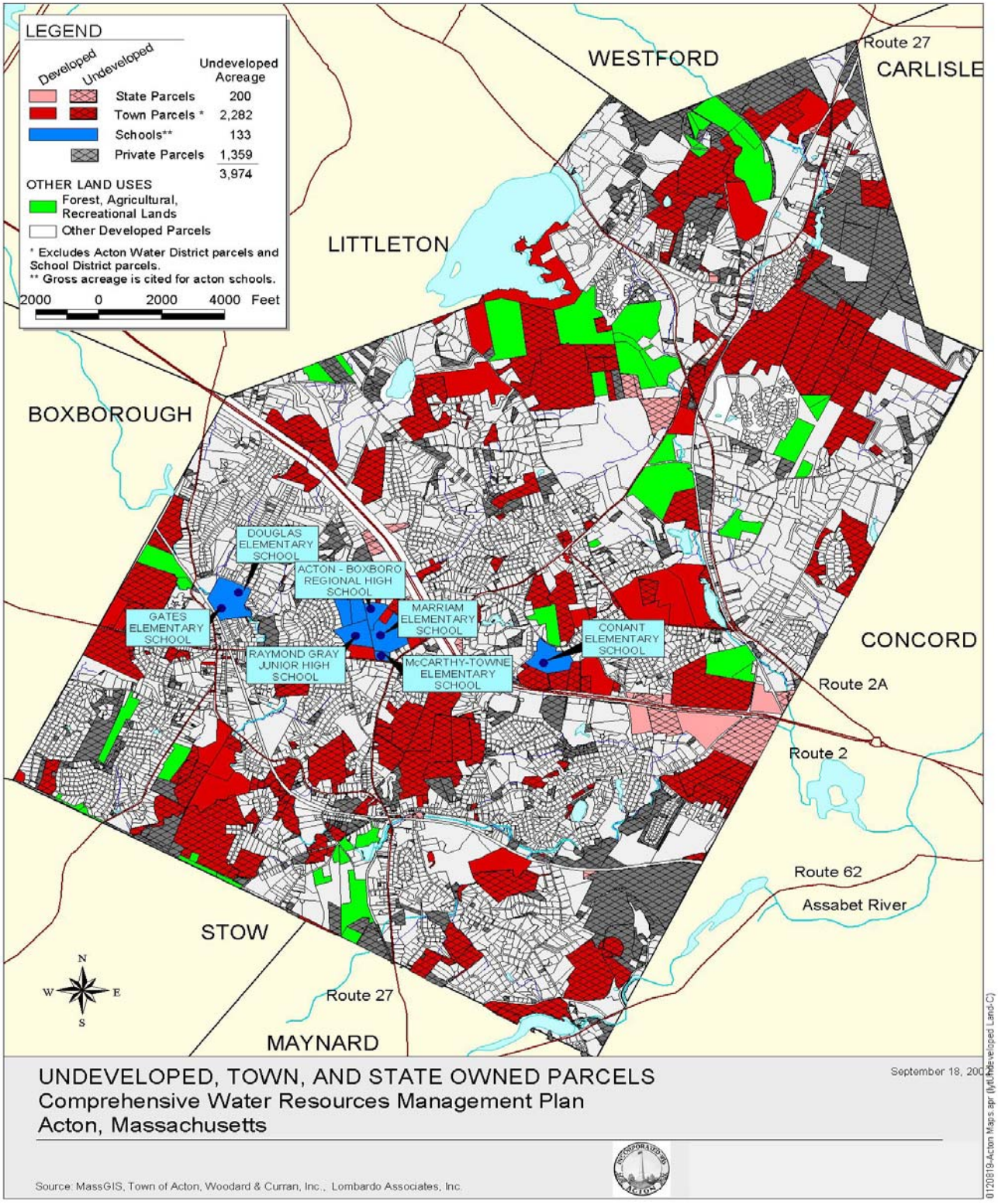


FIGURE 2-5: ACTON UNDEVELOPED & GOVERNMENT-OWNED LANDS



2.2.5 Housing and Development

Housing Stock

According to the 1998 Master Plan Update, the growth of Acton's housing stock has consistently outstripped population growth since approximately 1960. This has resulted in a decreasing household size, a phenomenon experienced nationwide during this period. Table 2-7 presents population, housing stock, and household size over this time period.

TABLE 2-7: HOUSING STOCK IN ACTON, 1960 – 2000

Year	Population	% Change from Prior Period	Annualized Percent Change	Dwelling Units	% Change from Prior Period	Average # Persons per Dwelling Unit (Household Size)
1960	7,238	106%	7.5%	--	--	--
1970	14,770	104%	7.4%	4,195	--	3.5
1980	17,544	19%	1.7%	6,309	50%	2.8
1990	17,872	2%	0.2%	6,891	9%	2.6
2000	20,331	14%	1.3%	7,680	11%	2.6

1960 – 1990 data from 1998 Master Plan Update; 2000 data from U.S. Census.

The number of dwelling units in Acton increased by 50.4% during the 1970's. The updated Master Plan states that this was the period during which many of the apartments and condominiums in Acton were constructed. The current composition of Acton's housing stock is presented in Table 2-8.

TABLE 2-8: ACTON HOUSING STOCK COMPOSITION, 2000

Housing Classification	Number of Units, 1990	Estimated Number of Parcels, 1990[2]	Number of Units, 2000[4]	Estimated Number of Parcels, 2000[2,4]
1-unit detached	4,263	4,263	--	--
1-unit attached[1]	412	21	--	--
2 to 4 units[2]	415	138	--	--
5 to 9 units[2]	350	50	--	--
10 or more units[2]	1,399	56	--	--
Mobile home, trailer, or other[1]	52	3	--	--
TOTAL	**6,891**	**4,530**	**7,680**	**5,048[3]**

1990, 2000 U.S. Census

[1]Likely includes multiple condo/mobile home units built on single parcels – Assumes 20 condos/mobile homes per parcel.
[2]Estimate uses 3, 7 and 25 units per parcel respectively.
[3]Uses same ratio as 1990 data.
[4]Housing classification breakdown not available at time of study.

2.2.6 Buildout Analysis

A buildout analysis was performed as part of the 1998 Master Plan Update. Also, buildout analyses for the Town of Acton have recently been performed by:

- Metropolitan Area Planning Commission (MAPC) buildout analysis in 2000.
- EOEA buildout analysis.

2.2.6.1 Methodology

The buildout analysis included in the 1998 Master Plan Update was performed assuming that all parcels will be developed to the maximum extent allowed under existing zoning bylaws.

- Parcels in residential areas were developed to the maximum extent possible based on minimum lot sizes for each residential zoning district.
- Parcels in non-residential districts were developed to the maximum amount of floor area allowed, as defined for each zoning district.

2.2.6.2 Residential Buildout Estimate

Acton's estimated maximum residential buildout is approximately 10,600 dwelling units (defined as the residence of one family) a net increase of about 3,400 units over the current (1998) housing stock of ~7,200 units. This includes the loss of 202 residential dwelling units currently located in non-residential zoning districts.

68% of this net increase is attributed to further development of existing developed single-family parcels, achieved through further subdivision of these parcels. Table 2-9 presents the maximum residential buildout analysis results in equivalent dwelling units (EDUs).

TABLE 2-9: 1998 RESIDENTIAL BUILDOUT ANALYSIS FOR ACTON

	Developed Residential Lot – *No Additional EDUs*[1]	**Developed Residential Lot – *Additional EDUs Possible***	**Undeveloped Residential Lots – *Additional EDUs Possible***	**Total EDUs**
Existing EDUs	6,261	939		**7,200**
Additional EDUs		2,300	1,100	**3,400**
Total EDUs	6,261	3,239	1,100	**10,600**

[1]Data from 1998 Update to Master Plan

2.2.6.3 Non-Residential Buildout Estimate

The non-residential buildout analysis performed for the 1998 Master Plan Update is based upon square footage of floor area that can be developed on a parcel, comparing the results of two computations:

- Developable site area multiplied by the maximum floor area ratio for the zoning district.
- Minimum open space requirement, maximum building height, and required off-street parking ratio.

Table 2-10 summarizes the findings of the 1998 non-residential buildout analysis. The non-residential buildout is estimated at 8.38 million square feet (MSF) of floor area, an increase of 3.68 MSF (78%) above the current 4.70 MSF. More than half of this potential increase is located within four zoning districts:

- Kelley's Corner District (KC) (0.56 MSF)
- Office Park 1 (OP1) (0.54 MSF)
- General Industrial District (GI) (0.45 MSF)
- Limited Business District (LB) (0.44 MSF)

Greenfield development (development occurring on undeveloped properties) accounts for only about 40% of the non-residential buildout. The remaining 60% is comprised of expansion on existing non-residential parcels and conversion of existing residential parcels to non-residential uses.

TABLE 2-10: 1998 NON-RESIDENTIAL BUILDOUT ANALYSIS FOR ACTON

Buildout Potential	Million Square Feet of Floor Space
Existing Floor Space	**4.70**
Development of Undeveloped Parcels (Greenfields)	*1.45*
Conversion of Existing Residential to Non-Residential Parcels	*0.56*
Expansion on Existing Developed Non-Residential Parcels	*1.67*
Estimated Potential Additional Floor Space	**3.68**
Total Estimated Floor space at Buildout	**8.38**

1998 Master Plan Update

2.2.7 Open Space

Approximately 17% of the Town's total land area is zoned Open Space (either ARC or PCRC Zoning Districts). These areas are shown on Figure 2-4.

2.2.8 Historic and Archeological Resources

Acton has a rich historical heritage. Acton's historic buildings and sites are tangible links with the town's past, which provide a sense of identity and shape the Town's character.

Acton has a Historical Commission. This commission seeks to protect and develop archeological and historical assets of the Town. It studies places of historical and archeological value, and then nominates buildings and areas for the National Register. The commission also implements the Demolition By-laws in regard to areas, that may be of historical value. It furthers its objectives through hearings, acceptance of gifts, contributions, and bequests. The Commission conducts surveys of historical sites. Historical research is done via written and oral interviews in order to help the Town retain and appreciate its historical heritage.

In 1991, an Historic District Study Committee, with the assistance of a historical consultant and the Acton Planning Department, inventoried the Town's historic buildings and assessed the feasibility of creating local historic districts in three of Acton's four village centers:

- South Acton Village District
- West Acton Village District

- North Acton (Acton Center) Village District

Subsequently the Town implemented the Plan's proposal to establish local historic districts in South Acton, West Acton, and North Acton (Acton Center) *(1998 Update to Acton Master Plan)*. The Districts are shown in Figure 2-4, Acton Zoning Districts.

Between August and October 1999 Public Archeological Laboratory (PAL) conducted a phased site investigation followed by an archeological data recovery program at the Pine Hawk Site in Acton. The site was located on an elevated terrace overlooking the Assabet River within the proposed location of a wastewater treatment plant for the Middle Fort Pond Brook Sewer project. The Pine Hawk Site was first identified during an intensive (locational) archeological survey of the Middle Fort Pond Brook Sewer project completed in December 1998. Subsurface sampling of the Pine Hawk Site in this survey indicated that it contained archeological deposits associated with Native American activity from about 7,500 to 4,000 years ago in the Middle to Late Archaic periods.

The site examination established that the Pine Hawk Site covered an area of 3,300 m^2 and contained three primary concentrations (Areas I, II, and III) of cultural material and features. Archeological materials recovered from the site included four projectile points diagnostic of the Middle and Late Archaic periods, chipping debris of various lithic materials (rhyolite, quartzite, quartz, mylonite) and a ceramic shard likely to be of Middle Woodland Period age. Two hearth features were radiocarbon dated to 3910±80 years before present (B.P.) and 4440±100 years B.P., respectively. The classes of archeological data recovered from the Pine Hawk Site were used to assess the research contexts, interpret the site and compare it to others at the local (Sudbury/Assabet/Concord drainage), subregional (south Merrimack basin) and regional (southeastern New England) scales.

Several locations in Acton are listed on the National Register:

- Exchange Hall, Quimby Square on School Street
- Faulkner Homestead, High Street
- Hosmer House, 300 Main Street
- Jones Tavern, 128 Main Street

Also, the Isaac Davis Trail runs east to west between the towns of Acton and Concord.

2.2.9 Human Sensitive Receptors

Human Sensitive Receptors include schools, senior centers and services facilities, children's centers such as daycare facilities, and recreational areas that are frequented by at-risk populations.

Table 2-11 lists the human sensitive receptors within Acton's town boundaries. The locations have been added to the geo-database for inclusion into the analysis of wastewater needs areas and assessment of potential satellite wastewater treatment facility locations. This data will be used in conjunction with environmentally sensitive areas and other decision criteria. Environmentally sensitive areas are described in Section 2.3.4.

TABLE 2-11, HUMAN SENSITIVE RECEPTORS

Schools	**Addresses**
Acton –Boxborough High School	96 Hayward Rd
Acton Community Education	409 Mass. Ave. #A1 15 Charter Rd
Douglas Elementary School	21 Elm Street
Gates Elementary School	75 Spruce Street
Luther Conant School	80 Taylor Street
McCarthy-Towne Elementary	1 Charter Road
Merriam Elementary School	11 Charter Road
Montessori Country Day School	164 Newton Road
R J Grey Junior High School	16 Charter Road
Senior Services	**Addresses**
Inn At Robbins Brook	10 Devon Drive
Senior Center	50 Audubon Drive
Children Centers	**Addresses**
Acton Barn Co-Operative Inc.	32 Nagog Park
Acton Children's School	394 Massachusetts Avenue
Acton Cooperative School	592 Massachusetts Avenue
Blossom Station Child Care Ctr.	222 Main Street
Building Blocks Child Care Inc.	32 Nagog Park #A
Child Care Search	37 Knox Trail
Children's World Learning Ctr.	90 Hayward Road
Infant Toddler Children Ctr.	149 Central Street
Kindersport	30 Great Road
Mt Calvary Christian School	472 Massachusetts Avenue
Mulberry Childcare & Preschool	5 Post Office Square
Nanny's House, Inc.	4 Oakwood Road
Nashoba Valley Children's Ctr.	481 Main Street
Recreation Areas – Other Services	**Addresses**
NARA Park Beach	Ledge Rock Way
Discovery Museum	177 Main Street
Acton Memorial Library	486 Main Street
West Acton Citizen's Library	21 Windsor Avenue

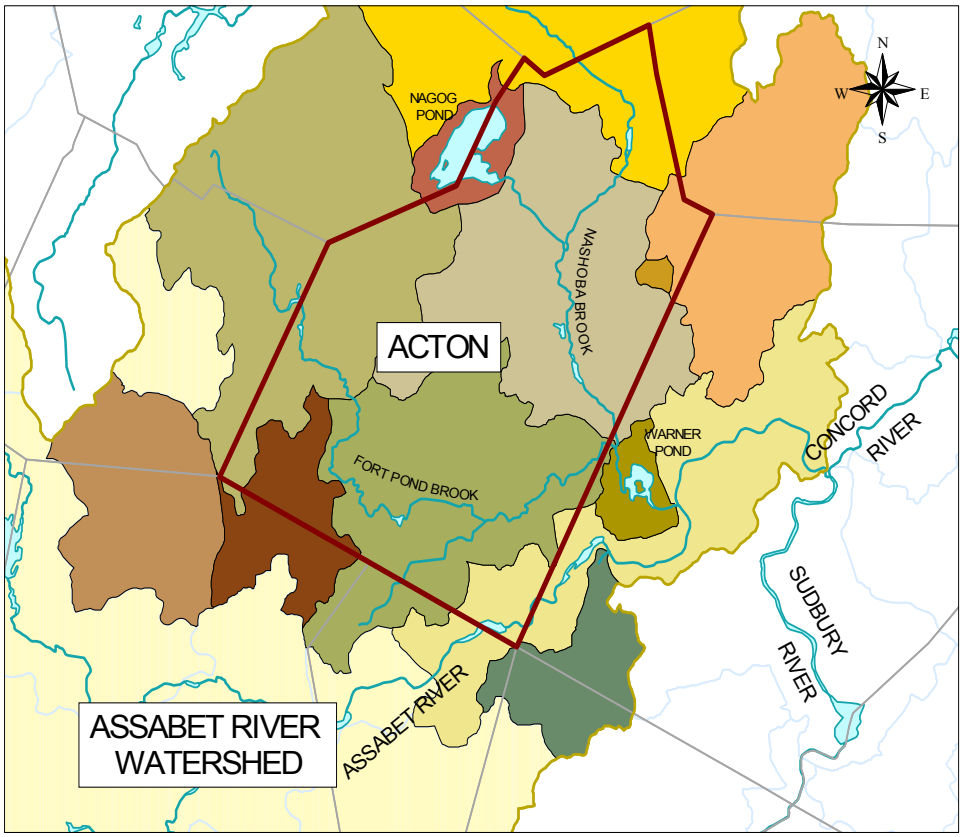
2.3 THE NATURAL ENVIRONMENT

2.3.1 Watershed Characteristics

Acton is located in the Merrimac basin and the Concord River watershed. The entire Town drains into the Assabet River, a tributary to the Concord River. As indicated in Figure 2-6, the majority of the Town lies within the Fort Pond Brook and Nashoba Brook drainages, with minor northeast and southeast portions of the Town located in the Spencer Brook and Assabet main stem drainages, respectively. Generally, surface water flows across the Town in a northwest to southeast direction.

The Assabet River Watershed, in which Acton is wholly located, drains approximately 173 square miles.

FIGURE 2-6: SUB WATERSHEDS IN ACTON



The remaining figures referred to in this section are grouped at the end of the section for easy comparison.

2.3.2 Soils

The National Resource Conservation Service (NCRS) published an Interim Soil Survey for Middlesex County in 1995. The soil survey describes soil types found in the Town and identifies their general locations. The majority of Acton has one of five soil types, listed and described in Table 2-12. The remainding areas of the Town are located within one of about 30 other soils classified by the NRCS.

TABLE 2-12: MAJOR SOIL TYPES IN ACTON

Percent of Town	Soil Name	Description
13%	Woodbridge Series	Consists of nearly level to steep, deep (5+ ft.), moderately well drained soils on drumlins. They formed on compact glacial till.
9%	Charlton-Hollis Rock Complex	Consists of undulating and rolling shallow soils, areas of exposed bedrock and very deep soils on hills and ridges where relief is highly affected by underlying bedrock. The components of this complex occur in such intricate patterns it is not practical to separate them.
9%	Hinckley Series	Consists of nearly level to very steep, deep (5+ ft.) excessively drained soils on glacial outwash plain, terraces, kames, and eskers. They formed in gravelly and cobbly coarse textured glacial outwash.
9%	Paxton Series	Consists of gently sloping to very steep, deep (5+ ft.), well-drained soils on drumlins. They formed in compact glacial till.
9%	Freetown Series	Consists of nearly level, deep (5+ ft.), very poorly drained organic soils in depressions and on flat areas of uplands and glacial outwash plains. They formed in 51 inches to many feet of black, highly decomposed organic material (muck) over sandy or loamy mineral material.
~51%	All Others	Varies

1995 NRCS Interim Soil Survey Middlesex County

2.3.3 Topography and Hydrology

2.3.3.1 Topography

The topography of Acton is characterized by gently rolling hills and some small peaks. Generally, the elevation ranges from a low of 39 meters (128 feet) along the Assabet River in the Town's extreme southeast corner to a high of about 115 meters (377 feet) atop a hill immediately south of Nagog Pond in the northwestern part of Town. Elevation generally increases from southeast to northwest across the Town. Figure 2-7 presents the USGS topography for the Town.

2.3.3.2 Surficial Geology

According to MassGIS and USGS data, Acton's surficial geology is predominantly sand/gravel and till/bedrock deposits. Generally, the sand/gravel deposits are located concurrently with the town's major aquifers, and run in two north-south lines, one each on the east and west sides of the Town. A large strip of till/bedrock separates the two sand/gravel areas, generally following Route 27 through the center of Town. Smaller pockets of till/bedrock are present throughout the Town. Table 2-13 indicates the

approximate relative abundance of these surficial geology types in the Town. Surficial geology is also shown on Figure 2-9.

TABLE 2-13: ACTON SURFICIAL GEOLOGY

Surficial Geology	Approximate Acreage	Approximate Percent of Total Land Area
Sand and Gravel Deposits	5,330	41%
Till or Bedrock	7,635	59%
Total Area	**12,966**	

Compiled from MassGIS Data

Sand and gravel deposits will generally have good percolation rates, which is favorable for septic systems. However, excessively rapid percolation rates (< 2 minutes per inch (mpi)) may not provide proper septic system treatment. Techniques exist to improve the septic system treatment levels of soils with fast percolation rates. Areas of till, bedrock, and floodplain alluviums may have slower percolation rates or high groundwater, both of which can pose challenges for septic system design.

The surficial geology information presented in Table 2-13 and on Figure 2-8 is very generalized and is useful only for very general planning purposes. Much more detailed and reliable lot-specific information is contained in the Board of Health records. This data could provide a very detailed lot-by-lot analysis of the Town's wastewater needs. Correlating the surficial geology data with NRCS soil survey data and Board of Health records is discussed in Section 5.

2.3.3.3 Hydrology

The entire Town of Acton lies within the drainage basin of the Assabet River. Thus all of the precipitation that falls on the town and does not evaporate travels down gradient through the aquifers or as runoff in streams to the Assabet River.

There are two principal streams that form the main drainage system for surface runoff from the Town: Nashoba Brook and Fort Pond (See Figure 2-6). Both of these streams cross the Town generally from northwest to southeast. Both streams begin in drainage basins, with headwaters outside the Town to the north and west. Neither stream meets its ultimate base discharge level (the Assabet River) within the town. The USGS topography map for Acton is included as Figure 2-7.

Nashoba Brook enters the north end of Town from Westford at about elevation 177 feet above mean sea level (msl). Within the first ¾ miles into Acton, the Nashoba is joined by a significant tributary, Butter Brook, which comes into Acton at about elevation 187 ft mean sea level (msl). Nashoba Brook then travels south for about 3 miles to East Acton where it swings slightly to the east and crosses the Concord town line. Within ½ mile the brook enters Warner Pond in Concord and then reaches the Assabet River. Nashoba Brook exits Acton into Concord at about elevation 127 ft msl. Thus the brook drops about 50 feet as it passes through Town.

Fort Pond Brook rises from Fort Pond just across the Acton Town line in Littleton. The Brook enters the west side of Acton from Boxborough at about elevation 206 ft mls. Within one mile it is joined by Guggins Brook from the west in Boxborough and Grassy Brook, which comes in from Grassy Pond within Acton to the north. Fort Pond Brook then flows southeastward through West Acton and on another two miles to South Acton. At South Acton, Fort Pond Brook turns eastward, cutting through the high

ground of Great Hill and Faulkner Hill. Fort Pond Brook continues eastward to East Acton where it exits the town and joins Nashoba Brook and continues to Warner Pond and on to the Assabet River. Fort Pond Brook is at about elevation 127 ft msl when it leaves Acton, thus the Brook drops about 80 feet as it passes through town.

The two largest surface water features in Acton are Nagog Pond in the northwest of Town and a small portion of the Assabet River at the very southern corner of Town. These are further defined in following sections of this report.

2.3.3.4 Hydrogeologic Setting

The surficial geology of Acton is the most important segment of geologic materials in the town for this project. Bedrock underlying the entire Town has not had a principal role in the water supply resources of the Town to date and is not likely to play any role in wastewater solutions developed in the CWRMP.

The surficial geologic materials are the result of the glacial geology history of the town. There are two principal types of glacial deposits in the Town, one is the sand and gravel that makes up the aquifers and the other is the glacial till (till). The relative distribution of these materials can be seen on Figure 2-8. The surficial geology relates well with the groundwater hydrology, as shown in Figure 2-9.

Sand and gravel aquifers - During the melting retreat of glaciers from the last age (some 12,000 years ago), the melting of the ice released great quantities of water from the retreating ice front. This melt water flowed into lower portions of the newly exposed topography in front of the ice sheet and the filled depressions forming ponds, which filled, overflowed and coalesced into stream channels. The melt water carried sands and gravels that were deposited in the channels where it flowed and created the water lain sand and gravels deposits, which we exploit as aquifers today. In general these stream channels, which are filled with sand and gravel, remain today as the principal drainage ways described earlier.

Till – In general till is deposited physically and directly by the glacial ice sheet. The glacial ice carries mineral soils and rock of all particle sizes from clays to boulders. Much of this heterogeneous mix of material is laid down beneath the ice sheet and then is consolidated into a dense mass by the weight of the ice. Because of mix of grain sizes and the density of till, it has little porosity or permeability. It is generally poor material for yielding or absorbing water. Thus it is not considered good aquifer material on a municipal scale, nor is it suitable for infiltration of large quantities of wastewater.

In most locations till is the base material under sand and gravel deposits, forming the lower boundary of aquifers. It is also often formed into ridges parallel to the direction of ice movement and is plastered onto bedrock highs creating high ground that form the flanks and limits of the stream valley aquifers. This is generally the case in Acton, as seen by the ridge of hills including Washington Drive, Great Hill and Faulkner Hill.

The distribution of sand and gravel aquifer materials is shown on Figure 2-8 as noted above. The sand and gravel deposits are distributed along the two major drainage ways in town: Nashoba Brook and Fort Pond Brook. In the grander sense, these two aquifers follow the paleo drainage systems that crossed Acton. In the present day, Fort Pond Brook abandons its former route of traveling from north to south across the western portion of Acton when it abruptly swings eastward near South Acton. The brook cuts through the till highlands and breaks into the drainage basin of Nashoba Brook and joins Nashoba Brook near East Acton just above Warner Pond in Concord at the Town line.

Despite the physical realities of where each brook flows, drainage basins have been “officially” defined for use in this project by following the basin delineation recognized by Massachusetts GIS. A number of

these basin designations are taken from the sub-basin delineation used by the USGS and many of those USGS basin outlets are determined by where the USGS stream gauging stations are located. The result is the basin delineation shown on Figure 2-6 and further defined in Figure 4-1.

Proposed project activities, either groundwater withdrawal for water supply or stormwater and wastewater discharge to groundwater, must be considered for implications down gradient throughout each of the major basins and aquifers. However, the impact of well withdrawals within the various aquifers can cause local areas where groundwater flow will reverse and flow "up stream" diverging from the general down basin gradient flow in the aquifers. This must be considered when calculating potential pollutant/contaminant travel time when siting disposal or withdrawal facilities. Furthermore, "black-out" zones around existing Zone II's are determined through this process. The process includes generating groundwater contours, within the sand and gravel deposits, which are considered suitable for wastewater effluent disposal. Final selection of sites for wastewater treatment and effluent disposal will include evaluation of transit times using data from the groundwater contour analysis.

Acton relies upon its local groundwater resources for 100% of its water supply. The Town has a municipal public water supply system, which is discussed in detail in Chapter 3. There are also several privately owned water supply wells that are classified by DEP as public water supplies. Acton has delineated Zone I Wellhead Protection Areas, Zone II Wellhead Recharge Areas, and Zone III Aquifer Recharge Areas. Zones I, II, and III are indicated in Figure 2-10.

Within the various basins there are located specific aquifers that have been routinely referred to by the name of the Town wells located in them. Most of the hydrogeological information is available is based on exploration and testing of the various aquifers in the areas around the town wells.

2.3.4 Environmentally Sensitive Areas

Acton's environmentally sensitive areas include surface waters, wetlands and wetland buffers, 100-year FEMA flood plans, certified and potential vernal pools, and estimated rare wildlife habitats. These areas are dispersed throughout the community and are shown in Figure 2-10.

FIGURE 2-7: ACTON USGS TOPOGRAPHY

FIGURE 2-8: ACTON SURFICIAL GEOLOGY

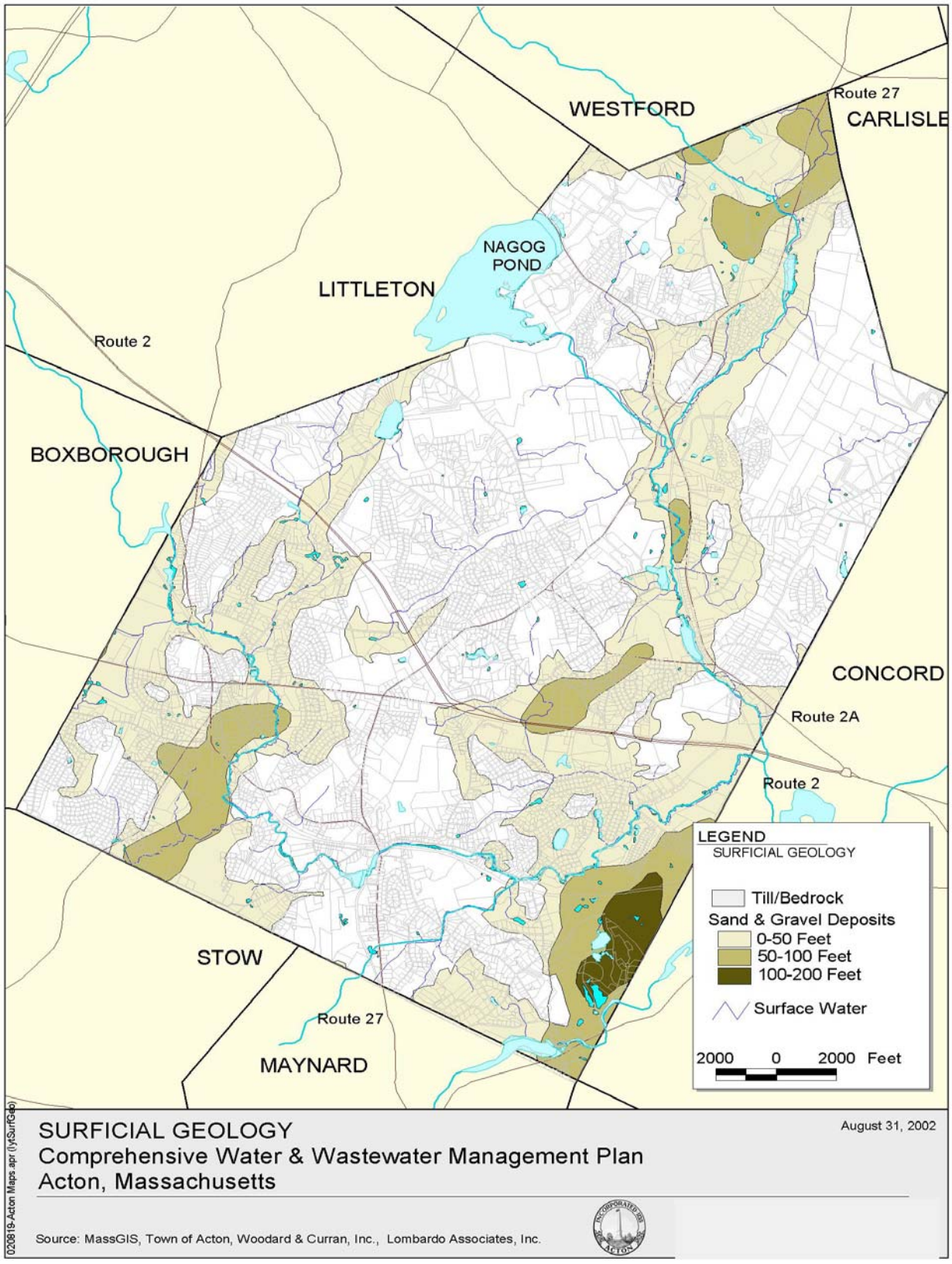


FIGURE 2-9: ACTON USGS GROUNDWATER HYDROLOGY

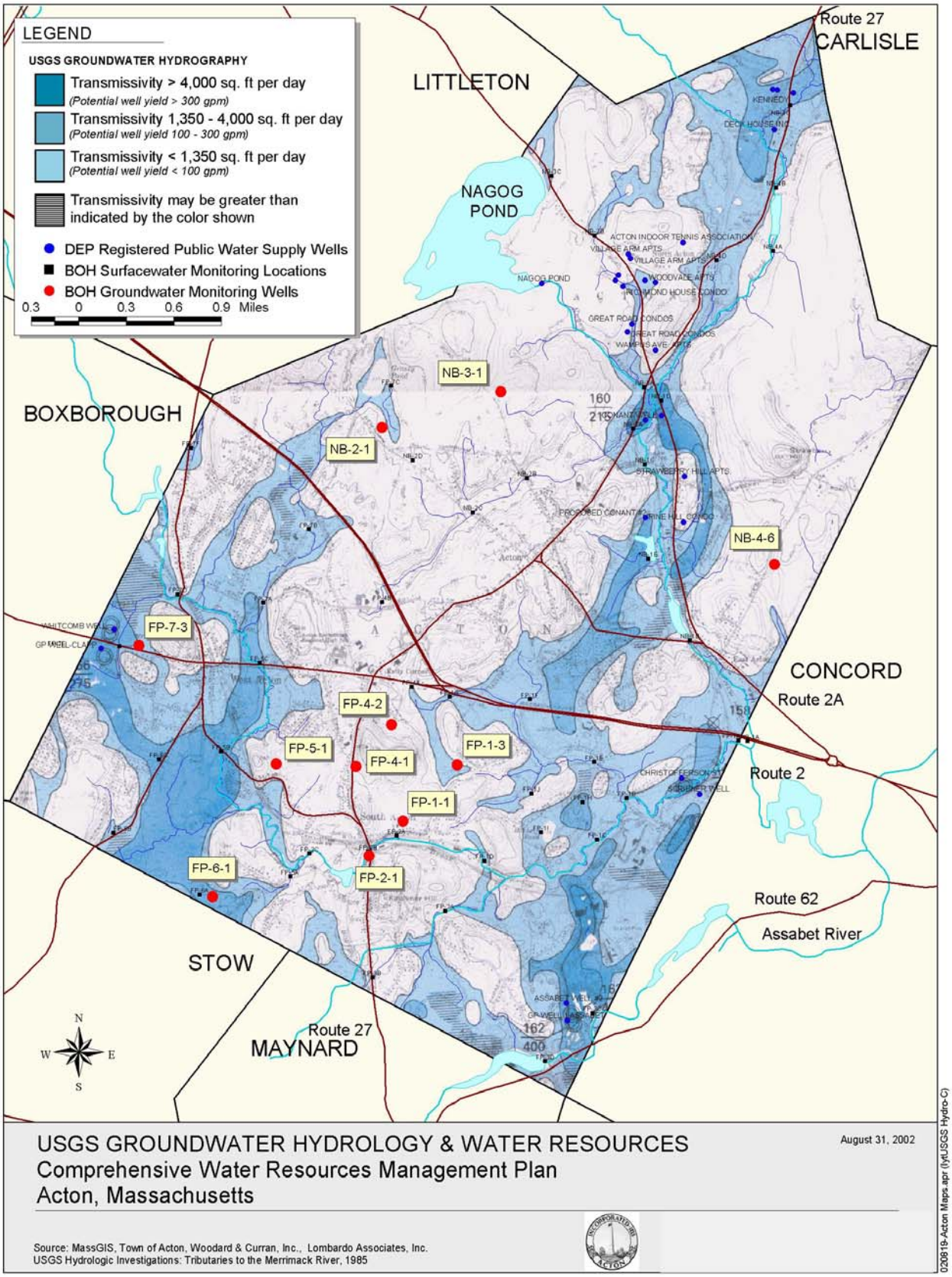


FIGURE 2-10: ACTON ENVIRONMENTALLY SENSITIVE AREAS

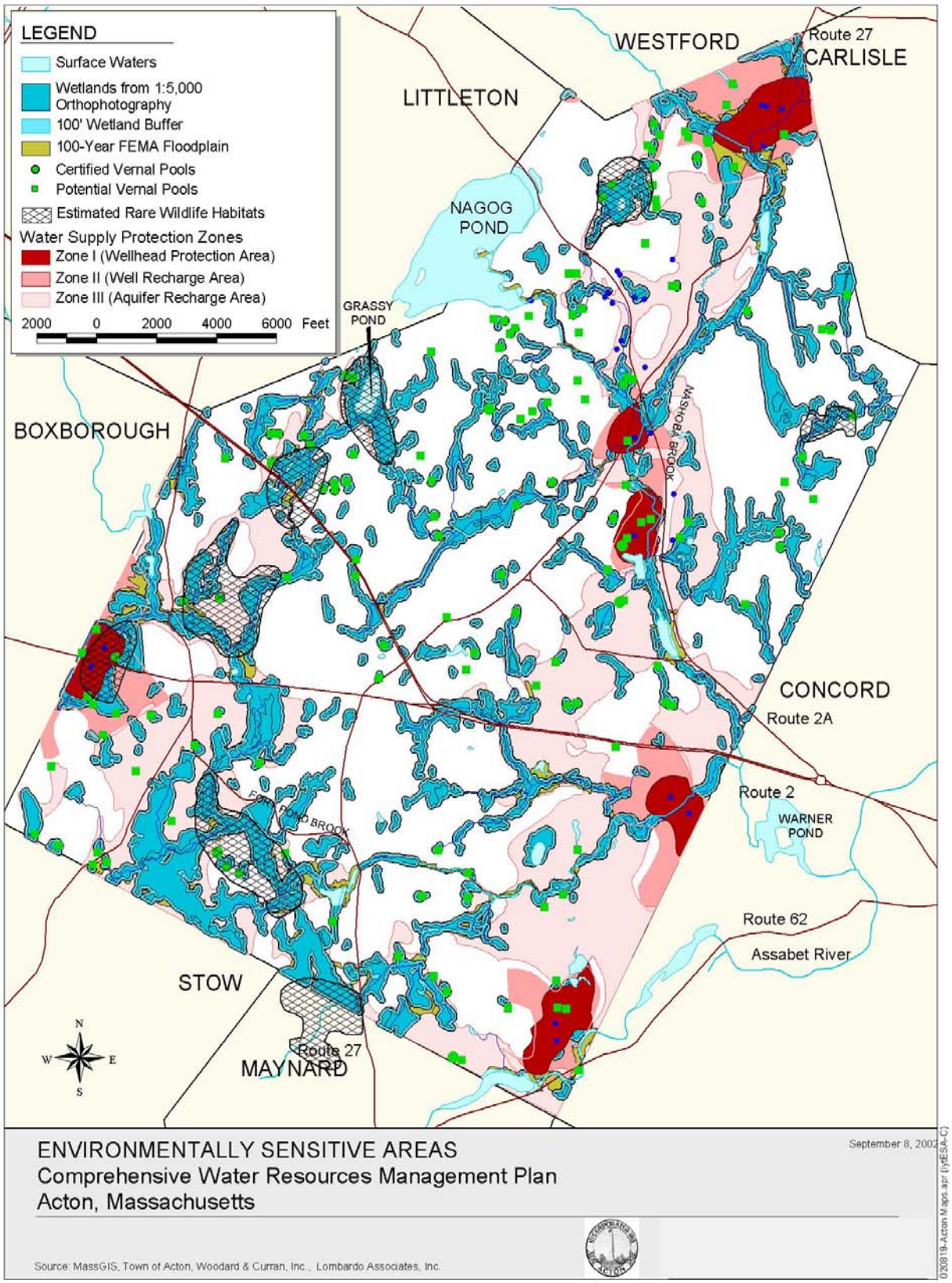
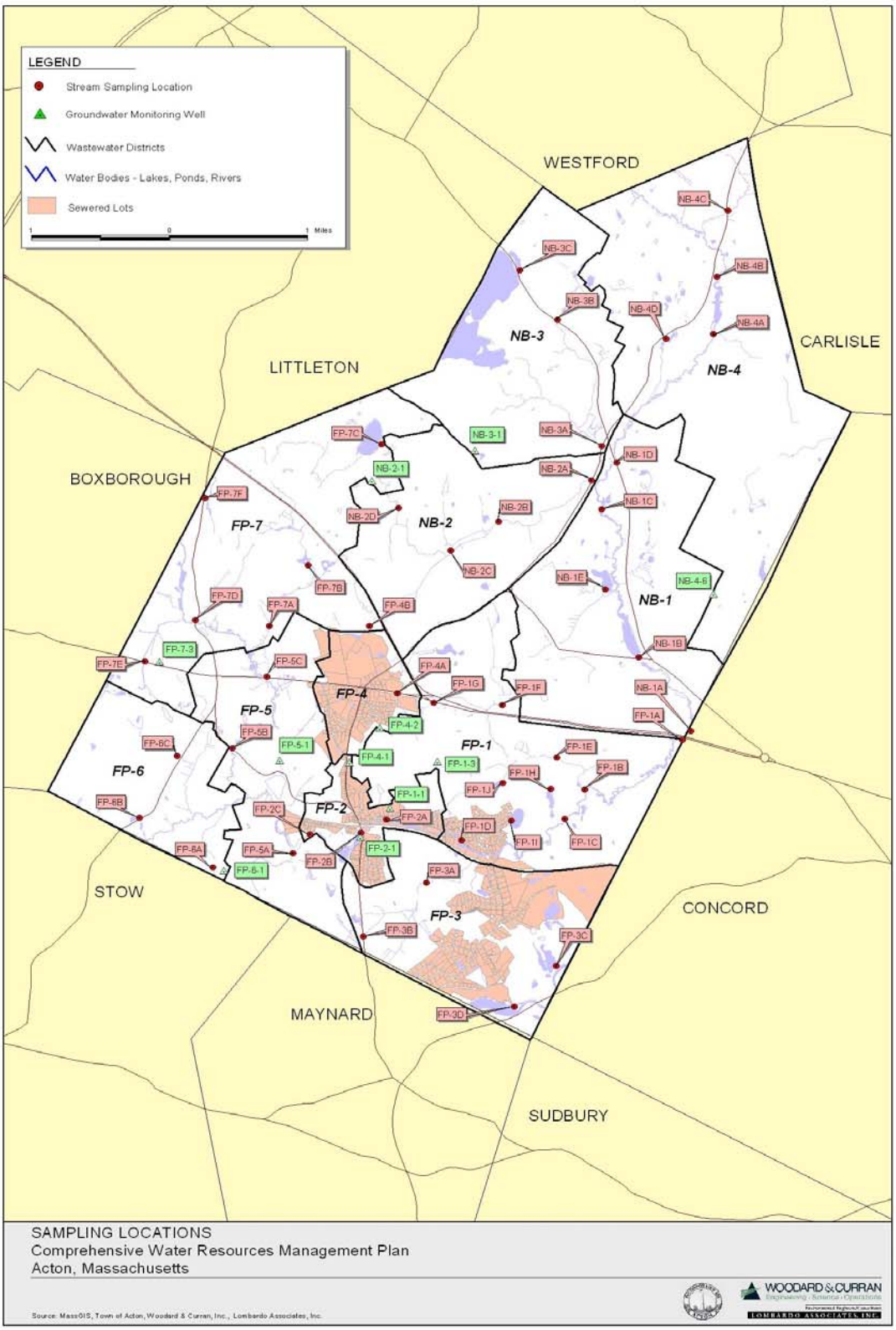


FIGURE 2-11:BOH GROUNDWATER AND SURFACE WATER SAMPLING LOCATIONS



2.3.4.1 Water Bodies – Lakes, Ponds and Streams

There are few large water bodies in the Town. The largest pond is Nagog Pond. Other ponds include Grassy Pond, Barker's Pond, and Partridge Pond. Several small impoundments (generally under 10 acres) also exist along the various streams in the Town.

TABLE 2-14: PRINCIPAL SURFACE WATERS IN ACTON

Water Body	Approximate Acreage	Percent of Total Surface Water Area
Nagog Pond	272	58%
Grassy Pond	17	4%
Other Ponds and Impoundments	180	38%
Total Approximate Surface Water Area	469	

Derived from MassGIS Hydrography Data

Several streams and brooks flow through Acton. These include Nagog Brook, Fort Pond Brook, Grassy Brook, Nashoba Brook, Muddy Brook, Pratts Brook, and Cole's Brook. Major streams are described in previous sections. The Assabet River flows through the southeast corner of Acton.

2.3.4.2 Wetlands & Vernal Pools

Wetlands

According to the 1998 Update to the Town's Master Plan, Acton has approximately 1,930 acres of wetlands, comprising 14.8% of the Town's total area. The Town's wetlands map, produced in 1980 by IEP, was digitized into GIS format for this study. The Town wetlands map is included in Figure 2-10, indicating environmentally sensitive areas.

Most of the wetlands in Acton are associated with the brooks and streams in the Town. Major wetlands areas are located along Fort Pond Brook in southwestern Acton and along Nashoba Brook in northern Acton.

In addition to the Engineering Departments' wetlands map, the Conservation Commission also has files on 800 +/- parcels where some type of wetlands delineation has been performed in the field. These files are currently stored as printed matter, and are not available electronically.

Vernal Pools

Several vernal pools have been identified in the Town of Acton. Both certified and uncertified vernal pools are indicated on Figure 2-10.

2.3.4.3 Rare and Sensitive Habitats

Acton contains a mixture of undisturbed habitats including deciduous and coniferous woodlands, open fields and meadows, and watercourses. These habitats provide food, nesting, and cover for wildlife. A variety of land, aquatic, and avian wildlife is known to reside in Acton.

The Massachusetts Natural Heritage Program has records of the following rare and sensitive species being observed in Acton:

- The Blue-Spotted Salamander was recorded in 1922. This is a Special Concern species.
- The Mystic Valley Amphipod has been recorded at two locations. This is a Special Concern species.
- The Small Yellow Lady's Slipper is the only listed plant species that has been identified in Acton. It is listed as an endangered species in Massachusetts.

A critical component of wildlife protection in Acton is the preservation of substantial open space. While there are numerous Town-owned conservation areas, they are scattered throughout the Town. For the enhancement of the wildlife protection value of these preserved open spaces, the Master Plan recommends future acquisition of additional open space with the goal of connecting existing habitats to create contiguous wildlife corridors within the Town.

The Master Plan also recommends that the Town promote development techniques that minimize the impact to wildlife communities and habitats.

2.3.5 Water Quality

Acton predominantly contains Class A and Class B surface waters. The Massachusetts Department of Environmental Protection definitions are:

- Class A waters generally include the highest quality inland waters, and are designated for use as a public water supply.
- Class B waters are designated for the protection and propagation of fish and other wildlife, and for primary or secondary recreation.

Nagog Pond is the only Class A water body in the Town, and issued as a public water supply by the Town of Concord. Most other surface waters in the Town are Class B waters.

2.3.6 Board of Health Groundwater Monitoring Program

The Board of Health (BOH) has maintained 11 monitoring wells (MW) located throughout Town since 1995. (Well FP-2-1 was discontinued in 1996, so only 10 MWs are currently active). Depth to groundwater and nitrate levels are measured monthly at each of the ten wells. The location of these wells and general data are listed in Table 2-15. Detailed depth to groundwater and water quality information is available in the 2000 – 2001 Annual Report prepared by the BOH. Monitoring well locations are shown in Figure 2-9 and Figure 2-11.

The BOH plans to use these data to adjust groundwater levels measured throughout the Town for septic system construction and other associated activities. Currently, the BOH does not make any adjustments to measured depth to groundwater.

TABLE 2-15: LOCATION OF BOARD OF HEALTH GROUNDWATER MONITORING WELLS

Well No.	Well ID	Location	Range of Meas. Depth to Ground water	Range of Meas. Nitrate Levels (ppm)	Average Meas. Nitrate Level (ppm)	Standard Deviation of Meas. Nitrate levels (ppm)
1	FP-1-1	Fire Station at School St.	1.6' – 10.8'	0 – 10		
2	FP-1-3	Piper Rd.	0.4' – 5.1'	0 – 3		
3[1]	FP-2-1	Main St at Mill Pond	4.8' – 9.85'	NA		
4	FP-4-1	Main St at Prospect Mobil	0' – 11.0'	0 – 3		
5	FP-4-2	Kelly Rd.	7.9' – 20.0'	0 – 25[2]	2.0/4.1[2]	3.0 / 7.0[2]
6	FP-5-1	Tuttle Dr.	5.8' – 20.2'	0 – 10		
7	FP-6-1	Billings St.	3.4' – 8.4'	0 – 5		
8	NB-2-1	Newtown Rd.	2.9' – 10.6'	0 – 10		
9	FP-7-3	Birch Ridge Rd.	3.0' – 11.5'	0 – 50[3]	2.1/3.7[3]	2.7 / 7.9[3]
10	NB-3-1	Nagog Hill	0.6' – 10.7'	0 – 3		
11	NB-4-6	Stoney -meade	0' – 9.5'	0 – 4		

Acton Board of Health

[1]Well discontinued in July 1996.

[2]Elevated nitrate levels are from 5 sampling episodes in 1996 – 1997. Levels exceeding 10 ppm have not been recorded since. Standard Deviation is presented as: (excluding 5 samples) / (including 5 samples).

[3]Elevated nitrate levels are from 3 sampling episodes in 1996 – 1997. Levels exceeding 10 ppm have not been recorded since. Standard Deviation is presented as: (excluding 3 samples) / (including 3 samples).

2.3.7 Board of Health Surface Water Monitoring Program

For the past 25 years the Acton Health Department has collected water samples from over 30 sites along Nashoba Brook and Fort Pond Brook and their tributaries and analyzed them for fecal coliform bacterial counts. The program has worked well to eliminate point source contamination and has been expanded to include 47 sampling locations. The Health Department conducts all the sampling with staff and volunteers.

The sampling results have been reviewed by the CWRMP project team and further results will continue to be monitored as part of the CWRMP planning effort. Although many sampling points still exceed the Massachusetts Class B inland water threshold at least once a year, current data do not show conclusive negative impacts that can be attributed to specific failing septic systems.

No additional sampling points are proposed under the CWRMP. To identify contamination sources, the surface water sampling program's evolution requires a retooled approach rather than additional sampling locations. The Health Department has developed a more advanced management and monitoring program using a micro-watershed approach that it wishes to conduct in conjunction with the CWRMP to identify and manage point and non-point sources.

The town has applied for a 319 grant through DEP/EPA to implement its Micro-Watershed Method with the following goals:

- Develop a transferable model for managing watershed health that can be implemented in many watersheds/subwatersheds using GIS-based technology;
- Develop a feasible, practical and cost-effective program for monitoring of water quality;

- Provide a diagnostic methodology for investigation of NPS contamination; and
- Produce a final deliverable: "A Guide to the Implementation for the Micro-Watershed Method for Watershed and Subwatershed Stakeholders".

The Micro-Watershed Method will use data developed through the CWRMP such as GIS maps showing problem septic systems and needs areas overlain on the sampling locations maps. The town will continue to target fecal coliform to maintain historical consistency. The CWRMP will benefit greatly from the sampling program especially if the program can produce traceable results that lead to sources of contamination.

2.3.8 Flood Plain Areas

The FEMA-designated 100-year floodplain covers approximately 1,873 acres in Acton, or about 14.4% of the Town's total area. These floodplains generally follow the Town's various brooks, and include many of the Town's ponds and wetlands. The most extensive floodplain areas are located along Fort Pond Brook and its tributaries in southwestern Acton. Other significant floodplains are located along Nashoba Brook in northern Acton. The Town's floodplains, as compiled by FEMA, are indicated in Figure 2-10.

2.3.9 Overview of Assabet River TMDL Phase I Findings

Between July of 1999 and September of 2000, ENSR International conducted a total of 13 field investigations of the Assabet River. These field investigations included measuring and sampling for a variety of parameters, including stream flow, dissolved oxygen concentration, water column nutrient concentration, point source nutrient loads, non-point source tributary nutrient loads, sediment nutrient flux, and levels of aquatic vegetation. The conclusion reached by these field investigations is that the Assabet River receives excessive levels of the nutrients, phosphorus and nitrogen, resulting in a severe ecological condition known as eutrophication.

The field investigations discovered that in-stream nutrient concentrations were often a full order of magnitude higher than nutrient limiting conditions. This means that nutrient loadings, hence in-stream nutrient concentrations, would need to be reduced significantly to even begin to lower biological production within the Assabet River. Slight reductions in nutrient loadings will not affect the eutrophic state of the river. Significant steps need to be taken to lower nutrient concentrations to points lower than the limiting concentrations.

The sources identified as the leading cause of nutrient impairment in the Assabet River are the publicly-owned treatment works (wastewater treatment facilities) located along the river. During the summertime months, under low flow conditions, wastewater treatment facility effluent accounts for approximately 80% of the total river flow. Wastewater treatment facilities were determined to be the source of a vast majority of the critical nutrient constituent, ortho-phosphate. Ortho-phosphate is the dissolved form of phosphorus, which is readily available for biological uptake. Non-point sources, analyzed as tributaries of the Assabet River, were identified to contribute the majority of most nutrient constituents during periods of wet weather.

The Assabet River Total Maximum Daily Load for Total Phosphorus report produced by DEP was released in Spring 2004. The TMDL report sets the total maximum daily load of phosphorus, including a margin of safety, which can be discharged to the Assabet River while maintaining water quality standards for designated uses. Corrective actions to achieve water quality goals include discharge limitations on total effluent phosphorus from wastewater treatment facilities (WWTFs) along the Assabet River and provisions for remediation of sediment, particularly at the dam impoundments.

Four publicly owned treatment works (POTWs) discharge to the Assabet River upstream of Acton: Westborough, Marlborough West, Hudson, and Maynard. According to the TMDL report, "The TMDL for meeting the water quality objectives, including a margin of safety, is removal of total phosphorus from the POTW effluents to 0.1 mg/l during the growing season and a 90% reduction of phosphorus sediment flux." Effluent limits for phosphorus are not required between November 1 and March 31. Two treatment facilities downstream of Acton (Middlesex School and MCI Concord), in the segment of the river downstream of dam impoundments, have effluent limitations of 0.5 mg/l year-round.

New 2004 NPDES permits will require that all POTWs be upgraded to meet 0.1 mg/l of effluent phosphorus by April 2009. Until the new permit limits are enacted the POTWs will be required to continue to meet the 2000 interim NPDES permit limits for seasonal total phosphorus of 0.75 mg/l. Effluent limitations in 2009 may be adjusted based on the feasibility of impoundment sediment remediation. The TMDL report is currently under review by EPA.

Expansion or alteration of Acton's WWTF to discharge to the Assabet River would need to satisfy DEP's Antidegradation Policy that no other feasible alternative exists including discharging treated effluent to groundwater to help restore tributary flows. Currently the Town of Acton's Middle Fort Pond Brook WWTF discharges to infiltration beds rather than directly into the Assabet River and has the most stringent NPDES permit requirements on the river. The Town has successfully been meeting the limit of 0.05mg/l for phosphorous and is committed to continuing to meet these high standards.

2.3.10 Air Quality

Acton is located in the western suburbs of the greater Boston metropolitan area and experiences air quality typical of the region. Acton is primarily a residentially developed community with minimal industrial development that could negatively impact air quality. The non-residential buildout estimate predicts a possible increase of 3.68 MSF (78%) of non-residential floor space above current levels. Of this increase, 60% is comprised of expansion on existing non-residential parcels and conversion of existing residential parcels to non-residential uses. If commercial and industrial development follow the existing uses and current trends no significant changes are anticipated that would potentially degrade local air quality.

For potential traffic related issues, Route 2 is a major highway corridor that transverses Acton. There are few traffic stops in Acton that would impact air quality.

3. WATER DEMAND PROJECTIONS AND SUPPLY SOURCES

3.1 INTRODUCTION

Clean, abundant drinking water is often considered to be a community's most important natural resource. Throughout many communities in the United States, significant amounts of money and time are spent every year studying, treating and distributing drinking water to their citizens. Communities must look into the future and project how much drinking water they will require in the years to come. If a community does not have an adequate supply of clean drinking water to serve its current or future needs, it may be left to the discretion of neighboring community's to help fulfill those needs. Most communities prefer to be self-reliant when it comes to utilities such as water. A self-reliant community has the ability to set its own price rates, choose its own form of treatment, and upgrade or maintain its own utility.

3.2 REGIONAL WATER QUANTITY

The purpose of computing a hydrologic budget is to determine the amount of groundwater available within the Town for use as water supply. To quantify the groundwater resource the quantity of water pumped from existing wells and the anticipated yield from planned new wells is compared to the groundwater recharge and any excess is available for future development in each drainage basin.

In the simplest hydrologic budget, annual runoff plus annual evapotranspiration are equal to annual precipitation. Annual runoff is divided into surface water runoff and groundwater runoff. Groundwater runoff is precipitation that infiltrates the aquifer as recharge and moves through the groundwater system before discharging to surface water. Groundwater runoff can be intercepted by wells that draw from the aquifer. The amount of groundwater recharge indicates the potential for groundwater supply in the drainage basin. The record of precipitation and an analysis of the geology of the basin will yield the amount of groundwater recharge.

When considering the long-term hydrologic budget it is appropriate to disregard soil moisture and groundwater storage since it is assumed that the aquifer is not consistently being over pumped.

The amount of groundwater recharge is controlled by the geology of the drainage basin. The most recharge occurs in areas where the geology is stratified drift composed of well-sorted sand and gravel deposits left by glacial meltwater flows. Areas underlain by till and bedrock at surface or near surface are less permeable. Portions of a basin with wetlands or surface water are non-recharge areas since there is no storage capacity in these locations (except possibly after extended dry periods).

3.2.1 Acton's Water Balance

Compiling a water balance for the Town of Acton can help with an understanding of how the groundwater and surface water interact with in the community. That understanding will be useful during selection of new wastewater dispersal locations in the Town.

As explained elsewhere in this document, sand and gravel deposits in Acton generally occur in the narrow and constrained valley aquifers along the principal streams of the Town. Figure 2-8 depicts the extent of till and sand and gravel deposits. These aquifers are the only source of public drinking water in Town. The need to dispose of wastewater at sand and gravel locations creates a challenge in protecting the quality of drinking water and locating the disposal sites. Therefore a thorough understanding of how the groundwater and surface water systems in the Town interact will be important.

The most basic water balance can be illustrated as inflow versus outflow. In Acton, inflows include:

- Precipitation,
- Out-of-town underflow (groundwater flow) into town, and
- Septic tank return flow.

Acton outflows include:

- Nagog Pond withdrawals to Concord,
- Underflow (groundwater flow) out of town,
- Middle Fort Pond Brook Sewer disposal to the WWTF adjacent to the Assabet River, and
- Evapo-transpiration (ET) losses.

At this point in the project, available published data allows a general review of water balance and preliminary understanding of the interaction of surface water and groundwater. In later phases of the work involving data collection, one objective will be to refine this understanding to evaluate any potential degradation of groundwater quality from the dispersal of wastewater effluent.

Analysis by the USGS in WRI 94-4256 – 1995 uses a combined hydrograph separation and streamflow-duration curve analysis to calculate that groundwater available for withdrawal without reducing the present 98 percent flow duration in Nashoba Brook approximates 0.2mgd /mi^2 of stratified drift. This factor was considered appropriate for application to all of the 17 watersheds and streams in the Concord River Basin, which includes all of the stream valley aquifers entirely or partially within Acton.

The various watersheds significant to Acton along with their respective areas of stratified drift (sand and gravel) are listed in Table 3-1. These stratified drift aquifers comprise a total of 4,952 acres within Acton. As shown on Table 3-2, the suggested maximum potential groundwater withdrawal available within Acton that will not reduce stream flow below the 98% duration flow is 3.4 mgd.

This analysis uses the complete basins, inside and outside Acton, available for groundwater withdrawal. It should be acknowledged that if Acton is withdrawing groundwater from a basin which has no other withdrawal and is only partially within the town, and if there is stratified drift in the portion outside of Town then Acton could safely withdraw groundwater up to the full capacity of the entire basin.

Without a municipal wastewater system, the majority of groundwater withdrawn from a community and delivered to the public water supply system is returned to the groundwater reservoir through septic leaching systems. Experience and literature suggest that water loss from municipal systems is about 10% (WRI–94-4256). Thus it can be assumed that except for the expected 10% (+-) consumptive use, there is no impact to the groundwater balance from development within Acton and groundwater withdrawal by the Water District.

On the average day, the Acton Water District pumps 1.86 mgd (2002 data) from its suite of wells and wellfields. Since the town as yet has no significant sewer system, most of the water withdrawn from the aquifers is returned to groundwater via septic system leaching fields. The new sewer system with groundwater discharge in town within the Assabet River basin is designed for 250,000 gpd when the all proposed users are connected. This new sewer system does not represent a loss to the Town's aquifers systems in a water balance because the wastewater will be dispersed to groundwater. However, the design quantity of wastewater will be moved from the various source basins to the discharge basin and the 250,000 gpd is dispersed at the lowest groundwater basin in Town – the Assabet.

There is no out-of-town water service by the Acton Water District, thus there is no direct basin loss as a result of groundwater withdrawal by the District. Typical water loss estimates for domestic service may range from 10% to 17%. The USGS has used 10% for the Concord River study (WRI 94-4256). Using the 10% figure, the Acton Water District withdrawal of 1.86 mgd for average day demand results in a net groundwater withdrawal of 186,000 gpd.

There is one small additional loss of water from the Town, the withdrawal by the Town of Concord from Nagog Pond. This out flow of water from the Town is not significant. The Nagog Pond basin is a small basin, only 767 acres, almost equally split between Acton and Littleton. Concord withdraws 1.071 mgd (USGS-WRI 94-4256). The precipitation gain from the 388 Nagog acres within Acton (0.16mgd) is not included as inflow to Acton.

The physical groundwater balance suggests that the District uses less than 200,000 gpd from a basin system, excluding the 250,000 gpd discharged through the WWTF, which can support 3.4 mgd without diminishing stream flow below a minimum conservative value.

TABLE 3-1 SIGNIFICANT WATERSHED DATA

Geology	Unit	Assabet River Basin	Butter Brook Basin	Fort Pond Brook Basin	Grassy Pond Brook Basin	Heath Hen Meadow Brook Basin	Nagog Pond Basin	Nashoba Brook Basin	Second Division Brook Basin	Spencer Brook Basin	Strawberry Hill Basin	Town of Acton
Sand and Gravel	Acres	236.16	442.80	1656.55	682.15	458.05	27.59	1416.27	0.00	19.20	13.81	4952.58
Till or Bedrock	Acres	89.24	390.59	1662.44	1136.27	172.92	250.50	2812.44	0.00	283.81	62.75	6860.97
Other	Acres	181.90	87.28	363.38	122.68	9.15	110.52	217.67	0.96	2.67	0.00	1096.22
Total Basin	Acres	507.30	920.67	3682.37	1941.10	640.13	388.61	4446.38	0.96	305.68	76.56	12909.77
Sand and Gravel	% of Basin Area	46.55	48.09	44.99	35.14	71.56	7.10	31.85	0.00	6.28	18.04	
Till or Bedrock	% of Basin Area	17.59	42.42	45.15	58.54	27.01	64.46	63.25	0.00	92.85	81.96	
Other	% of Basin Area	35.86	9.48	9.87	6.32	1.43	28.44	4.90	100.00	0.87	0.00	
Sand and Gravel	% of Total Sand and Gravel	4.77	8.94	33.45	13.77	9.25	0.56	28.60	0.00	0.39	0.28	
Till or Bedrock	% of Total Till or Bedrock	1.30	5.69	24.23	16.56	2.52	3.65	40.99	0.00	4.14	0.91	
Other	% of Total Other	16.59	7.96	33.15	11.19	0.83	10.08	19.86	0.09	0.24	0.00	
Total Basin	% of Total Town Area	3.93	7.13	28.52	15.04	4.96	3.01	34.44	0.01	2.37	0.59	

TABLE 3-2 GROUNDWATER AVAILABLE FOR MUNICIPAL USE

	Acres in Basin	Percent Stratified Drift in the Entire Basin [(1)]	Acres of Stratified Drift
Assabet River	507	46.5	235.8
Butter Brook	8,230	48	3,950.4
Fort Pond	4,339	45	1,952.6
Grassy Brook	6,590	35	2,306.5
Heath Hen Brook	1,419	71	1,007.5
Nagog Pond	N/A	N/A	N/A
Nashoba Brook	4,834	31.8	1,537.2
Second Division	0		
Spencer Brook	0		
Strawberry Brook	0		
Total acres of stratified drift in Town and in basins draining through Town of Acton			10,989.9
$Miles^2$ of stratified drift			17.2
Mi^2 stratified drift x 0.2mgd/mi^2 [(2)]			3.4 mgd

(1) based on assumed out of town proportion of stratified drift similar to in-town proportion (see Table 3-1)
(2) 0.2mgd /sq mi of stratified drift (from USGS WRI-94-4256)

The municipal groundwater supply withdrawal from the various basins within Acton can be tabulated as in Table3-3.

TABLE 3-3 GROUNDWATER SUPPLY WITHDRAWAL

Well Name	Approved Yield	Sub-basin
Assabet No. 1	350 gpm	Assabet River
Assabet No. 2	350 gpm	Assabet River
Assabet No. 2A (replacement)[1]	350 gpm	Assabet River
Christofferson Well	300 gpm	Fort Pond Brook
Clapp Well	210 gpm	Grassy Pond Brook
Conant No. 1	240 gpm	Nashoba Brook
Conant No. 2[2]	300 gpm	Nashoba Brook
Kennedy Wellfield (1-4)	375 gpm	Butter Brook
Lawsbrook Well	250 gpm	Fort Pond Brook
Marshall Wellfield[3]	360 gpm	Butter Brook
Scribner Wellfield	240 gpm	Fort Pond Brook
Whitcomb Well	325 gpm	Grassy Pond Brook

[1]Assabet No.2 and Assabet No.2A are mutually exclusive.

[2]Conant No.2 is limited by regulations to 217,000 gpd, or pumpimg 300 gpm for 12 hours per day, for an average of 150 gpm.
[3]Periodically used.

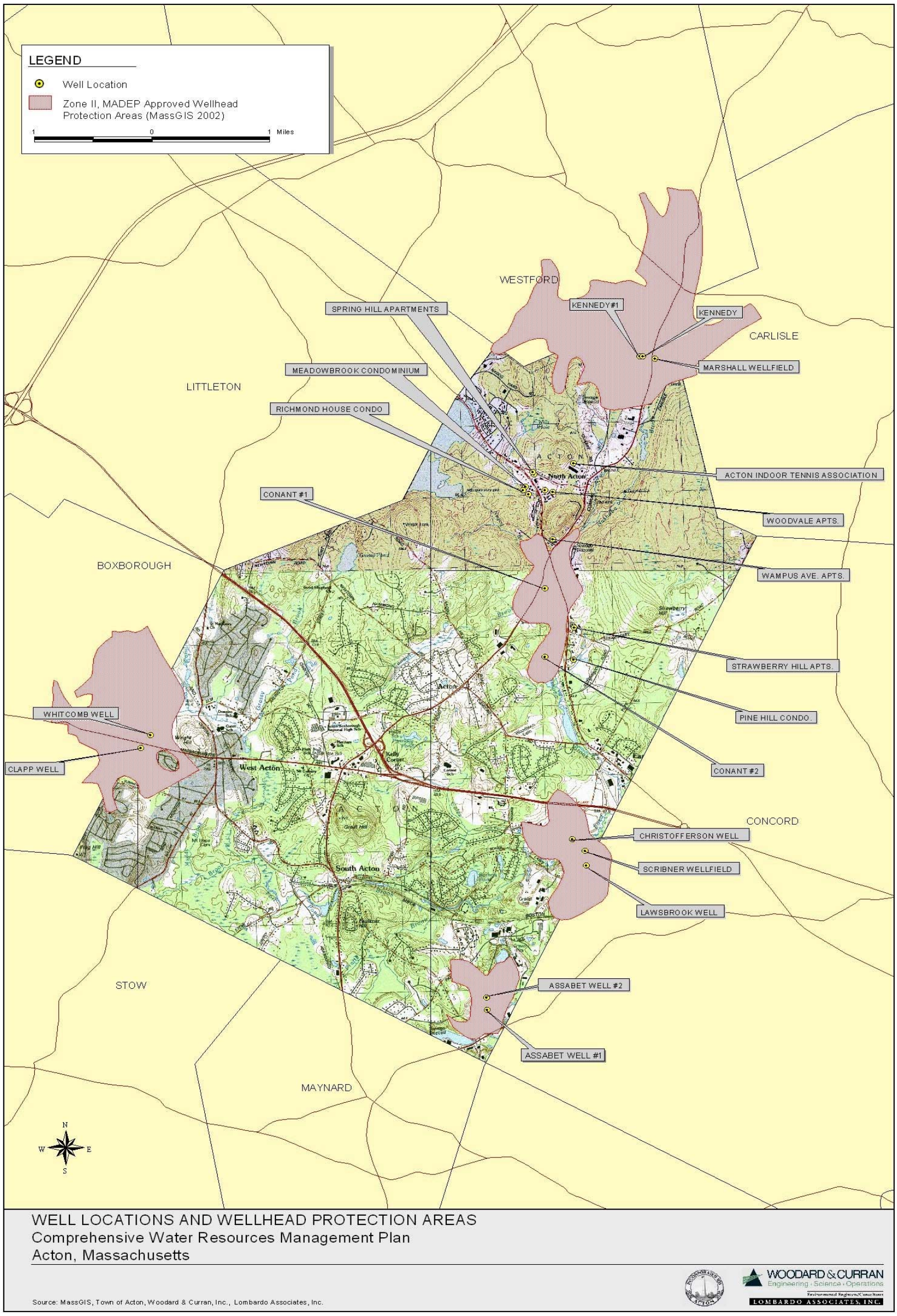
3.3 TOWN OF ACTON'S PUBLIC WATER SYSTEM

As of 2001, approximately 19,305 people, or ninety five percent (95%) of Acton's population, were served by the Acton Water Supply District (the District). Drinking water sources consist of eleven (11) wells and well fields located within Acton, nine of which are treated by packed tower aeration (PTA), granular activated carbon (GAC), or a combination of the two technologies. The District relies on ground water as its sole source for raw water. The District also has four drinking water storage facilities located at:

- Flagg Hill Reservoir
- Great Hill Standpipe
- Nagog Hill Reservoir
- Wampus Hill Booster Station and Reservoir

Figure 3-1 displays the District's drinking water wells and Zone II's.

FIGURE 3-1: ACTON WELLS AND WATER STORAGE TANKS.



3.3.1 Public Supply Aquifers in Use

The five major well systems in Action are the Kennedy-Marshall, the Conant, the Whitcomb-Clapp, the Lawsbrook–Scribner, and the Assabet. These are all similar in that they are located in valley fill aquifers where valleys in the bedrock or till topography are now filled with water-lain sands and gravels. The sides (or flanks) of these aquifers are defined by the location of the contact between the sand and gravel and the till or bedrock that makes up the surrounding high lands. For the purpose of this discussion, aquifers are named for mapping references only and no delineation of aquifers is to be assumed.

In North Acton the **Kennedy–Marshall Aquifer** in the Nashoba Brook –Butter Brook drainage basins supports two municipal water supply sites, Kennedy Wellfield and the Marshall Wellfield, and a single privately owned public supply site at Deck House Inc. According to a 1984 report by GZA the saturated thickness of sands and gravels in this area may exceed 50 feet. This aquifer area is utilized with a number of wells driven to refusal and fitted with submersible pumps. These two well fields provide approximately 1.05 mgd of supply.

Further south on Nashoba Brook the **Conant Aquifer** supports two publicly owned gravel packed wells, Conant #1 and Conant #2, and a number of privately owned public supply wells (bedrock wells) for condominiums and apartments. According to the 1984 GZA report the saturated thickness of sands and gravels in this aquifer reach to 50 feet. The Conant Wells are constructed at about 30 feet in depth. They supply a combined yield of about 0.75 mgd.

About one mile further down the Nashoba Brook valley aquifer from the Conant Wells are the three owned wells, **Christofferson Street Well**, **Lawsbrook Well** and the **Scribner Wellfield**. The saturated sands and gravels in this area exceed 50 feet. The three withdrawal sites combined yield is about 1.1 mgd.

The upper reaches of the actual Fort Pond Brook drainage area in western Acton, is defined as the Grassy Pond Brook Basin referencing a major tributary to Fort Pond Brook, (See Figure 2.7). In this area, immediately west of Wright Hill, between the hill and the Acton–Boxborough town line, there is a low flat area filled with sand and gravel. This area supports the **Clapp and Whitcomb wells.** The area of the Clapp and Whitcomb wells is drained by two brooks, Guggins Brook and Inch Brook. These streams probably supply some recharge to the wells. Yield is approximately 0.75 mgd.

As the name would imply, the **Assabet (Wellfield)** is located adjacent to the Assabet River in the southeast corner of Town. It incorporates two individual wells. Assabet 1 is a 68 foot deep gravel packed well and Assabet II is a 54 foot deep naturally developed well. Assabet IIA is a 34 foot deep gravel packed well, although Assabet II and Assabet IIA are mutually exclusive. When Assabet I and Assabet II/IIA are in service they can deliver 700 gpm. Water for these wells comes in part from the natural storage in the aquifer and in part from induced recharge from the Assabet River.

Yields of these municipal wells and the withdrawals from their associated aquifers are given in Table 3-4, derived primarily from Acton's February 2002 Water System Master Plan Update.

TABLE 3-4 – ACTON WATER DISTRICT SUPPLY SOURCES (WELLS)

Well Name	Year Built	Address	Well Type	Depth	Approve Yield	Sub-basin
Assabet No. 1	1970	284-290 High St.	Gravel Packed	68’	350 gpm	Assabet River
Assabet No. 2	1972	284-290 High St.	Naturally Dev.	53.8’	350 gpm	Assabet River
Assabet No. 2A (replacement)	2000	284-290 High St.	Gravel Packed	34’	350 gpm	Assabet River
Christofferson Well	1964	315 School St.	Gravel Packed	40’	300 gpm	Fort Pond Brook
Clapp Well	1976	680-700 Mass Ave.	Gravel Packed	42’	210 gpm	Grassy Pond Brook
Conant No. 1	1955	599-615 Main St.	Gravel Packed	31’	240 gpm	Nashoba Brook
Conant No. 2	1998	619-639 Main St.	Gravel Packed	25-32’	300 gpm	Nashoba Brook
Kennedy Wellfield	1989	954-962 Main St.	Gravel Packed	35’	375 gpm	Butter Brook
Lawsbrook Well	1960	28-60 Lawsbrook Rd.	Gravel Packed	53’	250 gpm	Fort Pond Brook
Marshall Wellfield[1]	1989	941-959 Main St.	Tubular Wellfield	28-31’	360 gpm	Butter Brook
Scribner Wellfield	1981	28-60 Lawsbrook Rd.	Tubular Wellfield	26-35’	240 gpm	Fort Pond Brook
Whitcomb Well	1970	677-699 Mass Ave.	Gravel Packed	32’	325 gpm	Grassy Pond Brook

[1]Periodically used

3.3.2 Distribution System

Acton’s water distribution system consists of 110 miles of water main pipes, ranging in diameter from 2 inches to 16 inches. There are a total of four (4) distribution storage facilities within the system. Table 3-5 displays several characteristics of these four facilities. Table 3-5 was derived from information contained within Acton’s February 2002 Water System Master Plan Update by Dufresne-Henry.

TABLE 3-5: ACTON WATER STORAGE FACILITIES

Storage Site	Capacity (MG)	Usable Storage (MG)	Overflow Elevation (ft)
Great Hill Standpipe	0.5	0.22	427.5 (at HGL[1])
Flagg Hill Reservoir	2.0	2.00	427.5 (at HGL[1])
Nagog Hill Reservoir	3.0	1.71	427.5 (at HGL[1])
Wampus Hill Reservoir	3.0	3.00[2]	317.0 (below HGL[1])
TOTAL	8.5	6.93	-

[1] HGL = Hydraulic Grade Line of the distribution system
[2] Wampus Hill Reservoir water must be pumped for use

These four storage facilities can store up to 8.5 million gallons of drinking water, with a usable storage capacity of 3.93 million gallons without pumping (usable represents the amount water available while still

maintaining adequate pressure in the system). The overflow elevation at three out of the four facilities is 427.5 ft, which establishes the hydraulic grade line of the system.

All of the water from the Wampus Hill Reservoir is usable, yet it must be pumped into the distribution system. A three pump booster station supplies the system with water from the Wampus Hill Reservoir.

Acton's water distribution system has a total of six (6) interconnections with the distribution systems of neighboring communities. One connection exists with Littleton, three connections with Concord, and two with Maynard.

3.3.3 Wells and Treatment Facilities

Although Acton is fully reliant on groundwater as its sole drinking water source, the Town has not escaped the need to treat its raw water before distributing it to residents. Five facilities treat nine of the eleven active wells within the Town. The primary focus of these facilities is to remove the volatile organic compounds (VOCs) that have been detected in multiple wells across Town. VOCs are typically the result of synthetic, volatile organic compounds being introduced into the subsurface through improper disposal techniques or due to leaking storage tanks. Fortunately, the technology exists to achieve near 100% removal of VOCs through packed tower aeration (PTA) or granular activated carbon (GAC) systems.

Naturally occurring impurities, common to many groundwater sources, are also found in Acton's well water. These impurities include iron, manganese, and organic color.

The following section provides a brief background and description of the five drinking water treatment facilities in Acton.

Assabet Treatment Facility

Water from three wells, Assabet no. 1, Assabet no. 2, and Assabet no. 2a, is treated at the Assabet treatment facility. Only two of the three wells can operate at one time. Assabet no. 2a was constructed in 2000 to replace no. 2 due to frequent plugging of no. 2's well screen. Even though Assabet no. 2 can still be reactivated, it cannot be pumped at the same time as no. 2a and is therefore primarily turned off. The overall pumping capacity for the Assabet treatment facility is 600 gpm.

The Assabet Treatment Facility was originally a GAC plant. VOCs were detected at wells No. 1 and No. 2 in the early 1980s. In 1983, the Acton Water District added PTA to the treatment process. The PTA alone was able to achieve 100% removal the VOCs. Therefore, GAC is no longer in use at the Assabet facility.

Clapp and Whitcomb Treatment Facility

Water from Clapp and Whitcomb wells originally received treatment to remove VOCs that were detected in the water in the early 1980's. Since that time, VOCs have diminished and are no longer detectable in the raw well water. More recently (early 1990's), organic color has become the main treatment focus. Color only has a recommended secondary standard set by the EPA. It is therefore seen as an aesthetic problem and not a health risk.

GAC was the original treatment process incorporated in this facility for the removal of the VOCs. Once the VOCs subsided and organic color became the problem, a process of coagulation and filtration using the existing GAC contactors was implemented. This process proved very costly due to the constant need

for tanker trucks to dispose of the backwash water produced on-site. Currently the facility is using a process of PTA and GAC for color treatment. Frequent and costly GAC regeneration is needed to achieve adequate results.

The Clapp/Whitcomb Treatment Facility has an overall pumping capacity of 500 gpm, but the District is rehabilitating the wells.

School Street Treatment Facility

As with the Assabet Treatment Plant, the School Street Treatment Plant removes VOCs present within the groundwater. The School Street Plant receives water from the Christofferson Well, the Lawsbrook Well, and the Scribner Well. The plant itself is a PTA system, removing VOCs through volatilization processes. The School Street Treatment Facility has an overall pumping capacity of 450 gpm.

Kennedy Treatment Facility

The Kennedy Treatment Facility treats the raw water from the Kennedy Wellfield through PTA. The overall pumping capacity of the Kennedy Treatment Facility is 425 gpm.

Conant II Treatment Facility

The Conant II Treatment Facility treats the raw water from the Conant II Wellfield through PTA. The overall pumping capacity of the Conant II Treatment Facility is 300 gpm, yet due to regulations, Conant II well is only pumped for 12 hours per day at 300 gpm for a daily average pumping rate of 150 gpm.

3.3.3.1 Summary of Treatment Facilities and Pump Stations

Table 3-6 displays the five treatment facilities and two pump stations located within Acton along with the treatment processes incorporated at each facility and the overall pumping capacity of each facility.

Chlorine is added to Acton's water as a disinfectant at all five treatment facilities. Chlorine disinfects water at the point of application and acts as a residual disinfectant, safeguarding the distribution system against potentially harmful microbial regrowth.

Potassium hydroxide, KOH, is used for pH adjustment. It is necessary to avoid an acidic pH within the distribution system, to guard against corrosion of metal pipes and joints. Potassium hydroxide is a base (pH above 7), which helps to raise the pH to adequate levels.

Although not used for treatment purposes, it should be noted that sodium fluoride is added to the water at all facilities listed below. Sodium fluoride provides protection against tooth decay.

TABLE 3-6: SUMMARY OF ACTON WATER TREATMENT FACILITIES AND PUMP STATIONS

Facility	Treatment	Pumping Capacity
Assabet Treatment Facility	PTA, Chlorine, KOH	600 gpm
Clapp/Whitcomb Treatment Facility	PTA, GAC, Chlorine, KOH	500 gpm
School Street Treatment Facility	PTA, Chlorine, KOH	450 gpm
Kennedy Treatment Facility	PTA, Chlorine, KOH	425 gpm
Conant II Treatment Facility	PTA, Chlorine, KOH	300 gpm
Conant I Pump Station	KOH	450 gpm
Marshall Pump Station	KOH	170 gpm
TOTAL	-	2,895 gpm or 4.17 mgd

3.3.4 Well Rehabilitation

The Acton Water District rehabilitates its wells to maintain an adequate pumping rate to serve the District's needs. Iron and manganese, naturally occurring elements in groundwater, can precipitate out of groundwater over time, plugging well screens and lowering the specific capacity of wells. The specific capacity of a well is a measure of how efficiently a well is operating. Specific capacity is derived by dividing the pumping rate of a well by the amount of drawdown observed. Rehabilitating wells that have plugged can significantly increase the specific capacity of the well. As of the February of 2002 Water System Master Plan Update, the District had recently redeveloped wells including Assabet Well No. 1, Christofferson, Lawsbrook, Conant I, and the four Kennedy Wells. Significant improvements in specific capacity were observed following the redevelopment of these wells. The District is currently rehabilitating Clapp and Whitcomb Wells.

3.3.5 Permitted Water Usage

As part of the Massachusetts Water Management Act (WMA) of 1986, communities or private entities that withdraw more than 100,000 gpd of water must be permitted by the MADEP. The process typically involves the Massachusetts Department of Environmental Management (MADEM) developing a draft withdrawal volume for a given water district, which is followed by an approval process conducted by the Massachusetts Water Resources Commission (WRC) and finally a WMA permit is issued by the MADEP. The Acton Water District is currently permitted to withdraw up to 1.93 mgd on average over any given calendar year. This permit will increase to an average of 1.94 mgd in 2006 and will expire on August 31, 2011.

The Acton Water District exceeded its permitted withdrawal capacity only once, in 2001, when unaccounted water reached 19% of water withdrawn primarily due to an open valve that allowed unmetered water to flow from Acton's distribution system into Maynard. With the exception of 2001, the District's average daily use has remained at approximately 1.85 mgd since 1997 even though Acton's population as grown by over 2,000 residents (10%).

The District is currently pursuing a reevaluation of their permit with the DEP, seeking to increase the acceptable withdrawal limit. Additional efforts continue on the part of the Water District to identify and fix leaks or deficiencies within the distribution system to limit the amount of unaccounted-for water. The Acton Water District continues to promote the conservation of drinking water among its customers.

3.4 FUTURE RESIDENTIAL, COMMERCIAL AND INDUSTRIAL DEVELOPMENT

Acton's December 1998 Master Plan Update by Whiteman & Taintor; LandUse, Incorporated; TAMS Consultants, Inc.; and Howard/Stein-Hudson Associates provides general projections of potential residential and non-residential development within Acton. More specific water service connection projections are located in Section 3.6 – Future Water Demands. Residential dwellings analyzed in the Master Plan Update do not correlate to the number of service connections analyzed in Section 3.6 since individual service connections may not represent a single residential dwelling.

Residential Build out

The build out analysis contained in Acton's 1998 Master Plan Update concluded that a total of 10,200 residential dwellings are likely to exist in Acton by the year 2030 (10,600 potential maximum dwelling). This projection estimated that, on average, 72 dwelling units will be constructed per year, starting in 1990 and continuing through forty (40) years of growth. At this rate of development, Acton is forecasted to see a total population of 24,500 people in the year 2020 and 29,300 people at projected build out. Acton's population in 2000 was 20,331 residents (US Census Data, 2000 Census).

Non-Residential Development

Non-residential development is estimated on a square foot basis. Computations are made based on zoning district, minimum open space requirements, maximum building heights and required off-street parking ratios. Overall, the 1998 Master Plan presents a non-residential build out estimate of 8.38 million square feet (MSF). For reference, Table 2-10 is reprinted here as Table 3-7.

TABLE 3-7: 1998 NON-RESIDENTIAL BUILDOUT ANALYSIS FOR ACTON (REPRINT OF TABLE 2-10)

Buildout Potential	Million Square Feet of Floor Space
Existing Floor Space	**4.70**
Development of Undeveloped Parcels (Greenfields)	*1.45*
Conversion of Existing Residential to Non-Residential Parcels	*0.56*
Expansion on Existing Developed Non-Residential Parcels	*1.67*
Estimated Potential Additional Floor Space	**3.68**
Total Estimated Floor space at Buildout	**8.38**

1998 Master Plan Update

Summary

The findings of the 1998 Master Plan Update reveal that the Town of Acton can expect continued growth over the coming years. A more detailed evaluation of projected water usage is presented in Section 3.6.

3.5 WATER USE TRENDS

Generic multipliers for water usage per household tend to provide broad projections of future conditions. This is because communities differ in average income, lot size, level of effort devoted to lawn care, and other factors that influence water consumption. Historical records, however, represent truer conditions, as they have existed within a given Town over a period of record. Evaluations of Acton's water usage within this report are based on historical data from:

- *Water System Master Plan Update*, Dufresne-Henry, Inc., February 2002
- Massachusetts DEP Public Water Supply Annual Statistical Reports (1999, 2000 and 2001)
- Acton's *Water Conservation Plan for Public Water Suppliers* report, Acton Water District, 2001

3.5.1 Classifications of Water Use

In Acton's March 27, 2001 *Water Conservation Plan for Public Water Suppliers*, water usage within the Town is broken down into several categories, including non-residential, residential, process water, and unaccounted water. Non-residential water uses are considered any agricultural, commercial, industrial or municipal applications (basically any applications outside of common residential use). Residential water uses are generally considered all water uses in or around a dwelling, including bathing, sanitation, and outdoor activity. Process water is water used for properly running or maintaining treatment and distribution equipment. Unaccounted water reflects leaks, illegal connections, faulty meters, and any other situation that would cause water to pass unaccounted.

Residential water use represents the largest use of water, on average, within Acton's distribution system. Fifty seven percent (57%) of water pumped within Acton's distribution system in 2000 was identified to be for residential use. This is consistent with Acton's predominately residential character.

Twenty percent (20%) of Acton's water use was identified to be non-residential water demand. Individually, non-residential users such as commercial businesses and municipal, industrial, and agricultural operations tend to use higher amounts of water, on average, than any one residence. Overall, however, non-residential water demand is considerably less than residential water demand.

Process water was determined to account for thirteen percent (13%) of the overall water pumped within the system. Primarily, process water includes water dispensed while flushing water mains (hydrants), water used to clean and operate treatment facilities, and water dispensed while bleeding lines. Overall, any water that was used for the upkeep or standard operating procedure of water treatment, storage, or distribution system is reflected in this thirteen percent.

Unaccounted water was determined to be ten percent (10%) for the year 2000. This number increased significantly to nineteen percent (19%) in 2001. An open valve allowing un-metered water to flow from Acton's distribution system into Maynard's system was determined to be the primary cause for the high level of unaccounted water in 2001. In 2002, unaccounted water dropped back to 12%.

3.5.2 Historical Water Demands

Table 3-7 contains water usage data from the Acton Water District for the years 1985 through 2001. Total yearly demand is expressed in millions of gallons (mg). Average daily and maximum day demands are displayed in millions of gallons per day (mgd). Total services represent the number of units, residential and non-residential, tied into the District's system. Gallons/Unit/Day is the water usage (in gallons/day) averaged across all residential and non-residential units within Acton.

TABLE 3-7: HISTORICAL ACTON WATER DATA

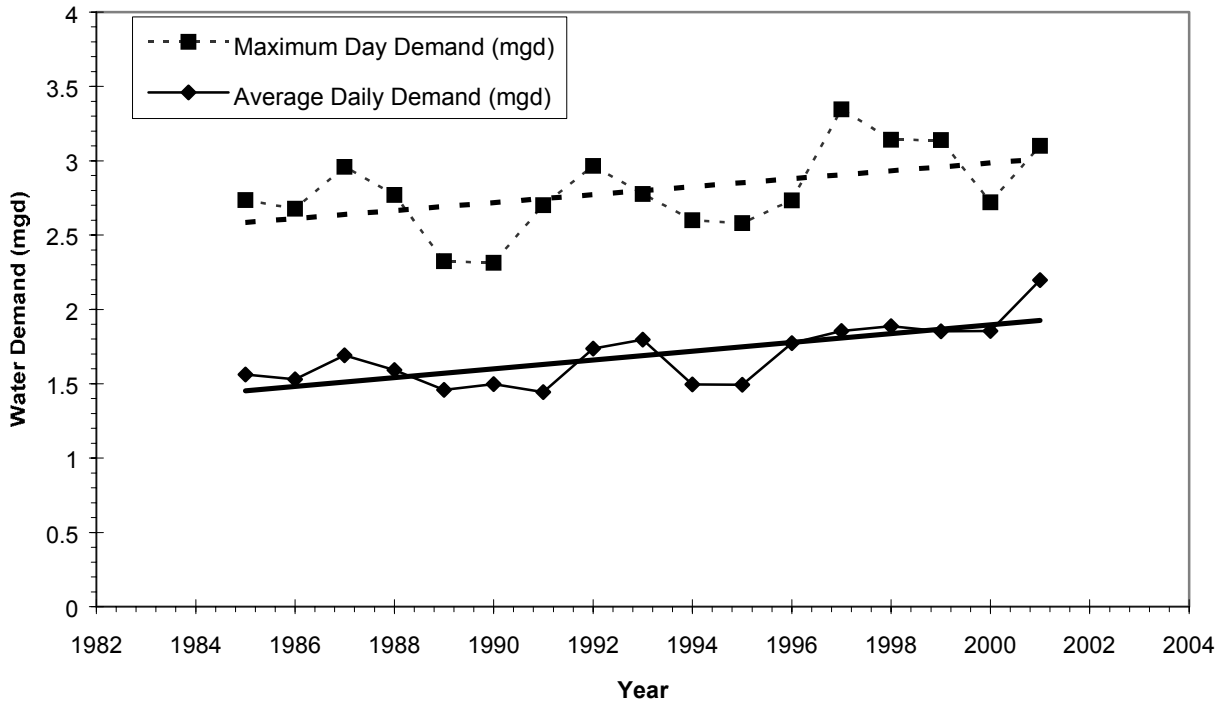
Year	Total Yearly Demand (mg)	Average Daily Demand (mgd)	Max Day Demand (mgd)	Total Services (Units)	Peak Demand Ratio	Gallons/Unit /Day	Unaccounted Water (%)
1985	570.43	1.56	2.73	5,222	1.75	299	N/A
1986	558.30	1.53	2.68	5,317	1.75	288	N/A
1987	617.17	1.69	2.96	5,365	1.75	315	N/A
1988	581.38	1.59	2.77	5,450	1.74	292	10 %
1989	532.21	1.46	2.32	5,550	1.59	263	10 %
1990	546.62	1.50	2.31	5,740	1.55	261	N/A
1991	527.22	1.44	2.70	5,830	1.87	248	10 %
1992	633.43	1.74	2.97	5,920	1.71	293	8 %
1993	655.85	1.80	2.78	6,200	1.54	290	15 %
1994	545.81	1.50	2.60	6,233	1.74	240	N/A
1995	544.79	1.49	2.58	6,334	1.73	236	8.1 %
1996	647.29	1.77	2.73	6,463	1.54	274	20 %
1997	677.37	1.86	3.35	6,679	1.80	278	17 %
1998	688.90	1.89	3.14	6,793	1.66	278	13 %
1999	676.23	1.85	3.14	6,737	1.70	275	9 %
2000	677.02	1.85	2.72	7,195	1.47	257	9.6 %
2001	801.60	2.20	3.10	7,285	1.41	301	19 %
2002	679.72	1.86	2.90	7.557	1.56	246	12%

From 1985 to 2001 Acton has experienced an increase in population. Official US Census data lists Acton's 1990 population at 17,872 residents. Within ten years, Acton has seen a 13.8 % increase in population. US Census data for 2000 put Acton's population at 20,331 residents. As the population has increased, so has the number of water service connections and the average daily water demand.

Figure 3-2 provides visual evidence of the upward trend in average daily water demand over time. The diamond shaped data points that range between 1.44 mgd and 2.20 mgd represent average daily water demand from 1985 through 2001. The line that intersects these data points is a linear trend line that displays an increased water usage in Acton over time.

Maximum day demand, the largest amount of water pumped in Acton over any given twenty- four (24) hour period within a year, is also displayed within Figure 3-2. A strong correlation exists between average daily demand and maximum day demand. The two linear fit lines for both the maximum day and average daily demands follow very similar slopes. Therefore, as water usage increases over time in Acton, the maximum water usage on any given day increases in a similar linear fashion from year to year.

FIGURE 3-2: GRAPHICAL DEPICTION OF HISTORICAL WATER USE IN ACTON



The ratio between average daily and maximum day demand can be used as a peaking factor for future water use projections. Since 1985, this ratio has ranged between 1.87 (1991) and 1.41 (2001). This means that the maximum water demand during a given twenty-four (24) hour period in 1991 was 1.87 times the average for that year. The lowest peaking factors were in 2000 and 2001, indicating that in recent years water conservation may be increasing during periods of high water demand.

3.5.3 Per Capita Consumption

The total population serviced by Acton's water system is estimated using Town and US census data. Records from 1998 through 2000 were compiled as part of the District's effort to increase their WMA water withdrawal permit. These records are incorporated in this analysis. Table 3-8 details per capita water usage from 1998 through 2001.

TABLE 3-8: PER-CAPITA WATER USAGE IN ACTON

Year	Estimated Population Served	Total Water Used (mg)	Daily Per Capita Water Usage (gal/capita-day)	Residential plus Unaccounted Water Used (mg)	Daily Residential Per Capita Water Usage (gal/capita-day)
1998	17,372	688.9	108.6	469.9	74.1
1999	17,953	676.2	103.2	449.1	68.5
2000	18,631	676.8	99.3	456.0	66.9
2001	19,305	801.6	113.8	572.0[1]	81.2[1]

[1]Residential water use data unavailable, therefore estimated by deducting an average percent of water devoted to non-residential and process O&M to calculate residential water use.

Daily per capita water use was calculated by dividing the overall water use (during a given year) by the population serviced by Acton's water system and by the number of days in the year. From 1998 to 2001, the daily per capita water usage ranged between 99.3 and 113.8 gal/capita-day. These values represent the total water demand in Acton distributed among its serviced population.

Since Acton is primarily a residential community with little industry and a minor amount of commercial establishment, the residential per capita water demand was also assessed. The daily residential per capita water usage ranged between 66.9 and 81.2 gal/capita-day. These values represent the residential water usage plus the unaccounted for water.

3.5.4 Water Demand Management and Conservation Programs

Though the Town of Acton and the Acton Water District are separate entities, the Town and the Water District recognize the potential impact of water conservation on water supplies and wastewater disposal needs.

3.5.4.1 Town of Acton Efforts

The Town of Acton has conducted a recent study of water use among single family residential (SFR) dwellings within the Middle Fort Pond Brook Sanitary Sewer System. Before the construction of the sewers, the SFR dwellings in the District used an average of 49.06 gallons per day per bedroom (gpd/bdrm). This calculation is based on Acton Water District billing records for the 2000-2001 winter billing season. In the 2001-2002 billing season, the first season in which sewers were available, the gpd/bdrm dropped to 48.61. It decreased again in 2002-2003 to 47.38 gpd/bdrm.

The Acton Health Department theorizes this decrease in water use is due to the billing method of Town of Acton Sewer Commissioners. While the Water District bills in gross cubic feet used per billing period, the Town bills users with a direct gallons per day number. The use of the gpd number to bill sewer users may allow the property owner to more directly relate actual water usage in the home to the amount billed. It is the belief of the Health Department that the method of billing chosen by the Town is increasing water conservation within the Sewer District.

As a specific example of the Town's practices, the Town's recreational fields have adopted the EOEA recommendations for lawn and landscape water conservation measures. The Town's 2002 Open Space and Recreation Plan (2003) recommends that residents follow the same practice.

3.5.4.2 Acton Water District Efforts

The Acton Water District produced a report, Water Conservation Plan for Public Water Suppliers, in 2001. The Acton Water District is very active in promoting the conservation of water among its customers.

The District's water demand management and conservation plan is comprised of several facets, including recommendations for outdoor water conservation in line with the Town's Open Space and Recreation Plan. The benefits of the District's demand and conservation programs are shown through the reduction in peak water usage. Decreases have been observed in maximum daily demand since 1997 despite increases in the number of service connections, which indicates that customers are conserving water during times of high demand (Water System Master Plan Update, February 2002). Ongoing projects aligned with proactive water demand and conservation practices include:

- Meter modernization program expected to be completed in 2005;
- Annual meter testing and certification program for large production meters;
- Bi-annual leak detection survey;
- Flushing program coordinated with the period of greatest water supply (April);
- Outdoor watering ban according to a specific schedule;
- Outreach and education program through
    - Schools,
    - Web site http://www.actonh2o.com ,
    - Semi-annual Water Words publication,
    - Open house events,
    - Partnering with local organizations to encourage water efficient landscape designs, and
    - Drinking water information center;
- Providing water conservation supplies such as shower heads; and
- Tiered water use rates to encourage conservation.

Outdoor Watering Ban

The District enacts watering bans from May 1 to October 1 according to the following plan:

- Even numbered houses may use water outdoors on Tuesday, Thursday, and Saturday.
- Odd numbered houses may use water outdoors on Wednesday, Friday, and Sunday.
- No lawn watering from 7AM-7PM.
- No outdoor water use is allowed on Mondays (including new lawns).

Outreach and Education

The outreach and education program includes a detailed and comprehensive program focused on water conservation for use in schools:

- Classroom visits and field trips to wells and a water-wise garden with Water District staff;
- A selection of lessons and activities available through the Drinking Water Information center that can be presented by Water District staff, or provided to teachers;
- Lesson plans and consultation on drinking water topics that incorporate the Massachusetts Department of Education Science and Technology Curriculum Frameworks; and
- Sponsorship of student summer internships and special drinking water-related projects.

At a Water Conservation Open House during Drinking Water Week in May 2003 the Water District focused on water conservation practices. The District subsidized rain barrels that were available for local residents.

The Acton Water District and Acton Garden Club jointly sponsor a Water Wise Recognition Program, which is open to all residents, businesses, and municipal entities in Acton. A water wise garden is located at the Water District headquarters and is highlighted on the web site.

The District's Drinking Water Information center contains free brochures and fact sheets on a variety of drinking water topics including:

- Drinking water curriculum packages: elementary, middle, and high school;
- Drinking water videotapes;

- Slideshows;
- Testing equipment and supplies;
- Books; and
- Groundwater simulator model.

Water Conservation Supplies

In addition to the shower heads and rain barrels, fixtures and supplies provided by the Water District include toilet leak detection tablets with an instructions sheet and rain gauges.

Water Use Billing Rates

Water use billing rates increase with usage according to the tiers listed in Table 3-9. To further encourage conservation the summer billing rate is greater than the winter rate, especially for high usage.

TABLE 3-9: WATER USE BILLING TIERS

BLOCKS	SUMMER RATE	WINTER RATE
Up to 500 cubic feet.	$10.00	$10.00
All usage between 1 and 5000 cubic feet When 5000 cubic feet has been exceeded	.029 pr. Cu. Ft.	.024 pr. Cu. Ft.
5001 – 10,000 cubic feet	.031 pr. Cu. Ft	.026 pr. Cu. Ft
Over 10,000 cubic feet	.042 pr. Cu. Ft.	.035 pr. Cu. Ft.
Municipal rate	.027 pr. Cu. Ft	.027 pr. Cu. Ft.

If a reading cannot be obtained, estimates will be based on average previous usages.

3.6 FUTURE WATER DEMANDS

3.6.1 Future Water Demand Projections

Water demand projections for the Town of Acton were performed within the February 2002 *Water System Master Plan Update*. Projections for average daily demand and maximum day demand were evaluated for 2002 up through 2011. Water usage was projected using per unit consumption records along with household development forecasts generated by the Metropolitan Area Planning Council (MAPC) for the Town of Acton.

From 1990 through 2001, average consumption of water in Acton was 269 gallons per service connection per day. Using the MAPC forecasts of 7,384 units in 2002 and 8,307 units in 2011, projections of 1.99 MGD in 2002 and 2.24 MGD in 2011 were developed. Table 3-10 displays these projections.

The maximum day demand, also included in Table 3-9, was projected using the average ratio of maximum day to average day over the past five years (1997, 1998, 1999, 2000, and 2001). This ratio

comes out to 1.64-max/average daily demand. The years used to develop this ratio tend to reflect water conservation practices recently adopted by Acton residents. Water conservation practices are expected to continue, if not increase, in the years to come.

TABLE 3-10: WATER DEMAND PROJECTIONS (WATER MASTER PLAN UPDATE 2002)

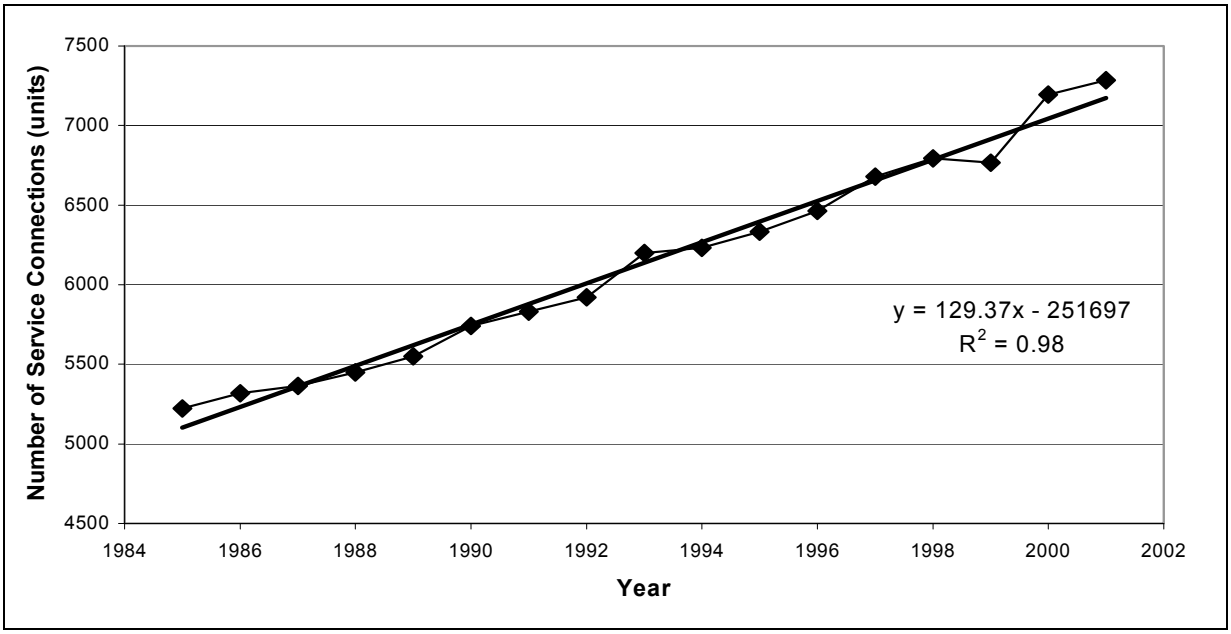
Year	Number of Services	Average Day Demand (MGD)	Maximum Day Demand (MGD)
2002	7,384	1.99	3.27
2003	7,484	2.02	3.31
2004	7,586	2.04	3.36
2005	7,689	2.07	3.40
2006	7,794	2.10	3.45
2007	7,900	2.13	3.50
2008	8,007	2.16	3.54
2009	8,116	2.19	3.59
2010	8,227	2.22	3.64
2011	8,307	2.24	3.68

3.6.2 Projected Service Connections

Since 1985, the number of services connected to Acton's drinking water distribution system has steadily risen, with the exception of 1998 to 1999, when the District accounted for a number of units that had previously been considered multiple service connections.

Figure 3-3 displays the increase in services connected to Acton's water system over time. Also displayed in Figure 3-3 is the linear trend line equation and the R-squared value, which can be used to assess the "fit" of the trend line to the data. An R-squared value of one represents a perfect linear fit. An R-squared of 0.98 is very close to one, which confirms that service connections in Acton have been increasing in a steady, linear fashion over time.

FIGURE 3-3: SERVICE CONNECTIONS TO ACTON'S WATER SYSTEM, 1985 TO 2001



The trend line equation predicts 8,466 service connections by 2011. The MAPC analysis discussed earlier suggests that there will be approximately 8,307 service connections. The difference between these two projections is 159 units, which does not significantly alter the projected water usage.

In 2000, the District provided a connection to the Great Road Condominiums, which added approximately 600 units to the system. This jump is displayed in Figure 3-3.

According to the Water System Master Plan, several large, undeveloped parcels exist within Acton that have a high possibility of future development. One site, the W.R. Grace property, is likely to be developed once remediation efforts are finalized. Possible developments at this location include a golf course or a business park.

3.6.3 Future WMA Permit Needs

Evaluating Acton's drinking water treatment and distribution system based on its overall pumping capacity of 4.17 mgd reveals that it would adequately supply the projected maximum day demand through 2011. Yet, to supply the projected 3.68 mgd (max day in 2011), most of the treatment and pumping facilities in Town would have to be running at maximum capacity.

In Acton's *Water System Master Plan Update* (February 2002), an evaluation of the adequacy of the current water system was conducted considering the possibility that the system was less than 100% operational. The evaluation was conducted with the Assabet Treatment Facility and the Marshall Pump Station offline. The Assabet Treatment Facility has the largest pumping capacity of all the facilities in Acton's system. Therefore, the worst-case scenario would be if the Assabet Facility were offline. The evaluation also considered the Marshall Pump Station to be offline since it has only been used periodically. The safe pumping capacity with these two sources offline is 3.06 mgd. Table 3-11 from the Water System Master Plan Update displays how the safe pumping capacity relates to future water use projections.

TABLE 3-11: ADEQUACY OF EXISTING SYSTEM (WATER SYSTEM MASTER PLAN UPDATE, FEBRUARY 2002)

Year	Safe Capacity (mgd)	Maximum Day Demand (mgd)	Surplus/Deficit (+)/(-)
2002	3.06	3.27	-0.21 mgd
2006	3.06	3.45	-0.39 mgd
2011	3.06	3.68	-0.62 mgd

Clearly, Acton's current drinking water collection, treatment and distribution system provides no factor of safety for maximum demand now or ten years into the future. The current safe capacity deficit is 0.21 mgd. This deficit is anticipated to grow as Acton's residential population continues to grow. Even with the Marshall Pump Station online, the Acton Water District needs to consider an additional well (or increased pumping rates) to ensure an adequate supply of drinking water in the coming years.

3.7 EVALUATION OF FUTURE WELL SITES

According to the latest update of the Water District Master Plan (March 2002) the only potential new groundwater source identified to date involves reactivation of Assabet Well #3. This well has been off line for over ten years due to contamination from volatile organic chemicals. It is likely that the well can only be put back in service if the water is treated for VOC removal. Other sand and gravel well sites were identified in the past but these have been lost to development. An earlier fracture trace analysis study by D.L. Maher identified four possible locations that are favorable for bedrock well exploration. These potential rock well locations may not be developed at a future date. The possible rock wells sites are located on higher ground near the center of Town and away from the stream valley aquifers.

3.8 IMPACTS TO WATER SUPPLY

To understand possible impacts to water supplies from wastewater disposal, we have addressed the possibility of locations where disposal facilities might be sited. Any disposal site must be located on sand and gravel soils. In addition, the water table must be 6 or more feet below grade to allow for a groundwater discharge and still maintain 4 feet of unsaturated soil beneath the disposal site.

To address the issue of potential impacts to water supplies we have developed a map of likely locations in Town where the soil type and depth to water table are favorable for location of such a facility. A more refined approach is addressed in Chapter 6 using the selection criteria for locations of satellite treatment facilities.

It is clear from Chapter 6 that a number of the potential disposal locations are in wellhead protections areas. Disposal of wastewater is not categorically excluded from these areas; however the presence of the water supply wells indicate that detailed field investigations will have to be made when planning facilities to insure sufficient travel time to meet DEP water reuse regulations.

3.9 WELLHEAD PROTECTION PROJECT

The Acton Water District (the District) commissioned a study by Woodard & Curran to identify high-risk land use activities that pose a threat to the District's drinking water sources. The Massachusetts DEP provided a grant for the project under its Source Water Assessment Program (SWAP). This project documented and located known high-risk land use activities within and near the Zone II's for the District wells.

The project entailed the identification, documentation, and mapping of threats of groundwater contamination to the supply wells of the District. The assessment included collecting information and conducting site investigations to locate and verify the following land use activities within the entire Zone II's of each well/wellfield:

- Hazardous material users/generators,
- Large septic systems,
- Rights-of-way,
- Farms and/or properties managed with pesticides/fertilizers/manure,
- Storage tanks (under ground and above ground), and
- Salt/deicing materials storage.

The information was compiled into a GIS database and mapped. The District was provided with tools and training to support the District's continued tracking of land use threats. A summary of threats to groundwater contamination in each Zone II is included in Table 3-12.

TABLE 3-12 THREATS TO GROUNDWATER CONTAMINATION IN ACTON'S ZONE II'S

Wellfield	Number of Septic Systems > 2,000 gpd	Groundwater Risk	Number of Sites Presenting Risk to Zone II	Number of Storage Tanks
		Low	3	0
Assabet	7	Medium	13	18
		High	26	31
		Low	3	0
Conant	21	Medium	6	3
		High	6	7
		Low	1	0
Kennedy	2	Medium	8	4
		High	6	5
		Low	0	0
School	10	Medium	1	1
		High	7	4
		Low	0	0
Whitcomb-Clapp	7	Medium	4	0
		High	10	2

These threats to groundwater contamination will be considered with other criteria such as the locations of sensitive receptors as part of the final site selection for potential wastewater treatment and disposal facilities.

4. STORMWATER MANAGEMENT SYSTEMS

4.1 INTRODUCTION

Over the last half of the 20th century, significant steps have been taken by the federal government to improve the nation's surface waters. Primarily, emphasis has been placed on regulating and treating municipal and industrial wastewater discharges. Treatment measures implemented by private and public entities to comply with rules and permits issued by federal, state and local officials have produced dramatic results. However, many of this nation's surface waters are still impaired by a wide range of pollutants. The next step toward improving water quality is stormwater management. Stormwater management is the broad term used to describe the efforts made to control non-point source pollution from roadways, lawns, and any other surfaces that may contribute flow to stormwater drainage systems.

Acton has experienced a rise in residential and commercial development over recent years. This increase in development has led to an increase in impervious land area. Land that is now roadways, lawns or parking lots was originally forestland or fields. Undeveloped land such as forestland promotes stormwater infiltration into the subsurface, which provides valuable recharge to the Town's aquifers. Roadways and rooftops, however, are impervious. Rainfall or snow melting off of impervious land collects and flows into the drainage system. The conversion of natural land to impervious land results in increased levels of runoff during rainfall events or during periods of snowmelt. Drainage systems that provide quick collection and transfer of stormwater from impervious surfaces to nearby surface waters can lead to a decrease in stormwater infiltration. Over time, less groundwater recharge can lead to lower base flow within the Town's rivers. In addition to the lack of groundwater recharge, stormwater flow from impervious land often collects, concentrates and delivers pollutants into natural water bodies.

This Chapter addresses stormwater management as it applies to the Town of Acton. A Watershed Trading Study (MADEP Project 00-07/319) that is currently underway in Acton applies to these analyses, and is therefore discussed in this Chapter. Sections of this Chapter include:

- Description of Acton's current stormwater drainage system
- Background to Watershed Trading Study (MADEP Project 00-07/319)
- Specific outfall site descriptions
- Analysis of groundwater recharge areas
- Stormwater Management Plan

EPA Phase II storm water regulations required the submittal of a Notice of Intent (NOI) under the general National Pollution Discharge Elimination System (NPDES) permit process. Acton has completed its work creating a Storm Water Management Plan (SWMP) and NOI in accordance with the draft general permit. The SWMP coordinates storm water issues with the Watershed Trading Study. Pertinent details are discussed in this Chapter.

4.2 STORMWATER DRAINAGE SYSTEM

Much of Acton's drainage system was constructed in the 1930's through the programs of the Works Progress Administration (WPA). At that time, little consideration was given to controlling the quantity or quality of stormwater entering natural water bodies. Only recently has stormwater management become an important topic among regulators, town departments, and concerned environmental activists.

Under the WPA programs, design of community stormdrain infrastructure was focused on reducing ponding or flooding of streets and/or properties. Since the construction of the original stormdrain system

in communities such as Acton, runoff from roads, parking lots, saturated yards, roofs, and many other impervious surfaces has been collected and conveyed to the closest, most accessible water body. Receiving waters include wetlands, ponds, or rivers. Unfortunately, direct discharge of stormwater to natural water bodies can prove to be detrimental to those water bodies. Constituents of stormwater such as sediments, nutrients, petroleum products, bacteria, and trash can place stress upon natural environments.

Since approximately 1980, new commercial and residential developments in Acton have been required to collect and transfer runoff into a vegetated detention basin, as stated under Section 8.2 of the Town of Acton Subdivision Rules and Regulations. Also stated in Section 8.2 of the Town Subdivision Rules and Regulations, "The peak rate of storm water runoff from the SUBDIVISION shall not exceed the rate existing prior to the new construction based on a 10 year design storm" (Section 8.2.3). A subdivision is defined as a tract of land divided into two or more lots.

In addition to these rules, developers of subdivisions containing 5 or more lots must adhere to Stormwater Management Standards set forth by MADEP. Standards listed in the Stormwater Management Handbooks (Volumes 1 and 2) include such measures as a minimum of 80% Total Suspended Solids (TSS) reduction in stormwater when designing a structural Best Management Practice (BMP) and the use of infiltration techniques to the maximum possible extent. These rules have been in effect in Massachusetts since March 1997 (date of Stormwater Management Handbook publication). New programs, such as the USEPA's NPDES Phase II Program, will act to further enhance stormwater management.

The ponds, rivers, and wetlands in Acton that receive stormwater flow from the Town's drainage system ultimately flow to the Assabet River. The Assabet River is an impaired body of water that suffers from excess nutrient loading and low dissolved oxygen.

Phase I of the Assabet River Total Maximum Daily Load (TMDL) study found that eutrophic conditions were common during the summertime months within many of the River's impoundments. A eutrophic state implies that a water body has accumulated excess nutrients, allowing for extensive plant growth to occur. In time, microorganisms break down the extensive plant growth, a process that requires significant amounts of dissolved oxygen. Eventually, slow flowing areas of the river experience deficiencies in dissolved oxygen, creating stagnant, anaerobic conditions. These conditions create unsuitable habitat for fish and most other native plant and animal species. Eutrophic areas can also be very unpleasing in an aesthetic sense, since algal mats are common within these areas.

The geography of Acton is not conducive to non-point source (NPS) controls in Acton having a direct benefit on the Assabet River. The only section of Acton that directly drains to the Assabet River is the southeastern corner of the Town, where a small section of the Assabet River crosses into the Town boundary. All other runoff within Acton discharges into wetlands, ponds and rivers that ultimately flow to the Assabet River through Warner Pond in Concord.

Warner Pond may be an effective remover of nutrients, which protects the Assabet River from excess nutrient loading due to non-point sources within Acton. NPS controls will benefit the streams within Acton that are tributary to Warner Pond. Despite the evidence of a no direct influence on the Assabet River, EPA has indicated that the watershed trading approach should be evaluated. The Town of Acton can claim credit for NPS controls that reduce phosphorous within the Town of Acton, since it is within the overall watershed. Therefore, even though most of Acton's stormwater is not directly discharged to the Assabet River, well-implemented stormwater management techniques in Town can influence tributary water quality that eventually enters the Assabet River.

4.3 WATERSHED BASED TRADING

Because of the current state of water quality in the Assabet River, the EPA and others have significant concerns about additional wastewater effluent discharges to the river. Through discussion with DEP/EPA, the Town of Acton embarked on a watershed based, point / non-point source trading study to demonstrate achievable reductions in phosphorous loading from non-point sources.

One of the original proposals for the WWTP included provisions for a point source discharge directly to the river. The goals of the watershed based trading program were to demonstrate whether sufficient phosphorous can be removed from non-point sources to offset the phosphorous that could be introduced via the new wastewater treatment facility. The methodology is to review NPS within Acton under existing conditions to establish the potential current phosphorus loading, and then to implement a pilot program to demonstrate the effectiveness and feasibility of solutions aimed at reducing NPS phosphorus loading.

The tasks to ascertain the potential effectiveness of watershed trading in the Town of Acton include the following:

1) Preliminary determination of the total amount of Phosphorus (P) available for trading throughout the Town;

2) Determination of implementable Best Management Practices (BMPs); and

3) Determination of the feasibility of using a computer-based model to estimate P loading from non-point sources.

The propsed WWTP discharge to surface waters was abandoned in favor of rapid infiltration beds (RIBs). The discharge to the RIBs resulted in groundwater flow to the Assabet River in lieau of a direct surface water discharge.

The Watershed Based Trading study was modified to:

1) Implement a pilot study to help determine the effectiveness and feasibility of structural and non-structural controls (BMPs) aimed at reducing phosphorus loading from stormwater sources; and

2) Generate a repot of findings.

4.3.1 Available Phosphorus in Non-Point Sources

A starting point to begin the analysis for available phosphorus included several assumptions that will be adjusted as data becomes available throughout the study. Preliminary determination of available P was made using the following assumptions:

- Rainfall = 41.5 inches/yr. = 0.11 inches/day = 0.0095 ft/day;
- 10% of rainfall will become runoff;
- The phosphorous concentration in the runoff averages between 0.2 and 0.5 mg/l;[1] and

[1] National Urban Runoff Program (NURP) Median Total Phosphorous concentration of 0.33 mg/l for residential areas.

- Acton encompasses approximately 20 sqmi.

Therefore, the following calculation is possible:

0.0095 ft of rain/day x (27,878,400 sq.ft./sq.mi.) x 7.48 gal/cu.ft. = 1.98 mgd of rain /sq.mi./day

1.98 mgd of rain / sq.mi. x 10% x 0.2 - 0.5 mg/l x 8.34 = 0.33 - 0.82 lbs P /sq.mi./day

0.33 to 0.82 lbs P / sq.mi. / day x 20 sq.mi. = 6.6 to 16.4 lbs P/day available for trading.

The amount of phosphorous which must be removed from non-point sources to offset or trade for the amount to be discharged is based on the following:

- The treatment facility is currently permitted for 250,000 gpd.
- The total phosphorus discharge limit will be 0.2 mg/l on an average monthly basis.
- Given these conditions, the phosphorous load to the river under design conditions would be 0.42 lbs/day (0.25 mgd x 0.2 mg/l x 8.34).
- Providing for a factor of safety set at a 3:1 trading ratio, the goal is to remove at least 3 lbs/day per lb of phosphorous discharged, or 1.25 lbs/day of P from the Acton watershed.

Using the above ranges of available phosphorous (6.6 to 16.4 lbs/day) and discharge scenarios, the goal of removing phosphorous from non-point sources in Acton represents an approximate removal rate of between 8% and 20%. If actual phosphorous concentrations, runoff coefficients, or feasible sites, are less than assumed, then a higher removal rate will be necessary to achieve the goal.

4.3.2 Best Management Practices – Non-point Source Control

The preliminary results of the Watershed Based Trading program recommend implementation of both structural and non-structural BMPs. Due to the prevalence of existing stormwater infrastructure in developed areas, it expected that both structural and non-structural controls will be employed to reduce runoff contaminants in these areas. Due to the lack of this type of infrastructure in non-developed areas, it is expected that the majority of controls implemented in farming and forestry areas will be non-structural controls.

The program continued through the implementation phase being undertaken in conjunction with the CWRMP and the Town's NPDES Phase II Permit Program. The USEPA's NPDES Phase II Program will soon govern Acton's stormwater management techniques. The Phase II program addresses many stormwater controls that can be implemented by a community to improve stormwater quality. A Stormwater Management Plan was completed in June of 2003 under NPDES Phase II guidelines. Acton has taken initiative to comply with portions of Phase II by working with the MADEP and the USEPA on a 319 Grant project (MADEP Project 00-07/319).

4.3.3 Grant Program – Non-point Source Control

The Watershed Trading Study is funded under an s.319 competitive grant. According to the USEPA grant scope, "This project is intended to pilot watershed trading programs that will become increasingly important and common in the coming years as communities strive to meet new NPDES requirements".

In addition to providing a valuable study program to the MADEP and the USEPA, Acton will construct two structural BMPs that will help reduce nutrient loading to local surface waters. Also, a non-structural

BMP program will be implemented which will educate and inform Town departments and the citizens of Acton on stormwater issues. The non-structural BMP program includes recommending additions or changes to Town bylaws for yard and pet waste management and suggesting policy changes for such things as catch basin cleaning or street sweeping. Portions of this program have been incorporated into Acton's Stormwater Management Plan.

4.3.4 Retrofitting Structural BMPs

Structural BMPs such as constructed wetlands or detention basins have become common across Massachusetts in areas of new residential and commercial development. Developers looking to meet 80% reduction in TSS (as per Massachusetts Stormwater Management Guidelines) within their stormwater runoff must implement a structural control that is designed to meet this TSS reduction percentage. Steps to implement stormwater quality and quantity controls in areas of new development are forward thinking and display initiative to protect surface waters from additional environmental stressors. BMPs designed to infiltrate stormwater into the ground not only act to improve surface water quality, they also provide valuable recharge water that would be lost if stormwater were simply discharged to a nearby surface water.

Measures to treat or detain stormwater from existing developments through implementing structural BMPs into existing drainage systems may further enhance the quality of receiving waters. However, changing or adding BMPs to an existing stormwater drainage system for the purpose of enhancing stormwater quality can prove to be a difficult process. The challenge lies in the limited space available near existing outfalls, the limited access for construction or Operation and Maintenance (O & M) equipment, the lack of available head loss between an outfall and its receiving water (since outfalls tend to be placed at the edge of streams and wetlands), and the limited number of potential technologies available for retrofitting. Also, many of the structural BMPs outlined in technical fact sheets and reports by the MADEP, the USEPA, and the Center for Watershed Protection, or studies conducted by colleges and universities tend to focus on treating stormwater produced from new developments, and not from existing drainage.

Due to the considerable cost and time associated with retrofitting stormwater quality controls across a Town's entire drainage system, the NPDES Phase II program does not require communities to retrofit structural BMPs. Instead, the Phase II program focuses on non-structural practices that may provide guidance to Town departments and draw attention to stormwater management to inform local citizens of their role in stormwater management.

Acton's Watershed Trading Study incorporates evaluating and recommending non-structural BMPs that can be implemented by Town departments. Additionally, two structural BMPs will be constructed and monitored for phosphorus reduction capability. Because of the aforementioned difficulties associated with retrofitting BMPs into existing systems, especially for nutrient reduction, sites for suitable retrofit were difficult to locate. Variations of traditional designs may be required.

Looking beyond typical "programmed" applications of new BMPs is important to the success of the Watershed Trading Study. For example, retrofitting an existing pond structure to allow for greater detainment of stormwater may produce significant results such as allowing for more suspended solids to settle, or additional infiltration. Changing a stormwater detention pond into a constructed wetland is also a possible retrofit. Additions such as sediment forebays in front of constructed wetlands can further enhance pollutant and nutrient removals. Many of these possibilities are currently being considered in the search for successful BMPs to install in Acton.

4.4 POLLUTANT LOADING ANALYSIS

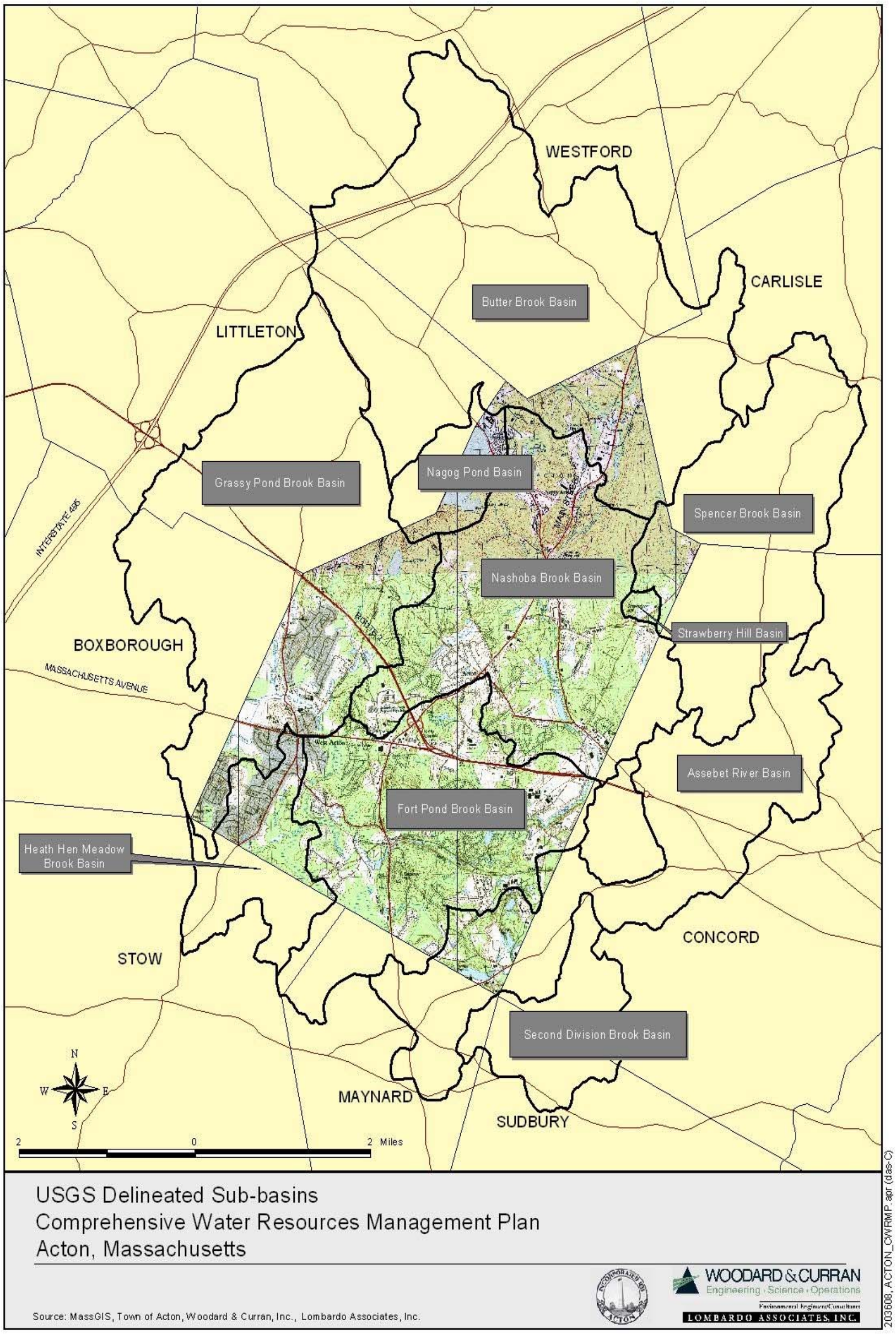
A major component of the Watershed Trading Study involves evaluating outfall sites throughout Acton to determine promising BMP study locations. These evaluations are applicable to this CWRMP since they provide descriptions of typical drainage basins across Acton. Included in these outfall evaluations is an analysis of potential nutrient sources within each contributing drainage area.

The mitigation of non-point sources of nutrient loading requires an iterative approach to analysis since an estimate of pollutant loading from a computer-based model does not provide any "real world" determination of the feasibility of installing structural mitigation measures. Non-structural mitigation measures would be carried town-wide, impacting all sub-basins. Therefore, determining the feasibility of implementing mitigation measures has taken precedence over the modeling of potential P loading.

4.4.1 Sub-basins in Acton

A total of ten (10) drainage sub-basins exist within Acton's boundary. These sub-basins are defined and used by the United States Geological Survey (USGS) Water Resources Division and by The Massachusetts Water Resources Commission. Sub-basins were delineated either from the mouth of a stream or from a USGS gauging station location. Names for these sub-basins are characterized by bodies of water or features located within the sub-basin. Figure 4-1 displays the names and delineations of the ten (10) drainage sub-basins within Acton.

FIGURE 4-1 DRAINAGE SUB-BASINS WITHIN ACTON



4.4.2 Evaluated Outfalls

Over 100 outfalls were inspected as part of the initial field inspection to identify sub-basins. A total of seventeen (17) outfall sites were subsequently evaluated as potential BMP study locations across Acton. The original seventeen (17) sites were determined through recommendations from the Board of Health along with evaluation of Acton's stormdrain maps and field reconnaissance. Ideally, a good cross-section of land-uses and basin sizes were sought when locating the initial sites. Sites were ranked based on such categories as potential for significant phosphorus loading and adequate room for a structural BMP. Specific ranking criteria are listed in Table 4-1, Site Selection Process.

The initial 17 sites were visually inspected and evaluated. A draft Site Selection Matrix (SSM) was developed during this initial round of inspections to focus the evaluation efforts on the most promising ten sites.

The SSM was refined with each round of inspections. Methods for developing the site selection matrix were derived from such sources as the Massachusetts Stormwater Policy Handbook (prepared by the MADEP and The Office of Coastal Zone Management), EPA fact sheets on BMP technologies, and EPA and MADEP stormwater management documents. These materials provide valuable information on non-point sources of nutrients, BMP technologies that may be used to lower nutrient concentrations in stormwater, and site characteristics that can be favorable to or complicate BMP applications.

The SSM displays all 17 sites across the top of the matrix columns. The site selection criteria, or categories, are aligned along the left side of the matrix in rows. The selection categories reflect the desirable characteristics for design and construction of a BMP at the site.

Each site was ranked based on a number of important site criteria. The matrix uses a ranking of 1 to 3 for any acceptable selection criteria, with 1 being the least favorable and 3 being the most favorable.

A multiplier from 0.3 to 1 was used to weigh the importance of the criteria. For example, the potential for high phosphorus loading is very important to this study; therefore, it was assigned a multiplier of 1. Less important criteria, such as the potential for combining multiple BMP technologies, were assigned a multiplier of 0.3.

TABLE 4-1: SITE SELECTION MATRIX

Selection Criteria / Category	Category Multiplier (0.1-1)	Agawam Road (B/W #34 & #36)	Agawam Road (B/W #32 & #34)	Cherokee Road	Cowdrey Lane	Duggan Road	Horseshoe Drive (Pond)	Kelley Corner (Across from Roche Bros.)	K-Mart (NW Corner of Parking Lot)	Knowlton Drive	Larch Road	Milldam Road	Mohawk Drive	(A) Phalen Street (BMP at End-of-Pipe)	(B) Phalen Street (BMP in Road)	Quaboag Road	Seneca Road	Simon-Willard Road	Wetherbee Street
Suitable Space for Structural BMP	1	3	3	1	1	2	3	2	2	2	3	2	3	2	2	3	3	1	3
Capacity for Headloss	0.8	1	1	1	1	2	3	3	0	1	3	1	1	0	1	1	1	0	3
Easement or Identified Land Ownership	0.5	1	1	1	1	1	2	3	2	2	3	1	1	2	3	1	2	1	3
Accessible for Construction	0.7	1	1	2	1	1	3	3	3	1	3	2	1	2	3	3	3	2	3
Accessible for Monitoring and O&M	0.7	1	1	2	1	1	3	3	3	1	3	2	1	2	3	3	3	2	3
Ease of Permitting	0.5	3	3	2	1	2	1	3	1	1	2	3	3	2	2	2	2	1	2
Infiltration Possibilities	0.8	3	3	2	0	2	2	1	0	0	1	3	3	0	0	2	2	0	2
Potential for Combined Technologies	0.3	2	2	1	1	1	3	2	1	1	2	2	2	2	0	3	2	1	2
Predictable Flows	0.8	3	3	3	3	3	3	2	2	3	2	3	2	2	2	3	2	3	3
Potential for High Phosphorus Loading	1	1	1	1	1	2	3	3	2	3	2	2	2	3	3	2	1	2	3
Neighborhood Acceptance	0.5	1	1	1	1	1	2	3	3	3	3	1	1	1	2	2	2	1	3
Demonstration Potential	0.7	1	1	1	1	1	2	3	2	1	2	1	1	2	2	2	1	1	3
Downstream Influence	0.8	1	1	1	3	1	3	2	1	3	1	1	1	2	3	2	1	1	3
Total Score:	-	15.6	15.6	13.4	11.5	14.8	23.8	22.8	15.3	16	20.8	17	15.8	15.5	18.9	20.4	17.3	11.5	25.7

Ranking Code:

1 = Least Favorable

3 = Most Favorable

0 = Disqualified Category

Color/Shading Code:

- 5 Sites Recommended for Baseline Monitoring
- 5 of the 10 Sites Outlined in QAPP, No Baseline Monitoring
- Sites Disqualified due to Low Ranking

In some cases a site was not acceptable, or not feasible, in one particular category for implementing a structural solution. Therefore, a ranking of zero (0) was assigned to these sites for that specific category. A site was removed from further consideration if it received a score of zero for any critical criteria, with critical criteria defined as having a category multiplier of at least 0.8.

Criteria deemed critical to the installation of a structural BMP are:

- Suitable space for a structural BMP (including minimizing any negative environmental impact);
- Capacity for head loss through a structural BMP;
- Potential for infiltration (the most effective means of reducing phosphorus loads in surface waters);
- Predictable flow (critical for proper sizing and operation of a structural BMP);
- Potential for high phosphorus loading; and
- Downstream influence (measurable and effective reduction in phosphorus).

Other criteria used for site selection are:

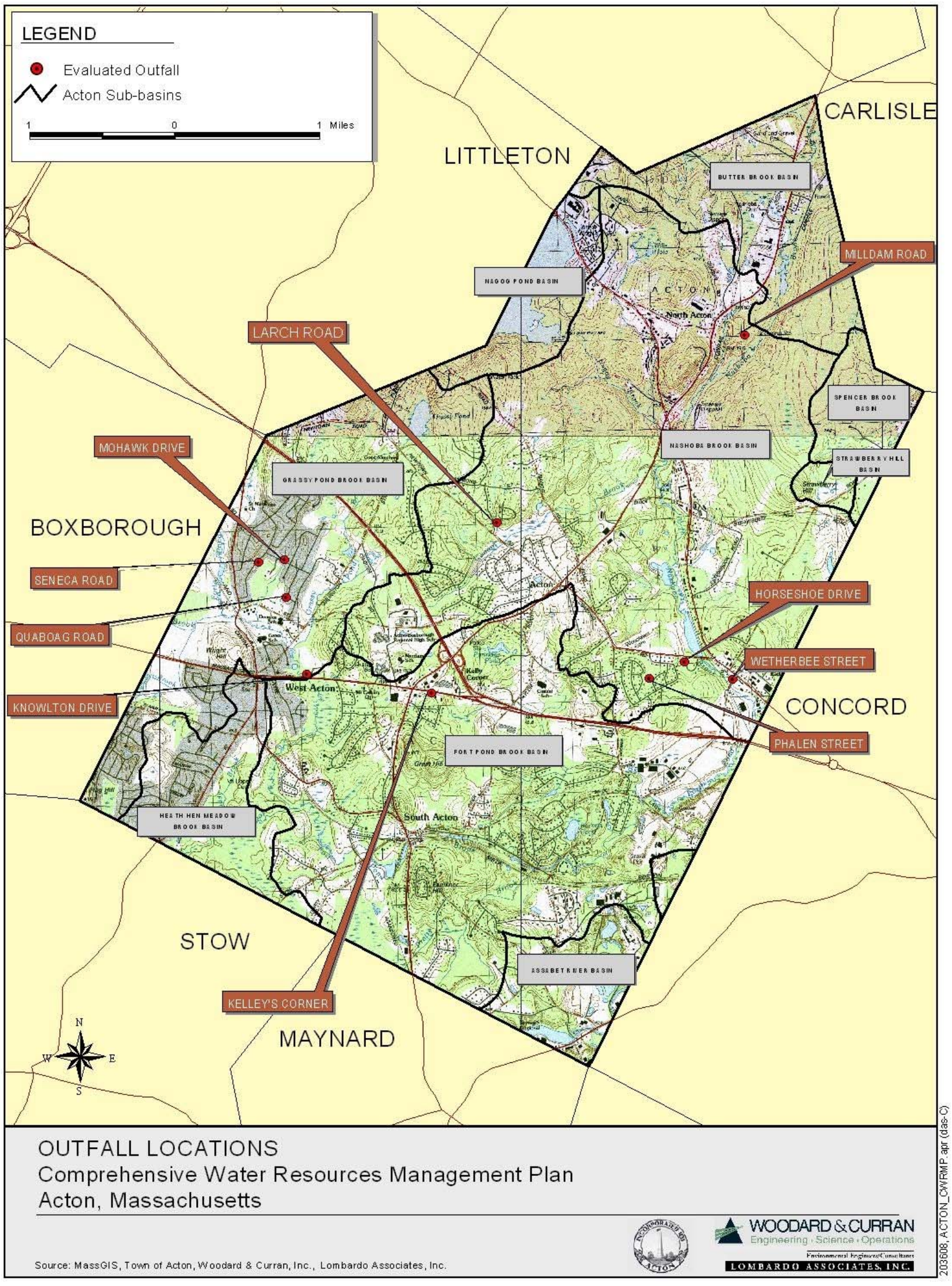
- Easement or identified land ownership at the site (necessary to avoid construction delays and acquisition costs);
- Accessible for construction
- Accessible for pre and post monitoring and Operation & Maintenance (O&M) (for continued proper operation, and to minimize long-term costs);
- Ease of permitting (to keep the project schedule on track);
- Potential for combined technologies;
- Neighborhood acceptance; and
- Demonstration potential (at a location easily viewed or accessed by the general public).

The list of seventeen (17) initial sites was narrowed down to ten (10) using the SSM ranking process. The ten sites include:

1. Horseshoe Drive
2. Kelley's Corner
3. Knowlton Drive
4. Larch Road
5. Milldam Road
6. Mohawk Drive
7. Phalen Street
8. Quaboag Road
9. Seneca Road
10. Wetherbee Street

These ten selected sites are displayed in Figure 4-2, Acton Evaluated Outfalls.

FIGURE 4-2 OUTFALL LOCATIONS



Horseshoe Drive

Horseshoe Drive is located in east Acton, close to the intersection of Concord Road and Great Road (Route 2A). Horseshoe Drive intersects Concord Road at both ends, wrapping in a semi-oval shape similar to that of a horseshoe. At the western intersection of Horseshoe Drive and Concord Road, drainage from the "Poets' Corner" residential village collects in a small, shallow pond located behind two homes that abut the intersection. The pond's area is estimated to be approximately 0.15 acres. Leaf litter and silt have accumulated in the pond over time. The continued accumulation of leaf litter and silt was confirmed by a resident of one of the adjoining properties, who contributed the following information:

- Hydraulically, the pond responds to short duration, heavy rainfall events by filling rapidly, followed by quickly draining back to baseflow depth.
- A noticeable reduction of wetland plants has occurred in the pond over recent years.
- Highest level of flooding observed when the flood level approached the foundation of the house on Horseshoe Drive.

Overflow from the pond drains east along Concord Road where it discharges to Nashoba Brook, located approximately 750 feet away. Base flow is observed under dry conditions, which indicates high groundwater in the area.

The drainage basin that contributes stormwater flow to the pond is primarily residential. Many medium sized, well-maintained residential lawns are located within the pond's drainage basin. Stormwater flow primarily originates from impermeable roads, driveways, roofs, and saturated yards. High potential exists for significant phosphorus loading to the pond and, in turn, to Nashoba Brook due to the lawn care activities of homeowners.

Characteristics of the Horseshoe Drive site that make it a suitable BMP study location include:

- Large residential area contributing stormwater, with the potential for high phosphorus loading;
- Numerous possibilities for altering or adding to current pond structure to enhance nutrient removal;
- Potential for combined technologies upstream of the pond;
- Potential for the upstream enhancement of the stormwater quality entering Nashoba Brook (relatively direct drainage channel from the pond outfall to Nashoba Brook exists);
- Potential for enhancement of pond landscape, thereby providing a good relationship between neighborhood residents and the Town; and
- Easy access for construction and O & M equipment.

Kelley's Corner

Kelley's Corner encompasses the commercial intersection of Massachusetts Avenue (Route 111) and Main Street (Route 27). Businesses in the area include K-Mart, Roche Brothers Grocery, McDonalds and several auto repair shops. The primary sources for stormwater runoff include the impermeable parking lots, roads, and roofs of these businesses. Some residential runoff from Kelley Road and Beverly Road also contributes to stormwater flow.

The potential for significant phosphorus loading exists at this location due to the contribution of stormwater from commercial, and, to some extent, residential land uses. Studies differ in concluding how significant phosphorus loading may be from commercial land use. Most studies indicate that residential land use exports higher concentrations of total phosphorus as compared to commercial land use, yet the

potential for a greater net export of total phosphorus exists at Kelley's Corner when compared to a smaller residential drainage area. This is due to the relatively large impermeable area, which, overall, produces more runoff than many of the residential outfall locations evaluated in this report.

A total of three drainage outfalls are located within the location identified as Kelley's Corner. These three outfalls are described as follows:

- A 24-inch outfall pipe oriented parallel to Massachusetts Avenue discharges into a drainage channel in front of a daycare center along Massachusetts Avenue (across Massachusetts Avenue from Roche Brothers).
- An 8-inch outfall pipe discharges diagonally from Massachusetts Avenue into the same drainage channel, at approximately the same location as the 24-inch outfall pipe.
- An 8-inch outfall pipe enters at a 90-degree angle to the drainage ditch, draining the parking lot of the daycare center. This pipe is located approximately 20 feet to the east of the other two outfall pipes.

The drainage channel that accepts stormwater from these three outfall pipes is a rocky channel located approximately 30 feet south of, and running parallel to, Massachusetts Avenue. The channel flows east toward a wetland area, which ultimately discharges to Fort Pond Brook. Wetlands are commonly considered to be nutrient sinks during the growing season, therefore acting as natural stormwater BMPs.

Characteristics of the Kelley's Corner site that make it a suitable BMP study location include:

- Extensive commercial drainage area, which may prove to export a significant net amount of total phosphorus;
- Excellent location for a community demonstration project;
- Few, if any, land ownership complications – adjacent Town easement may be used for structural BMP site; and
- Installing a structural BMP would take advantage of treating stormwater flow from one of the few highly commercialized areas in the Town.

Knowlton Drive

Knowlton Drive is located in West Acton, between Massachusetts Avenue and Joseph Reed Lane. A 36-inch outfall pipe discharges stormwater directly to Fort Pond Brook, just north of Massachusetts Avenue. The outfall discharges stormwater from the residential area to the east of Knowlton Drive, including catch basins along Joseph Reed Lane, Deacon Hunt Drive, Captain Brown Lane, and Captain Forbush Lane. The area is residential, with many medium sized, well-maintained yards. Stormwater flow in the area primarily consists of runoff from impervious roads, driveways, roofs, and saturated yards. Lawn care activity likely contributes phosphorus to stormwater runoff at this site.

Drawbacks to using this site for a BMP study project include limited access to the outfall location and the short distance/minimal elevation change from the outfall location to Fort Pond Brook. Flooding of Fort Pond Brook would likely impact any BMP constructed at the current outfall location. Limited potential exists for a BMP to be installed upstream of the outfall, close to the start of the 36-inch drainage pipe (near Joseph Reed Lane).

Characteristics of the Knowlton Drive site that make it a suitable BMP study location include:

- Large residential area contributing stormwater, with the potential for high phosphorus loading; and

- Direct downstream impact due to discharge to Fort Pond Brook.

Larch Road

Larch Road is a small residential road located off Evergreen Road in central Acton. Two pipes, a 12-inch pipe and a 24-inch pipe extend out of a headwall on the east side of Larch Road. The 24-inch pipe runs under Larch Road, parallel to Evergreen Road, while the 12-inch pipe drains the catch basins on Larch Road. A concrete diversion culvert inlet on the west side of Larch Road collects surface water from a rocky drainage channel. This water flows under Larch Road through the 24-inch pipe. From the east side of the Larch Road culvert, water flows out of the outfall pipes into a drainage channel that runs parallel to Evergreen Road. The drainage channel eventually discharges into a large wetland located approximately 300 feet downstream. The wetland ultimately flows into Nashoba Brook.

The contributing drainage area to this site primarily consists of mixed residential lots and woods. A significant amount of phosphorus export is not likely at this site due to the relatively small fraction of maintained residential land as compared to the extensive amount of forest in the area.

Positive attributes of implementing a study BMP at the Larch Road site include little to no land ownership or space restrictions, adequate capacity for head loss, and ease of accessibility. Drawbacks include the potential for only medium to low phosphorus loading along with the eventual flow of outfall waters into wetland areas, which typically act as nutrient sinks during the growing season.

Characteristics of the Larch Road site that make it a suitable BMP study location include:

- Few restrictions on land area and ownership;
- Easy site accessibility;
- Adequate capacity for head loss; and
- Plenty of room available for a structural BMP.

Milldam Road

Milldam Road is a residential cul-de-sac located in north Acton. Modern homes located on medium sized residential lots abut Milldam Road and the adjacent streets. Stormwater flow primarily consists of runoff from streets, driveways, roofs and saturated yards.

The stormwater outfall evaluated is located between #4 and #5 Milldam Road. The outfall is a debris cluttered concrete sluiceway located adjacent to the driveway of house #5. The outfall drainage basin is small, accepting flow from approximately 10 catch basins on Milldam Road, Kate Drive, and Sawmill Road. Flow from the outfall drains into the wooded backyards of #4 and #5 Milldam Road, where it ultimately enters Nashoba Brook, located approximately 200 feet to the east.

Although there is a potential for moderate phosphorus loading from lawn maintenance activities, space at the site is limited due to the close proximity of the outfall to surrounding homes and driveways. In addition, land ownership complications would likely impact efforts to implement a structural BMP at this location.

Characteristics of the Milldam Road site that make it a suitable BMP study location include::

- Potential for moderate phosphorus loading due to lawn care activities;
- Accessible for construction and O & M equipment; and

- Potential for a relatively direct enhancement of stormwater entering Nashoba Brook (a minor amount of buffer currently exists between the outfall and Nashoba Brook).

Mohawk Drive

Mohawk Drive is a residential road in west Acton located between Central Street and Nashoba Road. Medium sized, well-maintained residential parcels abut Mohawk Drive.

The stormwater outfall evaluated is located on the east side of Mohawk Drive, between #13 and #15 Mohawk Drive. The outfall is a 24-inch pipe that is half filled with debris. The outfall discharges stormwater from approximately six catch basins along Mohawk Drive, in addition to water from a drainage channel on the west side of Mohawk Drive. The drainage channel on the west side of the road accepts water from residential land to the west of Mohawk Drive. Stormwater flowing from the outfall enters forest land behind houses #13 and #14, where it ultimately flows into a small wetland. The wetland drains to Fort Pond Brook, which is located approximately 1,500 feet to the south of the outfall location.

Overall, phosphorus loading potential at this location is only moderate due to the limited drainage area, which consists primarily of mixed residential land and some forest land. Accessibility to the outfall is partially hindered by woods and by private property.

Characteristics of the Mohawk Drive site that make it a suitable BMP study location include:

- Moderate potential for phosphorus loading; and
- Suitable area available for a structural BMP.

Phalen Street

Phalen Street is located in the "Poets' Corner" residential neighborhood of east Acton. Many medium sized, well-maintained residential lots are located in the "Poets' Corner" area. Stormwater flow in the area primarily originates from impervious roads, roofs, driveways, and saturated runoff from yards. Groundwater appears to be high due to the year-round presence of standing and/or flowing water in the surface drainage channels.

The outfall evaluated is located on an easement to the west of #10 Phalen Street. The outfall consists of a 12-inch, partially submerged concrete pipe. A significant drainage area collects and drains to this outfall location. Significant phosphorus loading is likely due to the lawn care activities of homeowners within the large drainage basin.

Stormwater from the outfall flows through a drainage channel behind #10 Phalen Street, where it merges with a second drainage channel that contains flow from other sections of "Poets' Corner". The stormwater is then routed into a grated 24-inch pipe which outlets to the pond on Horseshoe Drive (Horseshoe Drive Site). Ultimately, drainage from "Poets' Corner" flows to Nashoba Brook.

Several disadvantages of using this site as a BMP study location include limited space at the site due to the close proximity of the outfall to surrounding homes and driveways, high groundwater levels, and little to no capacity for head loss.

Characteristics of the Phalen Street site that make it a suitable BMP study location include:

- Large residential area contributing stormwater, with the potential for high phosphorus loading; and
- Potential for addressing and improving drainage concerns in the area.

Quaboag Road

Quaboag Road is a residential street extending between Agawam Road and Seneca Road in east Acton. Like Mohawk Drive, Quaboag Road has many medium sized, well-maintained residential lots. Stormwater flow in the area primarily originates from impervious roads, roofs, driveways, and saturated runoff from yards.

The outfall evaluated on Quaboag Road is located on an easement to the south of #36 Quaboag Road. The outlet pipe is covered by a significant amount of silt, debris, and leaf litter. The outfall drains several catch basins and low-lying areas along Quaboag Road. Water from the outfall flows into a stagnant drainage pond behind house #36. The pond currently has no outlet. The homeowner at #36 Quaboag Road mentioned that the Town was considering alleviating flooding and drainage problems at the pond by installing a pipe to route a portion of the water in the pond to a wetland, which is also located behind house #36. The wetland area ultimately drains to Fort Pond Brook.

Phosphorus loading potential at this site is only moderate. Even though the primary runoff is residential, the drainage area is not as large as the other sites that were evaluated. Land ownership complications and high groundwater levels are disadvantages for constructing a structural BMP at this location.

Characteristics of the Quaboag Road site that make it a suitable BMP study location include:

- Potential for concurrently resolving drainage issues in the neighborhood;
- Easy access for construction and O & M equipment; and
- Potential for enhancement of pond landscape.

Seneca Road

Located in the same neighborhood as Mohawk Drive and Quaboag Road, Seneca Road is a residential road with medium sized, well-maintained residential lots. Seneca Road connects Agawam Road to Mohawk Drive. Stormwater flow in the area primarily originates from impervious roads, roofs, driveways, and runoff from saturated yards.

The evaluated outfall is located between #9 and #11 Seneca Road, approximately at the midpoint of the road. Drainage pipes for Seneca Road tie into a culvert that connects the wetland at the northerly side of the road to the wetland located at the southerly side of the road. Stormwater entering the wetland eventually flows into Fort Pond Brook.

Outflow from the culvert is a combination of high groundwater, stormwater, and outflow from the wetland. Room for implementing a structural BMP exists at the culvert location, yet phosphorus loading may be relatively low. A mix of ground water, outflow from the wetland, and stormwater from a small residential area is not likely to contain significant concentrations of total phosphorus. Non-structural BMPs may be best suited for this area.

Characteristics of the Seneca Road site that make it a suitable BMP study location include:

- Adequate room for implementing a structural BMP; and
- Good accessibility for O & M and construction equipment.

Wetherbee Street

Wetherbee Street is located in east Acton, running from the high traffic commercial area along Route 2A (Great Road) south to Route 2 (Massachusetts Avenue). Restaurants, shops, businesses, and residential parcels are located within this drainage area. Roads, parking lots and rooftops of these commercial and residential parcels are the primary sources of stormwater runoff.

The outfall lies just south of the intersection of Wetherbee Street and Route 2A. Stormwater from parking lots and residential areas located northeast of Route 2A is routed to an 18-inch outfall pipe. Residential roads contributing flow to the outfall include Azalea Road, Bayberry Road, and Myrtle Drive. Stormwater exiting the outfall on Wetherbee Street is routed directly to Nashoba Brook, located approximately 30 feet downstream of the outfall. A recently maintained earthen swale conveys stormwater from the outfall pipe to Nashoba Brook.

Two potential locations for a structural BMP exist at this location:

- The outfall pipe close to Nashoba Brook; and
- The overgrown drainage channel located between the Burger King parking lot and D'Angelo's Restaurant on Route 2A.

A high potential for significant phosphorus loading exists at this site. Fertilized lawns (commercial and residential), parking lots and roadways are all potential sources of phosphorus. The capability to enhance stormwater that directly enters Nashoba Brook provides additional incentive for further evaluation of this outfall location.

Characteristics of the Wetherbee Street site that make it a suitable BMP study location include:

- High potential for significant phosphorus loading;
- Adequate room and head loss capacity for implementing a structural BMP;
- A BMP along Wetherbee Street would enhance the quality of stormwater, which currently flows (relatively unhindered) into Nashoba Brook; and
- Excellent location for a demonstration project.

4.4.3 Summary of Outfall Site Characteristics

Table 4-2 contains an informative breakdown of pertinent characteristics for each of the ten (10) outfalls evaluated. The size of each drainage basin is described as small, medium or large in relation to other basins within the Town based on visual estimates from the Town drainage maps. The ten (10) outfalls are a good representative sample of typical outfalls throughout the Town, with varying land uses, drainage basin areas, pipe diameters, outfall locations, and watershed impacts.

TABLE 4-2: SUMMARY OF SITE CHARACTERISTICS

Site Location	Typical Land Use in Drainage Basin	Relative Size of Drainage Basin (S/M/L)	Outfall Diameter(s)	Impact on Receiving Stream (Low, Medium, High)	Watershed District
Horseshoe Drive	Residential	Large	30" pipe to drainage channel	High	Nashoba Brook
Kelley's Corner	Commercial	Large	24", 8", 8"	Low (drains to wetland)	Fort Pond Brook
Knowlton Drive	Residential	Medium	36"	High	Grassy Pond Brook
Larch Road	Forest/Residential	Medium	24", 12"	Low (drains to wetland)	Nashoba Brook
Milldam Road	Residential	Small	Concrete Sluiceway	Medium (buffered by woods)	Nashoba Brook
Mohawk Drive	Residential	Medium	24"	Low	Grassy Pond Brook
Phalen Street	Residential	Large	12"	Medium (buffered by pond)	Nashoba Brook
Quaboag Road	Residential	Small	18" (covered)	Low (drains to pond)	Grassy Pond Brook
Seneca Road	Residential/ Wetland	Medium	24"	Low (drains to wetland)	Grassy Pond Brook
Wetherbee Street	Commercial and Residential	Medium	18"	High	Nashoba Brook

4.5 GROUNDWATER RECHARGE

The natural recharge of groundwater through the infiltration of rain water or snow melt is very important for Acton. Acton relies on groundwater for its drinking water needs, therefore, it is beneficial for stormwater to infiltrate into the subsurface rather than flow into tributaries and streams, which ultimately lead out of the Town. This section discusses the extent of each hydrologic soil group present in Acton and presents a map (Figure 4-3) of these soil classifications for help in determining which areas of Town have the natural tendency to recharge subsurface aquifers through stormwater infiltration.

Several factors determine the extent of runoff from particular land areas. As discussed, urbanization typically increases impervious land area. However, even undisturbed land differs in infiltration capacity. The Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), has classified soils into four groups in relation to infiltration capacity. Table 4-3 displays each of the four hydrologic soil groups and lists the characteristics that define each.

TABLE 4-3: HYDROLOGIC SOIL GROUPS AS DEFINED BY THE UNITED STATE NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

SOIL GROUP	CHARACTERISTICS
A	Low overland-flow potential; high minimum infiltration capacity even when thoroughly wetted (> 0.30 in. h^{-1} = 0.76 cm h^{-1}). Deep, well- to excessively drained sands and gravels.
B	Moderate minimum infiltration capacity when thoroughly wetted (0.15 to 0.30 in. h^{-1} = 0.38 to 0.76 cm h^{-1}). Moderately deep to deep, moderately to well-drained, moderately fine- to moderately coarse-grained (e.g., sandy loam).
C	Low minimum infiltration capacity when thoroughly wetted (0.05 to 0. 15 in. h^{-1} = 0.13 to 0.38 cm h^{-1}). Moderately fine- to fine-grained soils or soils with an impeding layer (fragipan).
D	High overland-flow potential; very low minimum infiltration capacity when thoroughly wetted (<0.05 = 0.13 cm h^{-1}). Clay soils with high swelling potential, soils with permanent high water table, soils with a clay layer near the surface, shallow soils over impervious bedrock.

Figure 4-3 displays the hydrologic soil group designations assigned by NRCS as they apply to Acton's soil survey map. These hydrologic soil group designations are listed in the Middlesex County Interim Soil Survey Report (Fourth Ed., July 1995). To display which areas in Town have the natural capability for infiltrating stormwater, Table 4-4 was created. A percentage breakdown of the hydrological soil group for each sub-basin is displayed in Table 4-5.

FIGURE 4-3 NRCS HYDROLOGIC SOIL GROUPS

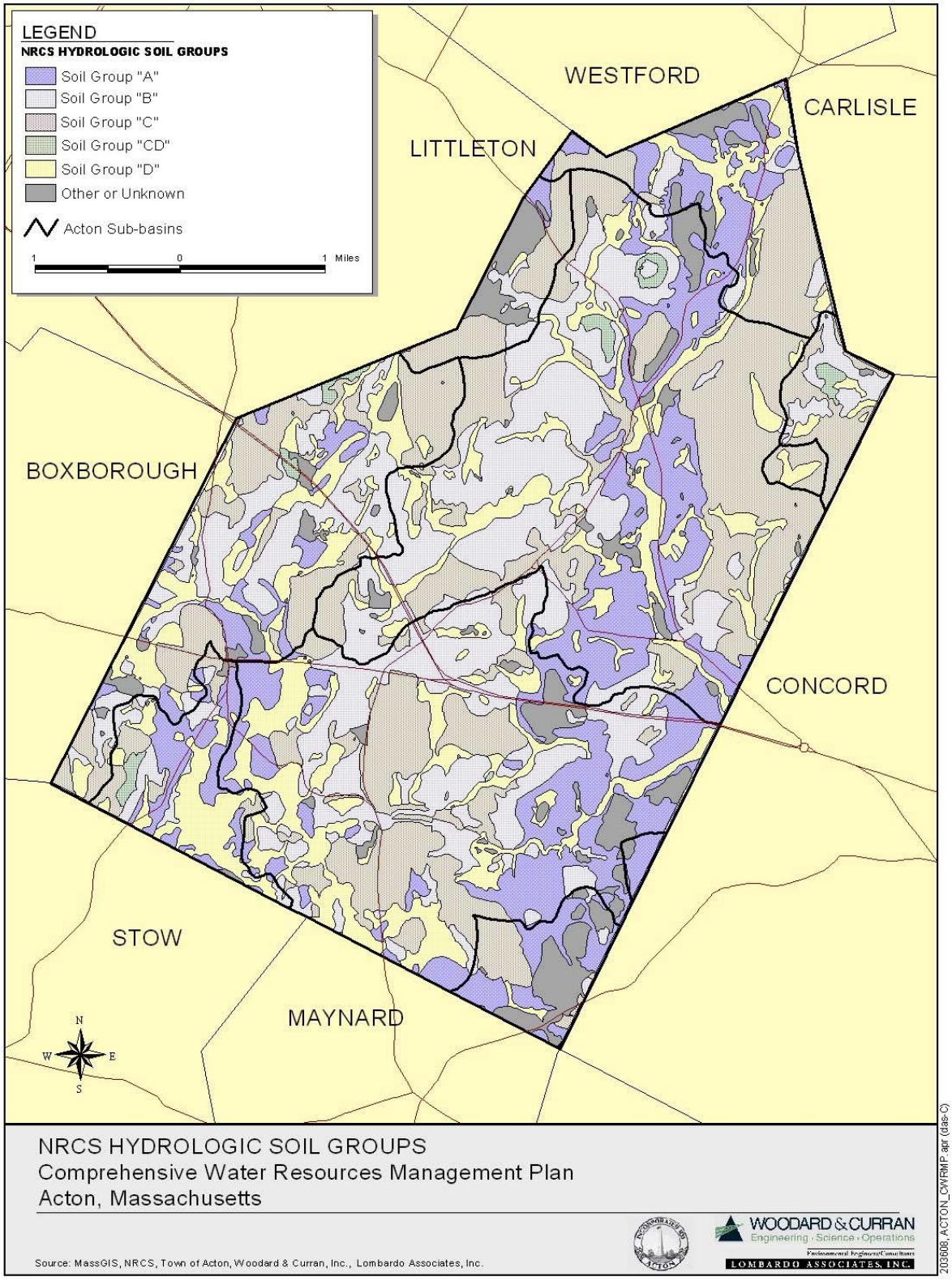


TABLE 4-4: BREAKDOWN OF HYDROLOGIC SOIL GROUP AREAS IN ACTON SUB-BASINS

Hydrologic Soil Group	BASIN										
	Assabet River	Butter Brook	Fort Pond Brook	Grassy Pond Brook	Heath Hen Meadow Brook	Nagog Pond	Nashoba Brook	Second Division Brook	Spencer Brook	Straw-berry Hill	Tow n of Acton
	AREA IN ACRES										
"A"	201	279	810	194	195	21	871	0	0	0	2571
"B"	14	78	1058	545	97	49	1301	0	108	0	3250
"C"	95	318	863	631	93	201	1381	0	150	56	3789
"CD"	0	0	1	26	20	0	44	0	19	0	110
"D"	11	158	749	451	225	7	689	0	26	21	2337
"Other" or "Unknown"	186	87	200	95	10	111	160	1	3	0	852

TABLE 4-5: PERCENTAGE BREAKDOWN OF HYDROLOGIC SOIL GROUPS IN ACTON SUB-BASINS

Hydrologic Soil Group	BASIN										
	Assabet River	Butter Brook	Fort Pond Brook	Grassy Pond Brook	Heath Hen Meadow Brook	Nagog Pond	Nashoba Brook	Second Division Brook	Spencer Brook	Strawberry Hill	Town of Acton
	PERCENT OF SUBBASIN										
"A"	39.7%	30.3%	22.0%	10.0%	30.5%	5.5%	19.6%	0%	0%	0%	19.9%
"B"	2.8%	8.5%	28.7%	28.1%	15.2%	12.5%	29.3%	0%	35.2%	0%	25.2%
"C"	18.8%	34.5%	23.5%	32.5%	14.5%	51.7%	31.1%	0%	49.1%	73.0%	29.4%
"CD"	0%	0%	0%	1.3%	3.2%	0%	1.0%	0%	6.2%	0%	0.9%
"D"	2.2%	17.2%	20.4%	23.2%	35.1%	1.8%	15.5%	0%	8.6%	27.0%	18.1%
"Other" or "Unknown"	36.6%	9.5%	5.4%	4.9%	1.5%	28.4%	3.6%	100%	0.9%	0%	6.6%

As Table 4-5 displays, hydrologic soil group "A" has the highest tendency to infiltrate stormwater. Areas designated with soil class "A" should be preserved as stormwater recharge areas, or, if developed, should contain adequate controls for infiltrating stormwater to the maximum possible extent. On a town-wide basis, approximately 20% of Acton is designated as soil class "A".

Approximately one quarter of the Town (25%) is designated under hydrologic soil group "B". Soil group "B" has a moderate minimum infiltration capacity and should be considered as important land for

groundwater recharge. As with soil class "A", open land and forestland in areas designated under soil class "B" should be preserved and any development in these areas should contain controls designed to infiltrate stormwater to the maximum possible extent.

The soil classification containing the largest amount of land area in Acton is soil group "C", with approximately 30% of the Town falling under this classification. Soil class "C" has a low capacity to infiltrate stormwater. Areas designated under this classification are less important as natural stormwater recharge areas.

Soil class "CD" falls between "C" and "D" and was rarely assigned to soil units found within Acton. "CD" areas have a low capacity for stormwater infiltration. This classification is only found in approximately 1% of the Town.

Soil class "D" is found in 18% of Acton's land area and typically follows river valleys and wetlands. Very little stormwater is infiltrated within these areas. Therefore, these areas are not seen as important for groundwater recharge.

The "other" or "unknown" designation applies to areas with no soil unit data, areas of open water (ponds) or, in a few cases, areas of developed or reworked soil. This designation applies to 6.6 % of Acton's land area.

The Town of Acton should focus on preserving open land or forestland within the 45% of the Town classified under hydrologic soil class "A" or "B". Since this analysis was performed on a town-wide basis, individual parcels have not been assigned a hydrologic soil classification. Therefore, the hydrologic soil classification of parcels where development is proposed should be assessed in the planning stages of development. Areas designated as soil class "A" or "B" should be considered as valuable open land or forestland capable of moderate to significant groundwater recharge. Any proposed development of these areas should act to maximize open, undisturbed space. Stormwater from impervious surfaces should be infiltrated into the subsurface to the maximum possible extent through the construction of structural BMPs.

4.6 STORM WATER MANAGEMENT PLAN (SWMP)

4.6.1 Background

New developments are required through State and local guidelines to treat the runoff produced from impervious surfaces by means of suspended solids removal and infiltration practices. The Environmental Protection Agency (EPA) is implementing an initiative that goes beyond controlling storm water runoff produced from new developments. The National Pollution Discharge Elimination System (NPDES) Storm Water Program is a nationwide, two phase program aimed at reducing the impacts of storm water on the nations surface waters. Phase I of the program requires permitting of Municipal Separate Storm Sewer Systems (MS4s) serving populations of 100,000 persons or greater. Phase II of the NPDES program requires storm water permitting for communities with smaller populations such as the Town of Acton.

4.6.2 Acton SWMP

Acton's Storm Water Management Plan (SWMP) represents the Town of Acton's plans to comply with NPDES Phase II guidelines over a five year period, 2003 – 2008. The goal is to create a fully integrated plan, both chronologically and comprehensively. Chronologically, the Best Management Practice

(BMPs) developed in any year should provide data, tools or programmatic assistance to BMPs developed or implemented in future years. Comprehensively, the BMPs developed for any one Minimum Control Measures (MCM) should be linked to all other Minimum Control Measures (MCMs) to the fullest extent possible. The SWMP will be assessed yearly and adapted continually to improve positive results, replace ineffective BMPs, and target new discoveries from field work and public outreach efforts.

This SWMP takes advantage of ongoing or planned efforts whenever possible. The Town has submitted a request for funding under the Costal Pollution Remediation Grant Program to continue the work currently underway under the 319 Grant Project. The scope of work associated with the 319 Non-Point Source Control Grant program provides a good opportunity to begin the *Public Education and Outreach* MCM through creating a kiosk at NARA Beach area and to begin to meet the *Illicit Detection* MCM by identifying BMPs for installation at existing outfalls in the community.

The overall level of effort to comply with the final SWMP will be determined by three factors:

- Requirements of the SWMP based on EPA's NPDES Phase II Final Rule
- The mitigation of threats to public and environmental health
- The financial and staffing resources of Acton

Although the Town is obligated by law to meet EPA's requirements, the five year plan will be modified in the event that one or more of these factors changes from its current state.

The six MCMs outlined by EPA are:

1. MCM 1 - Public Eductional/Outreach
2. MCM 2 - Public Participation/Involvement
3. MCM 3 - Illicit Discharge Detection and Elimination
4. MCM 4 - Construction Site Runoff Control
5. MCM 5 - Post-Construction Runoff Control
6. MCM 6 - Pollution Prevention/Good Housekeeping

4.6.3 Town Input to Plan

To develop a SWMP that fulfills EPA Phase II requirements and that is suitable for the Town of Acton, a SWMP workshop was held with town department heads on February 13, 2003. Departments represented included: Board of Health, Engineering, Highway, Recreation and Planning. During the workshop, numerous BMPs and measurable goals were proposed for each of the six MCMs. Discussions took place between departments to determine which particular BMPs and measurable goals were suitable for the Town of Acton. Individuals from each department offered suggestions on BMPs that could be implemented or managed by their particular department. The SWMP was further refined based on input from the Board of Selectmen at a public meeting held on February 24, 2003 and a workshop conducted with the Town Manager and Board of Health Director on March 4, 2003.

4.6.4 NOI Requirements

The Town of Acton is one of the many communities in Massachusetts that must file a Notice of Intent (NOI) with the MADEP. The original submission date was March 10, 2003; however, the new effective date of the Massachusetts General Permit is May 1, 2003 and therefore the NOI submission date has been changed to July 30, 2003. To obtain an NPDES Phase II permit for the Town's storm server system, the Town of Acton must develop a SWMP to implement proposed BMPs submitted under the NOI.

5. WASTEWATER MANAGEMENT SYSTEMS

5.1 INTRODUCTION

Wastewater management systems include all systems that collect, transport, treat, and dispose of wastewater generated within the Town of Acton. This chapter of the CWRMP presents a comprehensive overview of the Town's existing wastewater infrastructure, with an emphasis on on-site (septic) wastewater management systems.

5.2 REGIONAL WASTEWATER MANAGEMENT

Acton is wholly located within the Assabet River watershed. The Town is located in the lower portion of the Assabet watershed, near the confluence with the Sudbury River in Concord. A total of 20 communities, including Acton, are located within the Assabet River watershed. These communities are listed in Table 5-1.

TABLE 5-1: COMMUNITIES LOCATED WITHIN ASSABET WATERSHED

Town	Member Assabet River Consortium (ARC)	Total Area (Sq. Mi.)	Area in Assabet Watershed (Sq. Mi.)	Percent of Town Located within Assabet Watershed
ACTON		20.3	20.3	100%
BERLIN		13.2	12.3	93%
BOLTON		20.1	14.4	72%
BOXBOROUGH		10.4	6.9	66%
BOYLSTON		19.8	2.1	11%
CARLISLE		15.5	4.6	30%
CLINTON		7.3	0.6	9%
CONCORD		25.8	9.2	36%
GRAFTON		23.3	1.6	7%
HARVARD		27.1	5.8	21%
HUDSON	Yes	11.9	10.9	92%
LITTLETON		17.5	7.3	42%
MARLBOROUGH	Yes	22.0	9.5	43%
MAYNARD	Yes	5.4	5.4	100%
NORTHBOROUGH	Yes	18.7	17.4	93%
SHREWSBURY	Yes	21.7	8.0	37%
STOW		18.0	17.9	99%
SUDBURY		24.8	2.2	9%
WESTBOROUGH	Yes	21.4	8.8	41%
WESTFORD		31.4	7.4	24%

Six of these 20 communities are members of the Assabet River Consortium (ARC), as indicated on Table 5-1. The Assabet River watershed, member communities of ARC, and the Town of Acton are all shown on Figure 5-1. As indicated in Figure 5-1, all ARC member communities are located upstream from Acton. The ARC member communities are currently preparing a Comprehensive Water Resources

Management Plan (CWRMP), analyzing water supply and wastewater issues within the member communities. Table 5-2 summarizes the wastewater management solution strategies the CWRMP will evaluate for the various member communities. The four communities where off-site strategies will be evaluated are already largely sewered.

FIGURE 5-1: ASSABET RIVER WATERSHED & CONSORTIUM COMMUNITIES

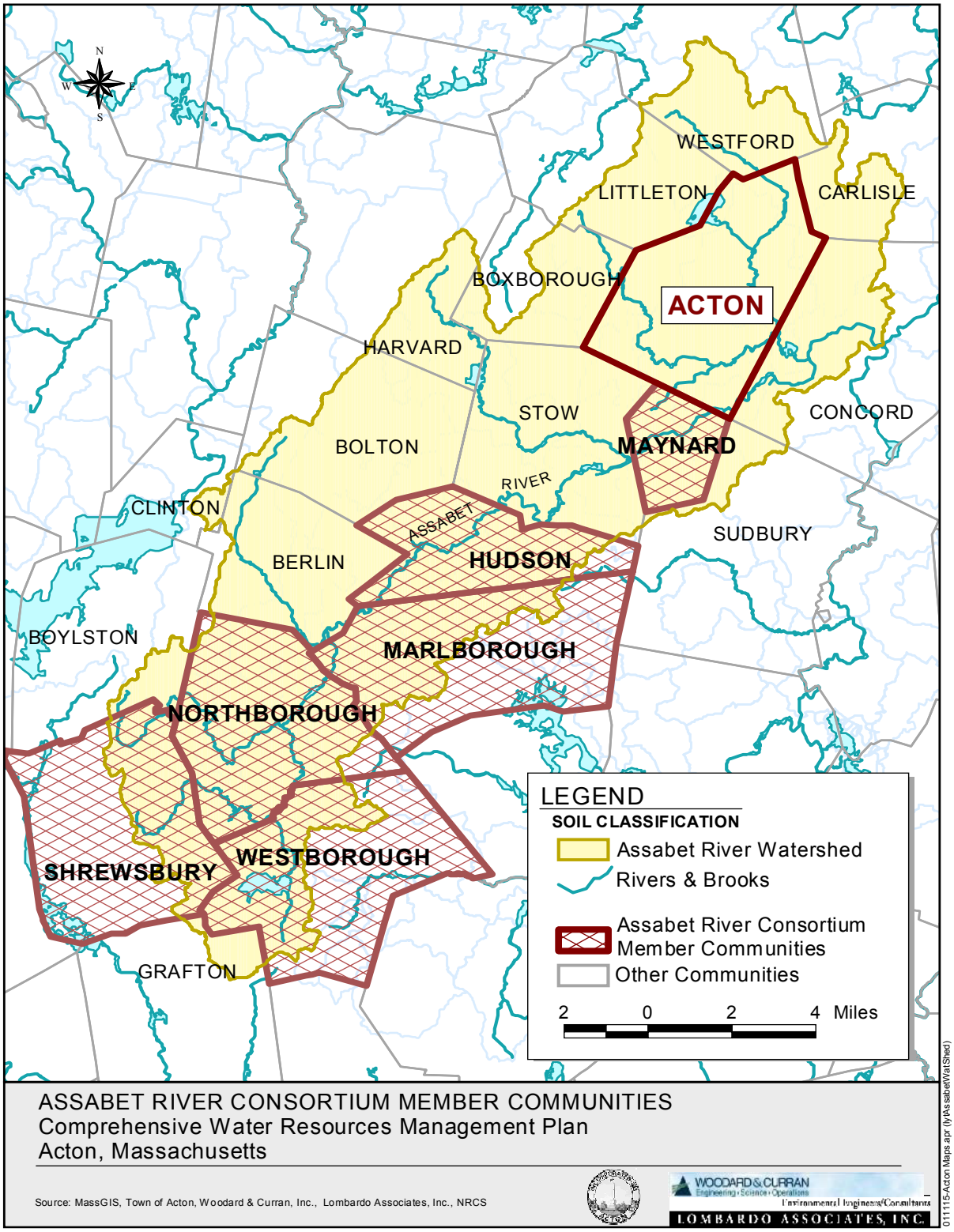


TABLE 5-2: WRC CWRMP WASTEWATER MANAGEMENT STRATEGIES FOR MEMBER COMMUNITIES

Town	CWRMP to Evaluate On-Site Wastewater Management Solutions	CWRMP to Evaluate Off-Site Wastewater Management Solutions
HUDSON	X	
MARLBOROUGH		X
MAYNARD		X
NORTHBOROUGH	X	
SHREWSBURY		X
WESTBOROUGH		X

The ARC's CWRMP will also be investigating:

- Groundwater discharge options, both for existing wastewater treatment facilities (many of which discharge directly into the Assabet) and for new cluster wastewater systems.
- Infiltration/ inflow (I/I) reduction opportunities.
- Secondary growth impacts of additional cluster / sewer systems

As of January 2003, ARC has submitted the Phase II Alternatives Development & Screening Report and received feedback as part of the public comment period. The ARC's schedule is currently delayed while the ARC considers alternatives regarding its planning scope. The planned schedule for the CWRMP is presented in Table 5-3.

TABLE 5-3: ASSABET RIVER CONSORTIUM CWRMP SCHEDULE

Milestone	Scheduled Deadline
Phase I – Needs Analysis	Completed
Phase II – Alternatives Development & Screening	March 15, 2002 Submitted
Phase III – Solution Alternatives	November 30, 2002 on hold
Phase IV – Recommended Solution & Implementation Plan	April 30, 2003 on hold

5.3 ACTON STUDY AREAS

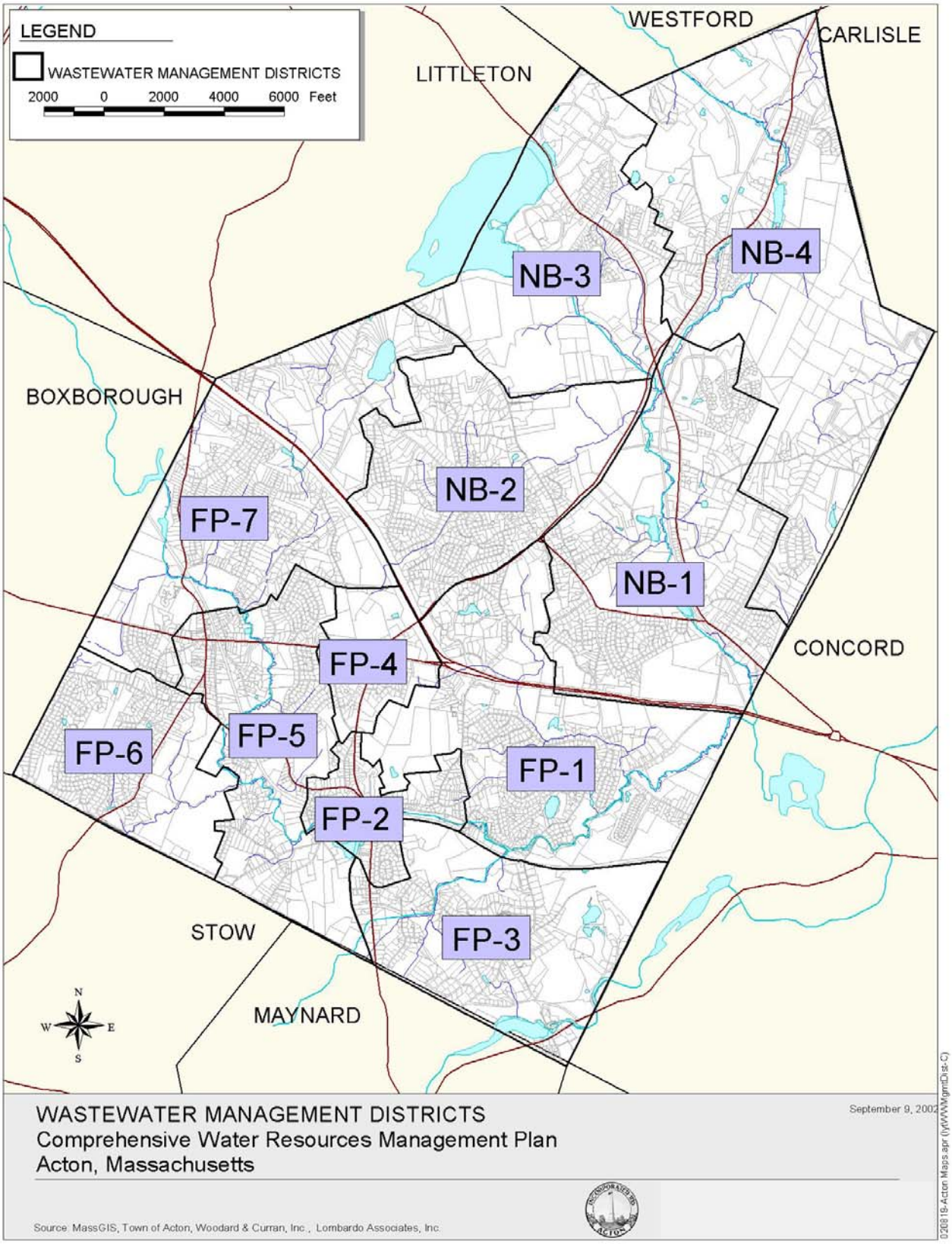
When the Town of Acton began its initial facilities planning process the Town was divided into study areas or wastewater management districts. The Town's wastewater management districts were derived from natural watershed sub-basins, adjusted to accommodate existing lot lines and similar features. Study areas are listed in Table 5-4 and Figure 5-2.

TABLE 5-4: ACTON STUDY AREAS

Study Area Name	Study Area ID	Number of Properties
Fort Pond #1	FP-1	880
Fort Pond #2	FP-2	359
Fort Pond #3	FP-3	510
Fort Pond #4	FP-4	162
Fort Pond #5	FP-5	816
Fort Pond #6	FP-6	600
Fort Pond #7	FP-7	853
Nashoba Brook #1	NB-1	842
Nashoba Brook #2	NB-2	739
Nashoba Brook #3	NB-3	366
Nashoba Brook #4	NB-4	573
	TOTAL	**6,700**

However, subsequent changes in Town, such as the construction of the collection system and wastewater treatment facility, and advances in technologies available for planning programs, most notably Geographic Information Systems (GIS) and relational databases, have reduced the significance of the study areas. The GIS tools and the depth and the breadth of data available from many sources have allowed a more refined anaysis to be performed on a representative lot by lot basis. The study area approach has been replaced by a two phase approach. First, "macro" issues are reviewed on a town-wide and watershed-wide basis, and second, a "micro" review is conducted using data related to individual parcels, or lots. The result is a more detailed analysis that produces "needs" lots instead of "needs" areas. The "needs" lots are then grouped or organized into logical areas of need related to wastewater collection, treatment and disposal. Consequently, the study areas are replaced by detailed analysis that produces more detailed "needs" areas. The study areas are shown in Figure 5-2 for reference and historical continuity.

FIGURE 5-2: ACTON WASTEWATER MANAGEMENT DISTRICTS



5.4 ACTON WASTEWATER MANAGEMENT

The Town of Acton is currently served by a combination of sewer, cluster, and on-site wastewater management systems. Table 5-5 summarizes the current wastewater management infrastructure in the Town by parcel.

TABLE 5-5: CURRENT WASTEWATER MANAGEMENT PRACTICES IN ACTON

Development Status	PARCELS UTILIZING SEWER / CLUSTER SYSTEMS[1]			
	Residential Parcels	All Other Parcels	Unknown	Total Sewer / Cluster Parcels
Developed	**780**	**85**	**39**	**904**
Undeveloped	34	5	0	39
Undevelopable	5	38	0	43
TOTAL	**819**	**128**	**39**	**986**
PERCENT OF DEVELOPED PARCELS USING SEWER/CLUSTER SYSTEMS				16%
PERCENT OF ALL PARCELS USING SEWER/CLUSTER SYSTEMS				15%

PARCELS USING ON-SITE SYSTEMS					TOTAL TOWN
Development Status	Residential Parcels	All Other Parcels	Unknown	Total On-Site Parcels	
Developed	**4,478**	**278**	**61**	**4,817**	**5,721**
Undeveloped	392	20	0	412	451
Undevelopable	111	363	11	485	528
Total	**4,981**	**661**	**72**	**5,714**	**6,700**
PERCENT OF DEVELOPED PARCELS USING ON-SITE SYSTEMS				84%	
PERCENT OF ALL PARCELS USING ON-SITE SYSTEMS				85%	

Compiled from 2001 Assessor's and BOH data.

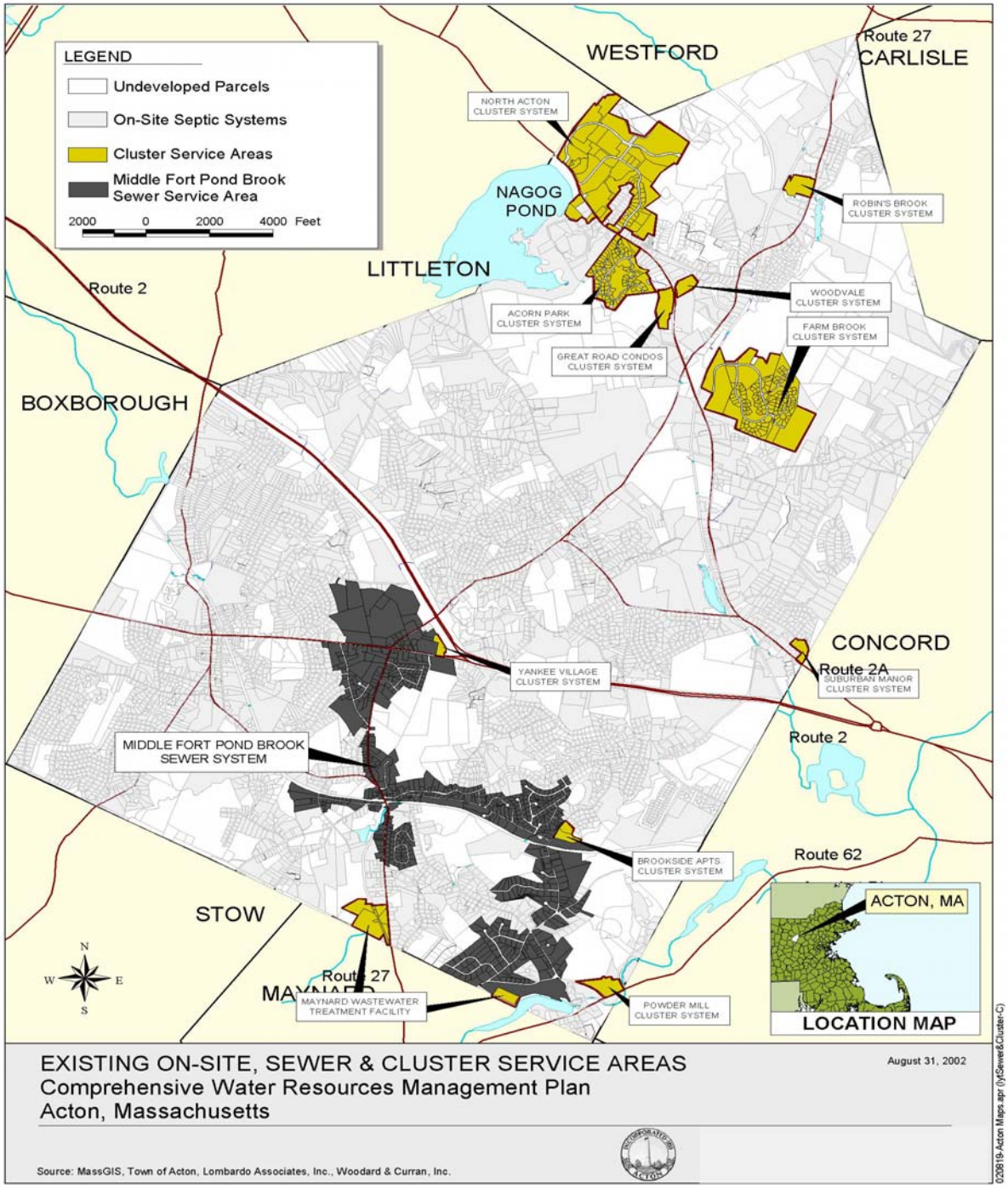
[1]Parcels may not currently be connected to cluster / sewer facilities, but they are included in these service areas, and are expected to connect when their existing on-site systems fail.

As indicated in Table 5-5, approximately 84% of existing developed parcels in the Town rely upon on-site septic systems for wastewater treatment and disposal. The remaining existing developed parcels are included in one of several cluster or sewer systems in the Town, as described in Section 5.5. The

distribution of developed and undeveloped lands, as well as the location and extent of off-site (sewer and cluster) service areas is shown on Figure 5-3.

FIGURE 5-3: WASTEWATER MANAGEMENT INFRASTRUCTURE

(SEWER, CLUSTER, AND ON-SITE SYSTEMS)



5.5 OFF-SITE WASTEWATER SYSTEMS

5.5.1 Middle Fort Pond Brook Sewer System

5.5.1.1 General

The Middle Fort Pond Brook Sewer System consists of approximately 700 residential and commercial service connections discharging to a network of 10 miles of gravity sewer and ten pumping stations of varying capacities, which flow to the Acton Wastewater Treatment Facility. The service area generally consists of parcels south of the school complex on Charter Road in the Kelly's Corner section of Town (intersections of Routes 111 and 27) along Main Street (Route 27) and those parcels in south Acton along the Fort Pond Brook. The Acton Treatment Facility is located on Adams Street adjacent to the Assabet River where the town lines of Acton, Concord and Maynard all meet.

The Middle Fort Pond Sewer Service area is shown in Figure 5-3. Table 5-6 describes the Middle Fort Pond Brook Sewer Service Area.

TABLE 5-6: MIDDLE FORT POND BROOK SEWER SERVICE AREA

Sewer Service Area	Developed Parcels in Service Area	Undeveloped Parcels in Service Area	Development Status Unknown	Total Parcels in Service Area
Middle Fort Pond Brook	606	62	14	682

The Middle Fort Pond Brook Sewer System is currently permitted for an average daily flow (ADF) of 250,000 gallons per day (GPD) and a peak daily flow (PDF) of 500,000 GPD. The conveyance, pumping and treatment facilities in the system have capacity in excess of 1 million gallons per day (MGD) however the groundwater discharge permit limits the Town to an ADF of 250,000 GPD.

Construction on the system began in March 2000 and the Acton Wastewater Treatment Facility was brought on line in February 2002. Total project costs, including permitting, design and construction, were $25.1M.

5.5.1.2 Acton Wastewater Treatment Facility

The Town was granted Groundwater Discharge Permit GW#0-656-T#W003143 on January 7, 2000 which limits effluent flow to 250,000 GPD. The Groundwater Discharge Permit also establishes the following effluent characteristics:

- BOD, 5 Day, 20° C = 20 mg/l
- Total Suspended Solids = 20 mg/l
- Oil and Grease = 15 mg/l
- Fecal Coliform = 200 org/100 ml
- Total Nitrate-Nitrogen = 10 mg/l
- Total Nitrogen (TKN + NO3 + NO2) = 10 mg/l
- Total Phosphorus

- 0.5 mg/l maximum daily limit until facility reaches 125,000 ADF or March 1, 2004, whichever is sooner;
- thereafter, 0.2 mg/l average monthly limit with a 0.5 mg/l maximum daily limit.

In order to meet these effluent characteristics the Acton Wastewater Treatment Facility was designed as a Sequencing Batch Reactor facility discharging to Rapid Infiltration Beds (RIBs). The treatment process consists of the following systems:

- Influent screening
- Grit removal
- Sequencing Batch Reactors (SBRs) and associated components.
  - Chemical Feed Systems,
  - Aeration
  - Pre and Post –Equalization
- Filtration via cloth media
- Ultraviolet (UV) Disinfection
- Sludge handling and disposal
- Odor Control
- Process Instrumentation and Controls via a SCADA system

Effluent from the Acton Wastewater Treatment Facility is pumped to one of six RIBs located adjacent to the facility. Discharge from the facility is controlled via a flow distribution vault on the RIBs site where the effluent is routed to the "active" basin. A hydrologic assessment of the RIBs area was performed during the design to develop preliminary estimates of the area's ability to accept the Facility's effluent and subsequently recharge the underlying aquifer. The hydrologic assessment showed a fine to course sand, very fine sand, and a layer of dense, very fine-grained sand, or till. This till is approximately 15 to 18 feet below grade and is the limiting factor in the discharge capacity of the site.

The sludge management system for the Facility consists of the following steps:

- Wasted solids from the SBR process are pumped to and stored in the aerated 115,000 gallon Waste Activated Sludge (WAS) Tank.
- Periodically the WAS is pumped to a gravity belt thickener, conditioned with polymer to control density, and thickened to 5 to 7 percent solids.
- Thickened Waste Activated Sludge (TWAS) is stored in a separate tank until removed by sludge haulers to an off-site disposal facility.
- Sludge haulers and the off-site disposal facility are determined based upon availability, price and market conditions at the time of hauling.

5.5.1.3 Collection and Conveyance System

The collection and conveyance system consists of approximately 700 residential and commercial service connections discharging to a network of 10 miles of gravity sewer and ten pumping stations of varying capacities, which flow to the Acton Wastewater Treatment Facility. The collection system and conveyance system has the following characteristics:

Gravity Sewers

- 8 to 18 inch diameters, SDR 35 PVC and DR-18 PVC dependent on depth and proximity to other utilities
- Minimum slopes per TR-16; maximum velocity of 10 feet per second (fps).
- Service connections 6 or 8 inch diameter SDR 35 PVC

Manholes

- Precast concrete structures
- Located at changes in alignment, changes in grade, intersections and a maximum of 350 feet apart.
- Sizes range from 4 to 6 foot diameter, with interim landings for deep structures
- Drop connections are internal with a minimum of 5 foot diameter structure

Force Mains

- Sized based upon pumping station design
- Diameters range from 4 inch to 12 inch for submersible and suction lift pumping stations; 1 ½" HDPE for "Can" Stations
- Minimum design velocity of 3.5 fps; maximum of 10 fps.
- Drain/flushing manholes at low points in piping; air release valve manholes at high points

Pumping Stations

- Two Main Stations
  - Wetwell and valve vault for storage and piping
  - Twin 800 gpm submersible pumps with capacity for future pump.
  - Dedicated auxiliary generator with automatic transfer switch
  - Chemical feed capabilities for odor control
  - Building for electrical system, process controls and auxiliary power storage
- Six Conveyance Stations
  - Wetwell for storage
  - Twin 150 gpm suction lift pumps with capacity for future pump.
  - Outlet for portable auxiliary generator connection with manual transfer switch
  - Building for electrical system and process controls
- Two "Can" Stations
  - Environment One Model 2014 Can Pumping Stations with twin positive displacement 11 gpm pumps
  - Outlet for portable auxiliary generator connection
- Process Instrumentation and Controls via a SCADA system at each station with dedicated line connections to the Treatment Facility

5.5.1.4 Institutional and Financial Structure

The Acton Board of Sewer Commissioners governs the Middle Fort Pond Brook Sewer System The Acton Board of Selectmen is acting as the Board of Sewer Commissioners. Daily operations and communication regarding the sewer system is handled through the Acton Health Department Office. Connection to the system and system use requirements are governed by the Acton Sewer Use Regulations, adopted by the Board of Sewer Commissioners.

The Middle Fort Pond Brook Sewer System was constructed with use of the Massachusetts State Revolving Fund Loan (SRF) Programs, which assisted the Town in amortizing a majority of the $25.1M capital cost. Each of the approximately 700 users were assessed a betterment based upon an equivalent unit system to cover the construction costs. Users fees are assessed quarterly to cover the operation of the sewer system. All of the system costs, both capital and operational, are borne by the system users. No funding is received from general taxes.

In February 2002 the Board of Sewer Commissioners executed an agreement for private operation of the Acton Wastewater Treatment Facility and Pumping Stations.

5.5.2 Cluster Systems

The Town's cluster systems are listed on Table 5-7. The service areas for these cluster systems are shown in Figure 5-3.

TABLE 5-7: ACTON CLUSTER SYSTEM SERVICE AREAS

Cluster System	Permitted Flows (GPD)	Developed Parcels in Service Area	Developable Parcels in Service Area	Total Parcels in Service Area
Acorn Park	33,380	85	7	**92**
Brookside Apts[1]	11,000	2	0	**2**
Farmbrook	105,000	134	7	**141**
Great Road Condos[1]	27,720	1	0	**1**
North Acton	200,000	53	11	**64**
Powdermill[1]	12,000	1	0	**1**
Robin's Brook Assisted Living[1]	22,420	1	0	**1**
Suburban Manor	24,450	2	0	**2**
Woodvale[1]	12,400	1	0	**1**
Yankee Village[1]	4,400	1	0	**1**
TOTAL	**452,770**	**281**	**25**	**306**

[1]Some cluster systems serve condominium developments that are represented by a single parcel in the GIS database.

5.5.3 Schools

Acton's public schools are listed in Table 5-8. At this time, no major renovations or wastewater system upgrades are planned for any of the schools located within the current on-site wastewater management portions of the Town.

TABLE 5-8: ACTON PUBLIC SCHOOLS

School	Number of Pupils (2003-04 Enrollment)
Conant Elementary School	490
McCarthy-Towne Elementary School	506
C.T. Douglas Elementary School	494
Merriam Elementary School	508
Paul P. Gates Elementary School	494
Minuteman High School of Applied Arts & Sciences	NA
Acton-Boxborough Regional High School	1683
Blanchard Memorial Elementary School (Located in Boxborough)	NA
Raymond J. Grey Regional Junior High School	930

2003 – 04 Enrollment Data from Acton Public Schools System Profile Report
NA: Not Available

5.6 ON-SITE WASTEWATER SYSTEMS

The majority of the Town is served by on-site septic systems. As indicated on Table 5-5, approximately 84% of the Town's existing developed parcels rely upon on-site septic systems for wastewater treatment and disposal (72%, if compare developed parcels with on-site systems to total parcels).

5.6.1 Board of Health Regulations

Key elements of Acton's Board of Health Regulations with regard to wastewater management practices and septic system design are summarized below.

5.6.2 Current Regulations

Key elements of the Town's Board of Health Regulations (as adopted by the Acton Board of Health on September 10, 2001) are summarized below. The current regulations should be consulted for the full scope and detail of the regulatory elements summarized below.

General

- The Board of Selectmen sets fees for Septage Disposal Permits. All other fees are set by the Board of Health.

5.6.3 Septage Pumping & Disposal

- Septage haulers must fill out and submit a Trip Ticket detailing the address of origin, quantity, and disposal site for all septage. The Board of Health regularly enters this data into its existing GIS system. (Septage pumping records are presented in Table 5-18).

- All septage haulers must be licensed by the Board of Health.
- Septage may be disposed only at facilities approved by the Board of Health.
- All non-residential septic systems and residential systems with a storage capacity greater than 1,500 gallons shall be pumped every 12 months.

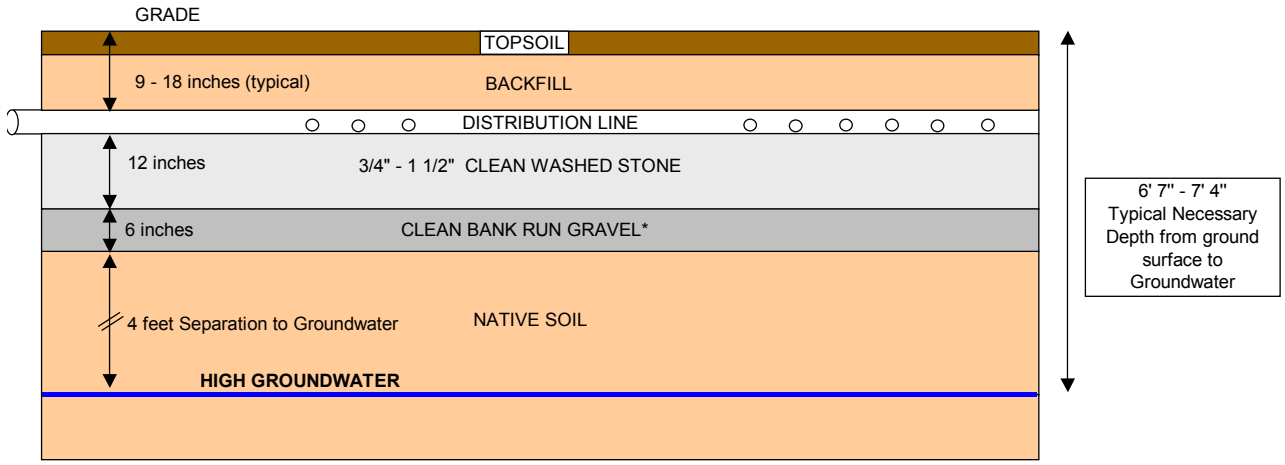
5.6.4 Septic System Design

Following is a summary of Acton Board of Health regulations that are in addition to Massachusetts Title 5, 310 CMR 15.

- Septic systems under 2,000 gpd prohibited within 75 feet of wetlands.
- Septic systems above 2,000 gpd prohibited within 100 feet of wetlands.
- New septic systems within the 100-year floodplain require a special permit from the Zoning Board of Appeals.
- Systems with less than 800 square feet of leaching area must have either:
  A second settling tank equal or larger than the septic tank, OR
  An equally bisected leach field with effluent distributed by gravity to the fields on an alternating basis.
- Bottom area loading rates for leaching facilities are up to 38% lower than provided in Title 5. Sidewall loading rates are generally similar to Title 5. (See Table 2 in BOH Regulations)
- Leaching works installed in other than sharp coarse sand or sharp gravel shall have a minimum of 6" of clean bank run gravel placed beneath the leachfield piping stone.
- The 4' minimum separation between the bottom of the leachfield and groundwater may not be lessened to provide for the 6" of bank run gravel.
- A minimum of 12" of clean washed stone ¾" – 1 ½" in size shall be installed below the invert of the distribution pipes.
- The minimum distance between sidewalls of leaching trenches must be 12 feet when the area between trenches is used for reserve area. This is illustrated in Figure 5-5.

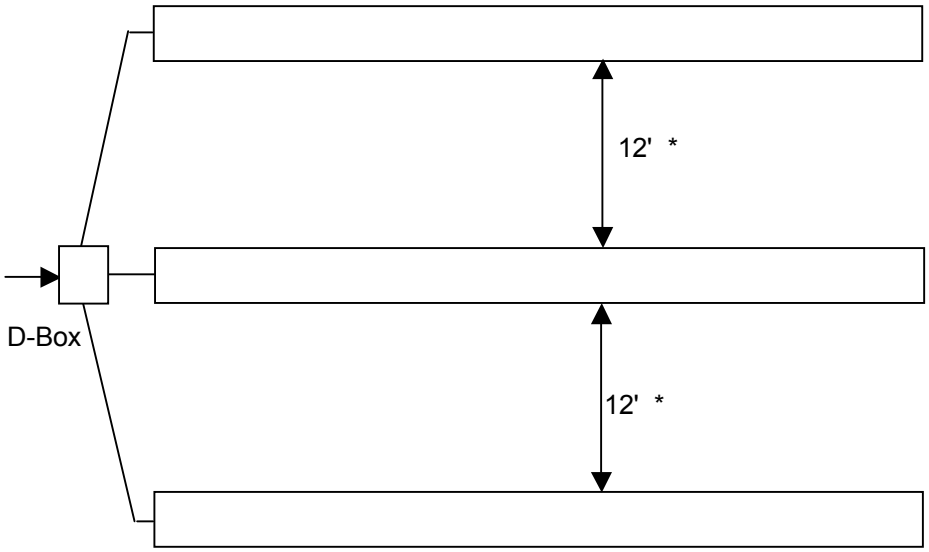
Figure 5-4 illustrates the select fill requirements established by the Board of Health regulations.

FIGURE 5-4: ACTON BOARD OF HEALTH LEACHFIELD REQUIREMENTS



* Required where native soil is NOT sharp coarse sand or sharp gravel, or at discretion of BOH & its agents.

FIGURE 5-5: TYPICAL LEACHFIELD PLAN



* 12' minimum trench separation if space between trenches is used for reserve area.

Permit Requirements for Septic Systems in Groundwater Protection Zones

In addition to the normal permitting process for septic system construction and repair, Acton also has an additional Groundwater Protection Zone Permit. Requirements for septic systems located within the Groundwater Protection Zones include:

- 16-2.5: Permit areas in the Town consist of Well Protection Areas (Zone I), Recharge Protection Areas (Zone II), and Aquifer Protection Areas (Zone III). (No Groundwater Protection Zone permit is required for Zone IV areas). These GW protection districts are shown on Figure 2-10.
- 16-4.2.4: A nitrate loading assessment shall be submitted to the Board of Health for any project or subdivision which will have a total effluent discharge over 2,000 gpd.
- 16-4.2.5: Within the Well Buffer Area (Zone I), monitoring wells shall be provided down gradient of all systems with a design flow over 550 gpd, and all commercial and industrial systems.
- 16-4.2.6: Within the Recharge Protection Area (Zone II), monitoring wells shall be provided down gradient of all systems with a design flow over 2,000 gpd, and all commercial and industrial systems.
- 16-4.2.7: Within the Well Buffer Area (Zone I), septic systems shall be set back 300' from any public, semi-public, or private well supply system. (It is noted that MADEP regulations may require 400 feet or more, depending on the yield of the well).
- 16-4.2.8: Within the Recharge Protection Area (Zone II), septic systems shall be set back 150' from any public, semi-public, or private well supply system.
- 16-4.2.9: Advanced on-site wastewater treatment plants shall be required for systems in excess of 10,000 gpd and located within an aquifer protection zone (Zone III).
- 16-4.2.10: All leaching areas within an aquifer protection zone shall be set back 100' from any recharge, retention, and detention, of surface drainage area.
- 16-4.2.11: Hydrogeological studies are required for any system over 5,000 gpd on a single property.

Key Additional Requirements for Direct Approval by Health Director (Otherwise approval of variance by Board of Health Required)

- Septic tanks must be pumped once every two years.
- Systems must be 100' from any wetlands or 100-year floodplains.
- Minimum groundwater separation for bottom of leachfields in the Aquifer Protection Zone is 4' for perc rates greater than 6 mpi. The minimum separation progressively increases to 6' for perc rates between 2 – 6 mpi. (See Table 16-6 in the BOH Regulations).
- Minimum groundwater separation for bottom of leachfields in the Well Recharge Zone is 4' for perc rates greater than 8 mpi. The minimum separation progressively increases to 7' for perc rates between 2 – 8 mpi. (See Table 16-6 in the BOH Regulations).
- Minimum groundwater separation for bottom of leachfields in the Well Buffer Zone is 4' for perc rates greater than 10 mpi. The minimum separation

progressively increases to 8' for perc rates between 2 – 10 mpi. (See Table 16-6 in the BOH Regulations).

5.6.5 Historical Regulations & Typical Design Practices

The State Code regulating septic system design has been revised and improved over the years, with significant changes occurring in 1962, 1978, and 1995. Standard practice in septic system design and installation has improved in accordance with the changes in the regulatory environment. Consequently, a system designed and installed after 1995 can be generally expected (if properly designed, constructed, used and maintained) to have a longer useful life than one installed prior to 1995. Similar trends should be expected at each stage of significant State Code revisions, such as in 1962 and 1978.

One major change in regulatory practices that has occurred in Massachusetts over the years is the manner in which depth to groundwater is determined. Past practices simply measured depth to groundwater at the time of installation. However, because depth to groundwater fluctuates throughout the year, measured depth to groundwater is often not depth to high groundwater, which is the criteria to which septic systems should be designed. The best measure of high groundwater is soil mottling – a visible mark made in the soil column by high groundwater. Depth to mottling is the current accepted practice for measuring depth to high groundwater in Massachusetts.

Because of the evolving science and accepted practice in measuring depth to groundwater, many older systems may not have been installed with adequate separation to groundwater. These systems may be underwater for all or a portion of the year, and thus could be providing inadequate treatment.

For properties where depth to mottling is not available or not apparent in the field, current practice in many communities is to use an adjustment factor for depth to groundwater. Acton is currently considering adopting a groundwater adjustment factor.

5.6.6 Board of Health Data Sources

The Acton Board of Health maintains a complete set of records for all septic systems in Acton. Recent records and records for active permits are maintained in paper form. Older records are converted to archival media:

- Design data (plans, as-builts, etc.) are converted to microfiche aperture cards.
- Permits and other paper files are converted to microfilm.

Paper records of all system maintenance, repair and replacement (any activities requiring a Board of Health permit) are also maintained, and relatively complete records exist back several decades. These paper records have been relatively well maintained, and the technical (soils, etc) information contained within the records are a very valuable resource for wastewater planning.

In recent years, the Board of Health has developed partial databases of key design information. To date, these databases have been populated with new incoming information. Efforts to input historical records are continuing.

The Acton Board of Health maintains several file systems containing septic system design data. Much of the information presented in this report section is derived from those files. In order to provide background on the source of septic system information presented in this report, the primary data sources are briefly described. The BOH file systems are:

- BOH Permit Lists
- BOH Title 5 Inspections List
- BOH Variance List (1995 – 2001)
- BOH GIS Database
- BOG Design Data List
- BOH Non-Electronic Files

Each of these data sources is briefly described below. These data sources have been consolidated into a single database, and are the basis for the wastewater needs definition analysis.

5.6.7 BOH Permit Lists

The BOH maintains electronic lists of permits issued for:

- New construction (~ 642 new systems, 1995 - 2001)
- System repairs (~ 1,073 system repairs, 1995 – 2001)
- Title 5 inspections (~ 1,515 inspections, 1995 - 2001)
- Sewer connections (~ 16 sewer connections, August – November 2001)

These lists cover all BOH septic system permits and inspections issued since 1995. The lists contain only basic information on the permit, such as date issued, address, permit number, etc.

The BOH has also compiled a separate list of septic system repairs performed between 1985 and 2000. This list contains the information described above, as well as some basic design information, such as leaching area, septic tank size, etc. This list contains approximately 1,638 records.

5.6.8 BOH Variance List

The BOH maintains a list of all variances granted in the Town since revised Title 5 was enacted in 1995. The list specifies the location of the septic system, the date the variance(s) was granted, and the specific types of variances granted. Approximately 520 variances on 249 parcels have been granted in Acton since 1995.

5.6.9 BOH GIS Database

The BOH had a GIS-based septic system management package installed in the late 1990's. BOH staff has been populating the GIS database with septic system information. As of December 2001, data for approximately 2,300 parcels had been entered into the database. Many of these records contained only minimal information, including septage pumping data. Approximately 250 records contained complete, detailed design information. These records contain depth to groundwater, percolation rates, leachfield sizing data and similar detailed design data.

5.6.10 BOH Design Data List

The BOH has been entering depth to groundwater and perc rate data for septic systems installed or replaced after 1995 into a database. As of December 2001, data had been collected for approximately 250 septic systems installed between 1997 and 2000.

5.6.11 BOH Non-Electronic Files

The Acton Board of Health maintains a complete set of records for all septic systems in Acton. Recent records and records for active permits are maintained in paper form. Older records are converted to archival media:

- Design data (plans, as-builts, etc.) are converted to microfiche aperture cards.
- Permits and other paper files, are converted to microfiche.

5.6.12 BOH Data Conversion

In order to provide best available information for the CWRMP, key design data recorded in existing non-electronic files were digitized and merged with existing BOH electronic information into a comprehensive GIS database.

5.6.13 BOH Microfiche Data Conversion

The full set of BOH microfiche records were scanned into electronic format (TIF files) for easier indexing and retrieval. A total of approximately 15,243 microfiche aperture cards were scanned into electronic format. These scanned plan files were linked with the parcel GIS database to allow for easy indexing and reference of the scanned files.

Key design data from selected BOH microfiche septic system records were extracted into a database. Approximately 1,675 system records were reviewed, and useful information extracted for 1,128 systems. The following criteria was applied for extracting records:

- Systems without existing BOH electronic design data
- Most recent system installations

These criteria were designed to provide the Town with a database of information covering the maximum number of parcels, with an emphasis on newer records. Newer records are expected to be more relevant to current septic system design practices, both due to revised Title 5 regulations in 1995, and due to improvements in the measurement techniques for depth to groundwater that have occurred in recent years.

Records digitized and extracted into database format are summarized in Table 5-9. Kinds of information extracted from the microfiche is summarized in Table 5-10. Analysis and review of the extracted data is provided in Section 5.5.

TABLE 5-9: OVERVIEW OF BOH MICROFICHE DATA EXTRACTION

Item	Number of Records Converted / Extracted	Total Number of Records	Percentage
BOH Microfiche Records	15,243	15,243	100%
Microfiche Records Linked to GIS Database	~12,600	15,243	~82%
Number of Parcels with Linked Microfiche Records	4,478	6,700 (~5,721 developed parcels)	66.8% (78.3%)
Microfiche Records Reviewed	4,389	~12,600	34.8%
Parcels w/ Microfiche Records Reviewed	1,675	4,478	37.4%
Parcels with Data Extracted[1]	1,128	1,675	67.3%

[1]Balance of reviewed microfiche had no significant design data

TABLE 5-10: DATA EXTRACTED FROM MICROFICHE RECORDS

Data	Description
Permit Type & Date	Up to three permits
Soil Type & Description	
Number of Bedrooms	
Garbage Grinder	
Design Perc Rate	
Design Loading Rate	
Design Flow	
Septic Tank Size	
Septic Tank Type	
Pressure System	
Pump Vault Size	
Leachfield Type	
Leaching Area	
Leachfield Footprint	
IA System Type	
Depth of Test Pit	Up to 4 Test Pits
Depth to Groundwater	
Depth to Mottling Layer	
Depth to Bedrock	
Date of Test Pit	
Measured Perc Rate	Up to 4 Perc Tests
Date of Perc Test	

5.6.14 BOH Paper File Database Development

BOH personnel and community volunteers extracted useful septic system information from paper files maintained by the Board of Health. Extracted information was entered into a database and key design information was integrated with the GIS database for future use by the BOH. Data being extracted is summarized in Table 5-11.

Table 5-11 also summarizes total parcels with key design data obtained from BOH records and the number of records obtained from each of the three major BOH data sources used for the CWRMP:

- Existing electronic data provided by BOH
- BOH microfiche data digitized for CWRMP
- BOH paper data digitized by BOH staff / volunteers

TABLE 5-11: DATA EXTRACTED FROM BOH PAPER RECORDS

Data	Description	Data from Existing BOH Records[1]	Data Extracted from Microfiche Records[1]	Data Extracted from Paper Records[1]	Total Parcels with Data
Perc Rate	--	362	1,059	430	1,851
Depth to Bedrock	--	0	201	0	201
Depth to groundwater – Test Pit Depth	--	0	402	173	575
Depth to groundwater – Observed Groundwater	--	315[2]	559	155	1,029
Depth to groundwater – Mottling Layer	--	0	165	0	165
Total GW Information		**315**	**1,126**	**328**	**1,769**
Title 5 Data	Inspection Date, Results, etc. – Up to 3 inspections per parcel	NA	0	1,047	1,047
Septage Pumping Records	--	NA	0	~3,650 annually for 1999 - 2001	~3,650 annually for 1999 - 2001
System Age	Compiled from variety of age indicators: COC date, permit date, Application date, house age, etc.	1,330	768	3,583	5,681
Post 1995 BOH Variances	--	297	NA	0	297

[1]Note: Additional records may have been extracted from a given data source, however data from a different source was used. Such instances of multiple data sources are omitted from this table for clarity.

[2]Type of observation (dry pit, mottling layer, or observed groundwater) not recorded in existing BOH databases.

NA – Data not included for final analyses or superceded by other data sources.

5.6.15 BOH Data Integration

All of these various data sources (as described in Sections 5.6.6 – 5.6.14) were integrated with the Town's parcel GIS to produce a single integrated database containing best available information for every parcel within the Town. The total number of parcels with specific key data obtained is summarized by general data source in Table 5-11.

5.6.16 Septic System Inventory

Septic system inventory is the total number of septic systems in a community. In 2001, Acton had a total of approximately 4,817 parcels served by on-site septic systems, as indicated in Table 5-5.

5.6.17 Septic System Age Distribution

The approximate age distribution of Acton's septic system stock is presented in Table 5-12. Reviewing the septic system inventory age distribution in a community can provide insights into wastewater management trends in the community. For example, a building boom during a time period would likely result in a future surge in the Town-wide system failure rate as these systems reach their "design life" and start to fail.

The useful life of a properly designed, installed, operated, and maintained septic system can vary widely due to a variety of conditions. A number of communities have demonstrated a useful life for their septic systems of 60 +/- years. Again, actual septic system life may vary considerably depending on numerous factors, including site conditions, design, installation, maintenance, usage and many other factors.

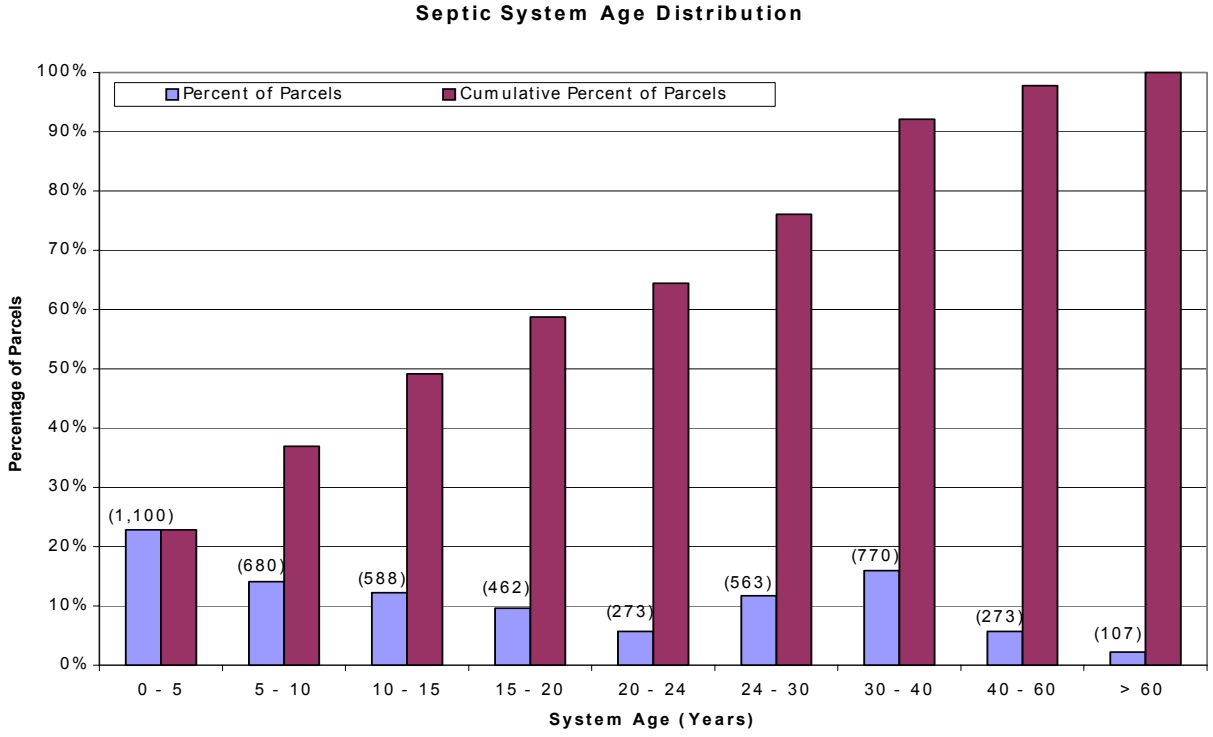
Septic system ages were compiled from several existing data sources provided by the Assessor and Board of Health. The various data sources used have progressively lower data quality, and are used in order of decreasing preference. For example, house age can be a very poor indicator of septic system age, especially for older homes. Correspondingly, house age is used for septic system age only if no other information is available.

The septic system age distribution is presented in Table 5-12, based upon best available information. The age distribution is presented graphically in Figure 5-6. According to available information, approximately 107 homes (2% of the Town's septic system inventory) with their original septic system were constructed prior to 1942 (60+ years old).

TABLE 5-12: SEPTIC SYSTEM STOCK AGE DISTRIBUTION

House Age (Years)	Year Built	Parcels	Cumulative Number of Parcels	Percent of Parcels	Cumulative Percent of Parcels
0 - 5	1998 - 2002	1,100	1,100	23%	23%
5 - 10	1993 - 1997	680	1,780	14%	37%
10 - 15	1988 - 1992	588	2,368	12%	49%
15 - 20	1983 - 1987	462	2,830	10%	59%
20 - 24	1979 - 1982	273	3,103	6%	64%
24 - 30	1972 - 1978	563	3,666	12%	76%
30 - 40	1962 - 1971	770	4,436	16%	92%
40 - 60	1942 - 1961	273	4,709	6%	98%
> 60	Pre-1942	107	4,816	2%	100%
No Data	0	1	4,817	0%	100%
Grand Total		**4,817**			

FIGURE 5-6: SEPTIC SYSTEM AGE DISTRIBUTION



5.6.18 Title 5 Inspections

Table 5-13 summarizes the results of Title 5 septic system inspections between 1995 and 2001.

As indicated on the Table, the annual Town Title 5 inspection failure rate varies between 6 – 10%. This is the percentage of the Town's total septic system inspections that fail Title 5 inspections each year.

It can be difficult to discern useful planning information from the Title 5 inspection failure rate, as it considers only a fraction of the total system inventory for a given year. The annual replacement rate (number of systems replaced divided over the entire system stock) is a more useful statistic, and is presented in the next section.

TABLE 5-13: TITLE 5 SEPTIC SYSTEM INSPECTION RESULTS (1995 – 2001)

Title 5 Inspection Results	Pre 1995	1995	1996	1997	1998	1999	2000	2001	2002[1]	Total 95 - 02
Fail	0	**5**	**8**	**11**	**17**	**18**	**5**	**6**	1	**71**
Percent of Inspections Failing	--	**6%**	**5%**	**8%**	**10%**	**10%**	**4%**	**4%**	**2%**	**7%**
Conditional Pass	0	5	4	14	8	4	10	3	1	**49**
Pass	11	69	134	114	144	155	125	127	57	**925**
Further Evaluation Required	0	0	0	2	0	0	0	0	0	**2**
Total[2]	11	79	146	141	169	177	140	136	59	**1,047**
Total Number of Systems in Town	--	4,176	4,248	4,404	4,510	4,638	4,760	4,817	4,817	--

[1]2002 data is through the end of August.

[2]Total includes 55 systems inspected twice due to two property transfers since 1995. Title 5 failure rate for these second inspections is ~4%.

5.6.19 Annual Repair Failure Rate

The annual septic system failure rate for a large number of septic systems is a useful statistic. The annual failure rate can be compared with other communities or between different years to gauge the average life of septic systems in the community. This can provide insights to design and installation practices.

Unfortunately, accurate and complete septic system failure data is generally not available for a community. The best available surrogate is septic system repair data. The Board of Health maintains records on system repairs, and these can be analyzed to deduce the failure rate (the actual failure rate is likely higher). Repairs are classified as either:

- Minor Repairs (D-Box, Septic tank, broken pipe, etc.)
- Major Repairs (New leachfield)

For practical purposes, system failure occurs when the leachfield fails, as the leachfield is generally the single most expensive and important component of a septic system. Repairs recorded by the Board of Health will include both major and minor system repairs. The minor repairs should not be counted for this analysis, as they are not considered septic system failures. To estimate the system failure rate, these minor repairs should be removed and considered separately.

Existing electronic information for the Town of Acton does not permit major and minor system repairs to be accurately disaggregated. They can be disaggregated for approximately one third of the records. The ratio obtained from this subset was applied to the full database to approximate the overall repair rate. This approximate of the overall repair rate is presented in Table 5-14.

The annual repair rate is properly calculated by dividing the number of repairs in a given year by the total number of septic systems in the community. Table 5-14 presents the annual repair rate from 1990 – 2001 for Acton, based upon the estimated number of annual system repairs.

TABLE 5-14: ANNUAL SEPTIC SYSTEM REPAIR RATE FOR ACTON

Year	Residential Systems		Total Number of Residential Systems*	Annual Repair Rate (Complete Replacement)
	New Construction	System Repairs *(Minor repairs and complete replacements)*		
1990	62	68	3,753	1.8%
1991	93	70	3,846	1.8%
1992	88	99	3,934	2.4%
1993	91	82	4,025	2.0%
1994	71	79	4,096	1.9%
			Average Repair Rate (1990 – 1994)	**2.0%**
REVISED TITLE 5 ENACTED				
1995	80	144	4,176	3.4%
1996	72	142	4,248	3.3%
1997	156	168	4,404	3.7%
1998	106	165	4,510	3.6%
1999	128	160	4,638	3.4%
2000	122	148	4,760	3.0%
2001**	57	103	4,817	2.1%
			Average Repair Rate (1995 – 2000)	**3.4%**

* 4,935 parcels using septic systems in 2001 based upon Assessor's and BOH records. Total number of systems for prior years is estimated by adjusting from 2001 using new construction.

** 2001 data is not annualized (only complete through November 2001), and is not included in the average.

The annual repair rate, as presented in Table 5-14, can be a good indicator of the average life of septic systems in a community. Because Acton's annual repair rate is somewhat inflated with minor repair data, the inferred average system life will be somewhat underestimated. Average system lives for varying compounded annual repair rates are presented in Table 5-15, below.

TABLE 5-15: AVERAGE SEPTIC SYSTEM LIFE INFERRED FROM ANNUAL REPAIR RATES

Annual Repair Rate	Inferred Average System Life
0.5% / year	140
1.0% / year	70
1.5% / year	50
2.0% / year	35
2.5% / year	28
3.0% / year	23
3.5% / year	20

Of course, the average system life inferred from annual replacement rates is useful only for community-wide planning purposes. The actual life of a given septic system may vary considerably, depending on site conditions, system design, installation, maintenance, and usage. Additionally, it is very important to identify and consider other factors that may influence the annual repair rate. For Acton, the most apparent factor is the 1995 Title 5 revision:

- Like Acton, many communities have experienced a surge in their repair rates since 1995. Revisions to Title 5 in 1995 likely forced some property owners to address existing septic system problems that had been deferred. There has likely been an increased level of repair activity since 1995 as this 'pent up demand' for system repairs and replacements is addressed through the Title 5 inspection process. Based on this premise, one would expect annual failure rates to decrease somewhat in future years. Based on Table 5-14, Acton's annual repair rate may already be falling.

The average annual septic system replacement rate for Acton is consistent with rates observed in other New England communities.

5.6.20 Variances

Table 5-16 lists the number and general type of variances issued in the Town since revised Title 5 was enacted in 1995.

TABLE 5-16: VARIANCES GRANTED BY ACTON BOH, APRIL 1995 –MAY 2002

Type of Variance Granted	Number of Variances Granted *(April 1995 – May 2002)*
Wetland Setback Variances	63
Groundwater Separation Variances	77
Gravel Select Fill Variances	116
Separation from Well Variances	8
Property Setback Variances	27
Building Setback Variances	45
Leachfield Size Variances (Trench separation, loading rate, reserve area, etc.)	108
Mound Design Variances (distance to retaining wall, mound slope, etc.)	16
Perc Rate Variance (Title 5 30 mpi)	2
Perc Test Method Variance (season, etc.)	6
System Located on Different Parcel Variance	2
Other Variances (IA System, Pump System, etc)	107
TOTAL NUMBER OF VARIANCES GRANTED *(4/1995 – 5/2002)*	**577**
TOTAL PARCELS GRANTED VARIANCES *(4/1995 – 5/2002)*	**297[1]**

[1]Total number of parcels granted variances is less than total number of variances because many parcels are granted multiple variances.

5.7 SEPTAGE PUMPING PRACTICES AND DATA

5.7.1 Septage Pumping Practices

The Acton Board of Health requires septage haulers to submit Trip Tickets detailing the originating address, date and quantity of all septage hauled in the Town. A sample trip ticket is presented in Figure 5-7.

There are two general options for disposing of septage in the Town:

1. The Board of Health has a contract with the Upper Blackstone Water Pollution Abatement District's Wastewater Treatment Facility to receive septage from Acton. To dispose of septage at the Upper Blackstone Facility, septage haulers must pre-pay the Board of Health according to a rate schedule set by the Board of Health. The Upper Blackstone Facility is required under the terms of the contract to receive septage from Acton.

2. Other regional wastewater treatment facilities are also approved by the Board of Health for septage disposal. The Fitchburg and Templeton WWTPs are widely used by the Town's septage haulers. Other WWTPs are approved on a case-by-case basis. To dispose of septage at these or

other regional WWTPs, septage haulers must obtain a $15 septage pumping slip from the Board of Health. A sample slip is presented in Figure 5-8.

TABLE 5-17: SEPTAGE DISPOSAL COSTS

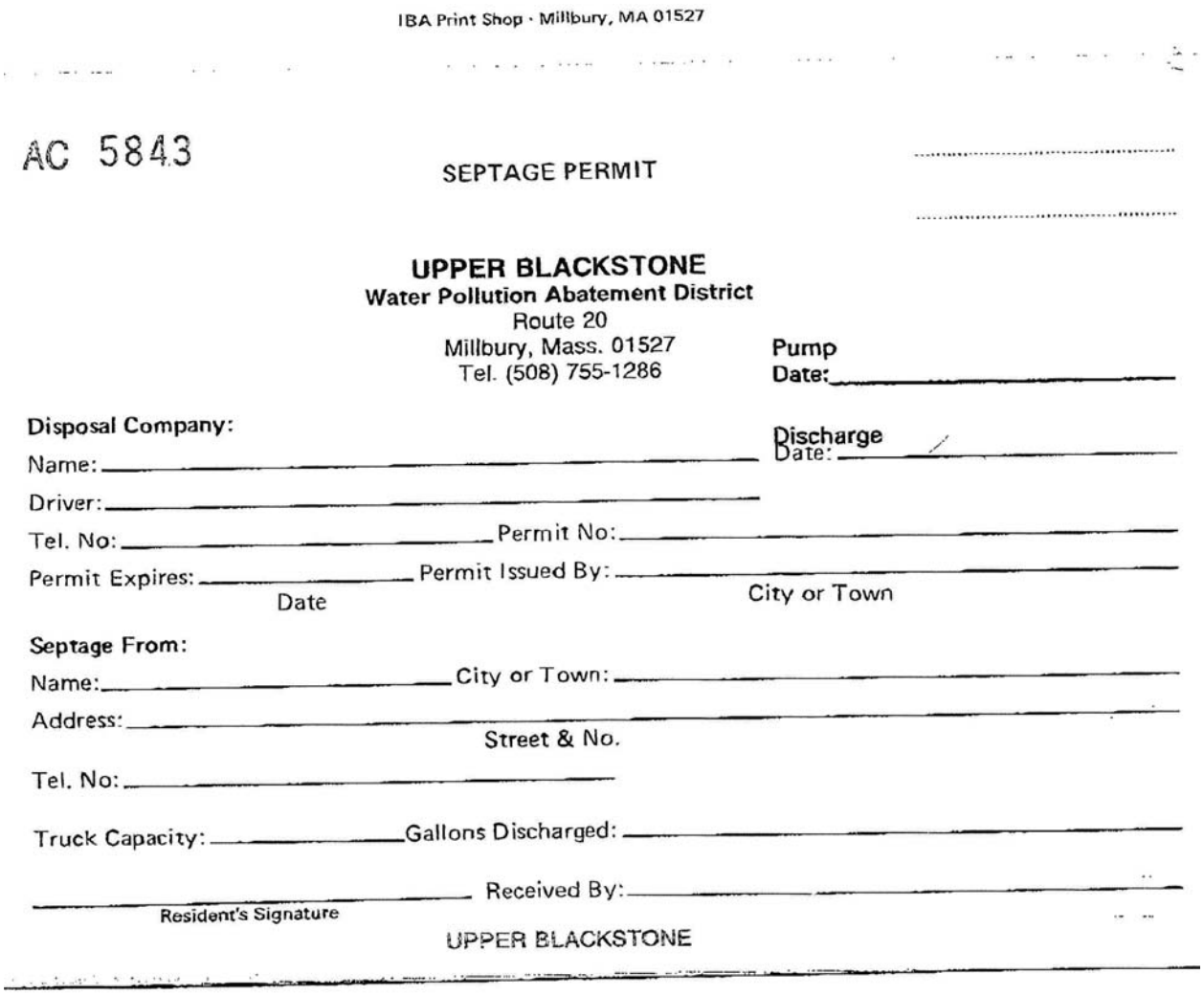
Disposal Facility	Acton BOH Fee	Disposal Facility Fees	Typical Disposal Fee (1,000 gallons of residential Septage)
Upper Blackstone	Set by BOH	$52.50 per 1,000 gal. + $21 Tipping Fee	$73.50
Fitchburg	$15 per pumping slip		
Templeton	$15 per pumping slip		

It should be noted that Table 5-17 does not include charges that maybe applied by septage haulers for septage pumping, transportation, or related services. Grease is typically charged a higher fee.

5.7.2 Septage Pumping Data

Table 5-18 summarizes the septage pumping information recorded by the BOH. Title 5 classifies septic systems with 4+ septage pump-outs per year as failing. Only a handful of systems in Acton meet this threshold, under 0.5% (~ 20 systems per year) for 1999, 2000, and 2001. Systems with 2+ septage pump-outs per year are classified as problem systems under Title 5. Less than 2% (~80 systems per year) of the Town's septic systems were pumped more than twice annually during 1999 – 2001.

FIGURE 5-7: SAMPLE SEPTAGE PUMPING SLIP – BLACKSTONE WASTEWATER TREATMENT FACILITY



IBA Print Shop · Millbury, MA 01527

AC 5843

SEPTAGE PERMIT

UPPER BLACKSTONE
Water Pollution Abatement District
Route 20
Millbury, Mass. 01527
Tel. (508) 755-1286

Pump Date: _____

Disposal Company:

Name: _____ **Discharge Date:** _____

Driver: _____

Tel. No: _____ Permit No: _____

Permit Expires: _____ (Date) Permit Issued By: _____ (City or Town)

Septage From:

Name: _____ City or Town: _____

Address: _____ (Street & No.)

Tel. No: _____

Truck Capacity: _____ Gallons Discharged: _____

_____ (Resident's Signature) Received By: _____

UPPER BLACKSTONE

FIGURE 5-8: SAMPLE GENERIC SEPTAGE PUMPING SLIP

Acton Board of Health Pumping Report

SEPTAGE HAULER _____

DATE: _____

ADDRESS: _____

OWNER: _____

GALLONS PUMPED: _____

GREASE TRAP: _____ SEPTIC TANK : _____

ROUTINE: _____Y _____N

BLOCKAGE: _____Y _____N

ACTION TAKEN: _____

PEROX TREATMENT: _____Y _____N

Acton Board of Health Pumping Report

SEPTAGE HAULER _____

DATE: _____

ADDRESS: _____

OWNER: _____

GALLONS PUMPED: _____

GREASE TRAP: _____ SEPTIC TANK : _____

ROUTINE: _____Y _____N

BLOCKAGE: _____Y _____N

ACTION TAKEN: _____

PEROX TREATMENT: _____Y _____N

TABLE 5-18: SEPTAGE PUMPING DATA

Septage Pumping Frequency	1999		2000		2001	
	# of Parcels	% of Parcels	# of Parcels	% of Parcels	# of Parcels	% of Parcels
< 2 pumps / year	3,544	76.4%	3,582	75.3%	3,574	74.2%
2 pumps / year	**39**	**0.8%**	**53**	**1.1%**	**46**	**1.0%**
3 pumps / year	**5**	**0.1%**	**9**	**0.2%**	**13**	**0.3%**
4+ pumps / year	**12**	**0.3%**	**15**	**0.3%**	**20**	**0.4%**
Total Parcels with Data	3,600		3,659		3,653	
Total Parcels without Data	1,038	22.4%	1,101	23.1%	1,164	24.2%
Total Parcels on Septic Systems	4,638		4,760		4,817	
Total Parcels	6,700		6,700		6,700	

5.7.3 Water Usage

Table 5-19 summarizes residential water usage data for residential parcels on Town water. Residential water usage is presented in gallons per day per bedroom (gpd/bedroom). The usage is based upon meter readings for the November 2000 – April 2001 billing cycle. This billing cycle likely includes minimal outdoor water usage (irrigation, etc.).

TABLE 5-19: RESIDENTIAL WATER USAGE IN ACTON

Water Usage (gpd per bedroom)	Residential Water Usage Per Bedroom (gpd/bedroom)[1]	Percent of Total	Cumulative Percentage of Total
2,000+	2	0.1%	0.1%
1,000 – 2,000	0	0.0%	0.1%
500 – 1,000	10	0.3%	0.3%
350 - 500	17	0.4%	0.7%
250 - 350	46	1.2%	1.9%
200 - 250	56	1.4%	3.4%
150 - 200	132	3.4%	6.7%
75 - 150	927	23.8%	30.5%
< 75	2,709	69.5%	100.0%
Total	**4,470**	100.0%	
No Data / Individual Wells	571		

[1]Compiled from Acton Water District Database. Usage data from November 2000 – April 2001 billing cycle.

5.7.4 General Septic System Design Conditions in Acton

Many factors determine the ability of a parcel to accommodate a Title 5 septic system. This section discusses these factors, and summarizes Acton's local conditions.

5.7.5 Water Supply

The majority of the Town of Acton (approximately 84.4%, or 4,827 / 5,721 developed parcels) is provided water by the Acton Water District. An additional approximately 472 parcels front existing water mains and are eligible for water service. Approximately 1,266 of the town's 6,700 total parcels do not have ready access to Town water.

Water supply is a significant factor in determining wastewater needs. If a parcel uses an on-site well for drinking water, an additional ~8,000 – 32,000+ square feet of land may be ineligible for septic system siting, due to the required 100' separation between wells and septic systems. Table 5-20 summarizes the existing water supply source for all parcels in the Town of Acton.

TABLE 5-20: WATER SUPPLY SOURCE FOR DEVELOPED PROPERTIES

Water Supply	Developed Parcels		Undeveloped Parcels	Total
	On-Site Septic Systems	Off-Site Wastewater Systems (Sewer / Cluster)		
Public Water	4,042	785	**135**	4,962
Private Well[1]	0	0	0	0
Fronted by Water Main[2] (Service Status Unknown or not Installed)	369	103	0	472
Not Fronted By Water Main[2]	406	16	844	1,266
TOTAL	**4,817**	**904**	**979**	**6,700**

Compiled from Acton Water Department (AWD), Board of Health, Assessor's Databases.

[1]No information on number or location of private wells available.

[2]Water main locations derived from 1996 AWD map.

5.7.6 Gross Parcel Size Distribution

One of the factors, which determine whether a parcel can accommodate a septic system, is the parcels' gross area. Depending on numerous design criteria and site conditions, parcels smaller than approximately 15,000 – 25,000 square feet may face challenges siting septic systems. Of course, this is highly dependent on the design flows of the system, environmental and zoning setbacks, other land uses on the property, soils characteristics, depth to groundwater or bedrock, and other variables. Some larger parcels may also face challenges, and some smaller parcels may have little or no difficulty accommodating a septic system.

Because of the complicated nature of septic system design, using a threshold parcel size as an indicator of suitability for septic systems is useful only for very generalized analysis, and can be misleading if used for lot-by-lot analysis or other more detailed approaches.

Table 5-21 indicates the parcel size distribution for developed, unsewered parcels in the Town. As mentioned, parcels smaller than approximately 15,000 – 25,000 square feet gross area may face challenges siting septic systems. This same information is presented graphically in Figure 5-9.

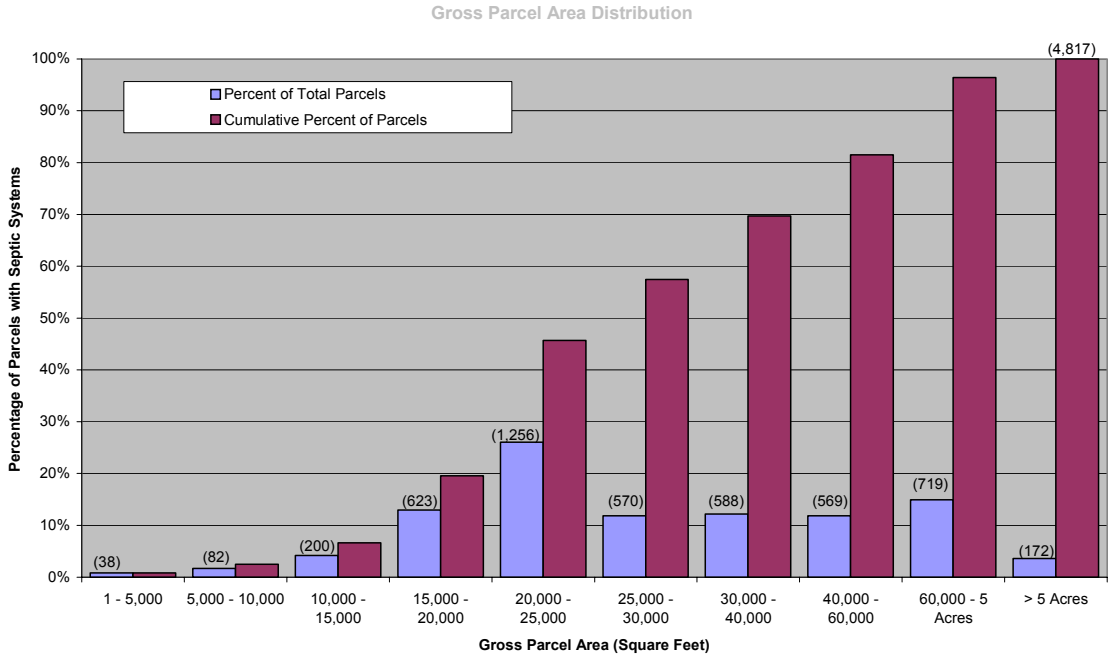
Also, large parcels may have soils unfavorable to septic systems, regardless of their size.

TABLE 5-21: LOT SIZE DISTRIBUTION – DEVELOPED PARCELS WITH SEPTIC SYSTEMS

Gross Parcel Area (Sq. Ft)	Number of Parcels	Cumulative Number of Parcels	Percent of Total Parcels	Cumulative Percent of Parcels
1 – 5,000	38	38	1%	1%
5,000 – 10,000	82	120	2%	2%
10,000 – 15,000	200	320	4%	7%
15,000 – 20,000	623	943	13%	20%
20,000 – 25,000	1,256	2,199	26%	46%
25,000 – 30,000	570	2,769	12%	57%
30,000 – 40,000	588	3,357	12%	70%
40,000 – 60,000	569	3,926	12%	82%
60,000 – 5 Acres	719	4,645	15%	96%
> 5 Acres	172	4,817	4%	100%
TOTAL	**4,817**			

Compiled from Acton Town GIS

FIGURE 5-9: GROSS PARCEL AREA DISTRIBUTION FOR ACTON



5.7.7 NRCS Soils Data

The National Resource Conservation Service (NRCS) Middlesex Conservation District published an interim soil survey report covering the Acton area in 1995. The interim soil survey report identifies the general spatial extent of soil units, and describes expected depth to groundwater, bedrock, and soil permeabilities for each soil unit to a depth of 6 feet. While the NRCS soil survey is not suitable for site specific analysis, it is very useful for planning purposes, especially when used in conjunction with site specific soil testing data from Board of Health records.

The correlation between NRCS soil units and site specific design information can be quite good, and some states use soil units identification as the sole basis for residential septic system leachfield sizing. For the wastewater needs definition, NRCS soil units, adjusted using site specific BOH data, will be used to estimate soil design criteria for parcels where no BOH data exists.

The key information derived from NRCS soils is:

- Depth to Groundwater
- Depth to Bedrock
- Percolation Rate

5.7.8 Depth to Groundwater / Bedrock

Depth to groundwater and depth to bedrock as estimated in the NRCS soil survey is presented in Table 5-22 and 5-23, respectively. The depth to groundwater/bedrock information is also presented in Figure 5-10. Depth to groundwater or bedrock less than 6 feet begins to impact septic system design. NRCS data only described the top six (6) feet of the soil profile. While it is possible to install septic systems in areas with shallow groundwater and/or bedrock, septic systems are generally more costly to design and build.

TABLE 5-22: ACTON DEPTH TO GROUNDWATER (DERIVED FROM NRCS SOIL SURVEY)

Depth to Groundwater	Total Acres	% of Land Area
0 - 1.5 Feet	2,190	18%
1.5 - 3.0 Feet	3,867	31%
3.0 - 6.0 Feet	0	0.0%
6 + Feet	5,299	43%
No Classification	1,003	8.1%
Total Land Acres	**12,358**	
Open Water	*469*	
TOTAL TOWN ACREAGE	**12,827**	

TABLE 5-23: ACTON DEPTH TO BEDROCK (DERIVED FROM NRCS SOIL SURVEY)

DEPTH TO BEDROCK	Total Acres	% of Land Area
0 – 3 Feet to Bedrock	110	0.8%
6 + Feet to Bedrock	12,248	99.2%
TOTAL LAND ACRES	**12,358**	

5.7.9 Percolation Rates

NRCS soil surveys generally assign a very broad range of percolation (perc) rates (soil permeability) to a given soil group. As an example, Charlton Fine Sandy Loam is assigned a perc rate of 10 – 100 minutes per inch. This range is so broad as to be not very useful for septic system design purposes. For reference, septic systems for new construction are only allowed in soils with percolation rates of less than 30 mpi. Septic system repairs are allowed in soils with percolation rates less than 60 mpi.

Because the perc rate specified by the NRCS is so broad, it is difficult to use NRCS perc information for wastewater needs definition analysis. Table 5-24 and Figure 5-10 present an analysis of suitability for septic systems based solely upon the 60 mpi maximum perc rate allowed for existing septic system repairs under Title 5. The three classifications were made as follows:

- Favorable: Range of perc rates is entirely below 60 mpi (e.g., 3 - 30 mpi)
- Unclear: Range of perc rates spans 60 mpi (e.g., 10 – 100 mpi)
- Unfavorable: Range of perc rates is entirely above 60 mpi (e.g., 100 – 1,000 mpi)

TABLE 5-24: LAND SUITABLE FOR ON-SITE SEPTIC SYSTEMS (NRCS PERC RATE < 60 MPI)

Classification	Developed Land on Septic Systems				Sewered, Cluster, or Undeveloped Land (Acres)	Total Land (Acres)	Percent of Total Land
	Non Residential Land (Acres)	Percent of Non-Residential Land (Acres)	Residential Land (Acres)	Percent of Residential Land (Acres)			
Likely Favorable for Septic Systems	729	39%	**1,656**	**36%**	1,624	**4,010**	34%
Unclear if Favorable for Septic Systems	491	26%	**979**	**21%**	1,282	**2,752**	23%
Likely Unfavorable for Septic Systems	328	18%	**1,788**	**38%**	1,968	**4,084**	34%
No Data	305	16%	**237**	**5%**	489	**1,031**	9%
TOTALS	**1,854**		**4,661**		**5,363**		

FIGURE 5-9: DEPTH TO GROUNDWATER AND BEDROCK FROM NRCS SOIL SURVEY

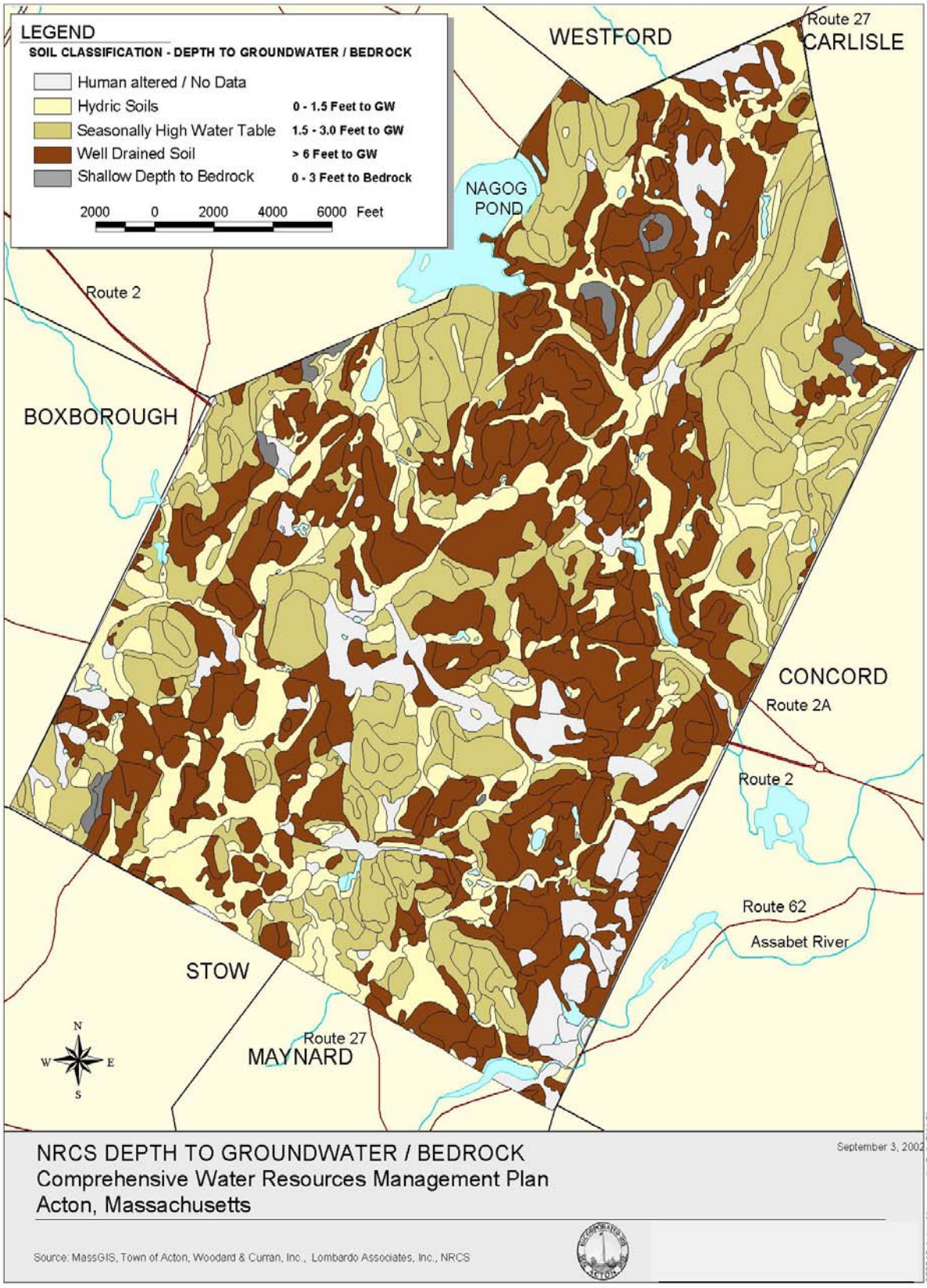
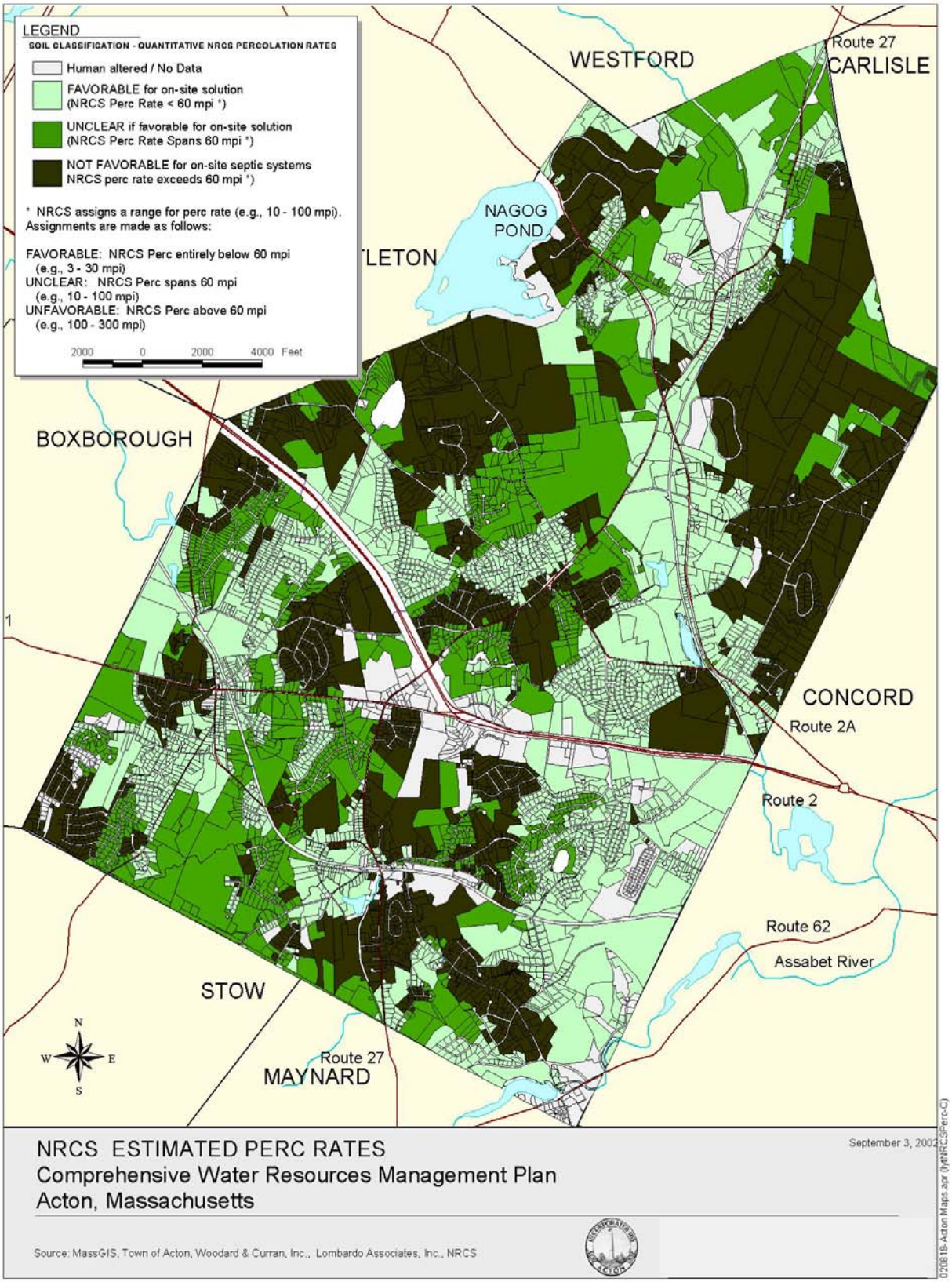


FIGURE 5-10: QUALITATIVE PERC RATES IN ACTON FROM NRCS SOIL SURVEY



Board of Health perc data can be correlated with NRCS soil groups to generate a more precise perc rate than the estimates published by the NRCS. The next Section discusses the correlation process and results for Acton.

5.7.10 Board of Health Soils Data

There are approximately 1,851 parcels with BOH soils information available electronically, compiled from the data sources described in Table 5-11. This database provides lot-specific design data for approximately 38.4% of the 4,817 developed parcels in Acton that are served by septic systems. The soils information contained in the BOH database is summarized in Table 5-25. Additional detail for each design parameter is provided in subsequent tables.

TABLE 5-25: OVERVIEW OF BOH SOILS INFORMATION

1. Design Parameter	2. Number of Parcels w/ Specific Data	3. Number of Parcels - T5 Septic Design Impacted by Data*	4. Total Number of Parcels With Data	5. Percentage of Parcels with Data Impacted by Design Data	6. Threshold for Impact Designation
Ground water	1,769	700	1,851	**37.8%**	GW Depth < 6’
Mottle Depth	165	137	1,851	**7.4%**	Mottle Depth < 6’
Bedrock	201	55	1,851	**3.0%**	Bedrock Depth < 6’
Perc Rate	1,851	44	1,851	**2.4%**	Perc > 30 mpi
		4	1,851	**~0.2%**	Perc > 60 mpi

1. Specific Design parameter
2. Number of parcels in electronic database containing information for a specific design parameter. (Not all parcels will necessarily contain data for all parameters)
3. Title 5 septic system designs are deemed impacted by the design criteria if the criteria results in a design modification – i.e., a mounded system or use of an I/A system.
4. This is the number of parcels with some design data in BOH records. A given parcel may not have a complete set of design data.
5. Obtained by dividing (3) by (4) (3) / (4). Represents an estimate of the number of parcels likely to be impacted by the design criteria.
6. Threshold for determining the number of parcels entered in Column (3).

5.7.11 Depth to Groundwater / Mottling Layer / Pit Depth

Existing electronic depth to groundwater information from the Board of Health is presented in Table 5-26. Table 5-26 indicates that of the 1,769 parcels with depth to groundwater information, 700 (39.5%) of the parcels had groundwater that could impact a Title 5 septic system design.

TABLE 5-26: EXISTING ELECTRONIC BOH DEPTH TO GW INFORMATION

Depth to Groundwater	Number of Parcels	Cumulative Number of Parcels	Percent of Parcels with Data	Cumulative Percentage of Parcels With Data
0 – 1.5 Feet	45	45	3%	3%
1.5 – 3.0 Feet	163	208	9%	12%
3.0 – 6.0 Feet	492	700	28%	40%
6.0 – 10.0 Feet[1]	387	1,087	22%	61%
< 10.0 feet	62	1,149	4%	65%
Parcels No Groundwater Encountered (dry test pits)	620	1,769	35%	100%
TOTAL RECORDS with GW DATA	**1,769**			
Parcels without Electronic Data			3,048	
Total Developed Unsewered Parcels			**4,817**	

[1]Depth to groundwater between 6.0 and 10.0' may impact septic system designs under certain conditions under Acton BOH regulations.

The number of parcels with groundwater issues is somewhat higher under Acton's Board of Health regulations, as more stringent separation to groundwater is required for faster perc rates in the Town's wellhead protection areas. The more stringent groundwater separation standard, summarized in Table 5-27, is only applicable for direct approval of system designs by the Board of Health Director. Septic systems may use the 4' separation allowed under Title 5 with approval of the Board of Health.

The maximum number of systems (of those with lot-specific groundwater data) impacted by this BOH regulation is 387 (21.9%) of systems. This is the number of systems with groundwater within 6 - 10' of grade. Septic system designs on these parcels could potentially be impacted by groundwater under BOH regulations, depending on their location and percolation rates.

TABLE 5-27: BOH GROUNDWATER SEPARATION GUIDELINE

(FOR DIRECT APPROVAL BY BOH DIRECTOR)

Perc Rate (mpi)	Minimum Separation to Groundwater (ft)		
	Well Buffer Zone (Zone I)	Aquifer Recharge Zone (Zone II)	Aquifer Protection Zone (Zone III)
< 2	8.00	7.00	6.00
3	7.00	6.00	5.00
4	6.00	5.25	4.50
5	5.50	4.75	4.25
6	5.00	4.50	4.00
7	4.75	4.25	4.00
8	4.50	4.00	4.00
9	4.25	4.00	4.00
10	4.00	4.00	4.00

From Acton BOH Regulations

The impact of this regulation is summarized in Table 5-28, for the parcels with electronic perc rate data. As illustrated in Table 5-28, approximately 1/5th of parcels in the Town are impacted by this regulation.

TABLE 5-28: PARCELS IMPACTED BY BOH MINIMUM GROUNDWATER SEPARATION

BOH Separation to Groundwater (ft)	Well Buffer Zone (Zone I)	Aquifer Recharge Zone (Zone II)	Aquifer Protection Zone (Zone III)	Remainder of Town[1] (Zone IV)	Town-Wide Total	Percentage of Parcels with Data
8.00’	7				7	0.4%
7.00’	1	38			39	2.2%
6.00’	1	5	219		225	12.7%
5.50’	1				1	0.1%
5.25’		3			3	0.2%
5.00’	1		22		23	1.3%
4.75’	1	4			5	0.3%
4.50’		1	23		24	1.4%
4.25’		2	20		22	1.2%
Total Parcels with Increased Separation to Groundwater	12	53	284	0	12	**19.7%**
Parcels Not Impacted (Req’d Separation to GW = 4.00’)	5	31	241	1,143	1,420	80.3%
TOTAL PARCELS W/ DATA	17	84	525	1,143	1,769	
Percent of Parcels within Each Zone Impacted by Regulation	**70.6%**	**63.1%**	**54.1%**	**0.0%**	**19.7%**	

[1]Regulation allows 4’ separation to groundwater in Zone IV for full range of perc rates.

Table 5-29 presents depth to mottling layer information. A significant percentage (83%) of the parcels have a mottling layer at less than 6 feet. These parcels would require mounded systems or IA pretreatment systems under Title 5 regulations.

TABLE 5-29: BOH DEPTH TO MOTTLING LAYER INFORMATION

Depth to Mottling Layer	Number of Parcels	Percent of Parcels with Data	Cumulative Percentage of Parcels With Data
0 – 1.5 Feet	4	2%	2%
1.5 – 3.0 Feet	42	25%	28%
3.0 – 6.0 Feet	91	55%	83%
6.0 + Feet	28	17%	100%
TOTAL RECORDS with MOTTLING DATA	**165**		
Parcels without Data*		4,652	
Total Developed Unsewered Parcels		**4,817**	

Table 5-30 presents depth to bedrock information contained in electronic BOH files. Bedrock was recorded for 201 of 1,425 (~14%) parcels in the Town with electronic design data. Bedrock could affect septic system designs for approximately 27% of the parcels where it was encountered, or 3.9% of parcels with data.

TABLE 5-30: DEPTH TO BEDROCK ON DEVELOPED PARCELS SERVED BY SEPTIC SYSTEMS

Depth to Bedrock	# of Parcels	Percent of Parcels with Data	Cumulative Percentage of Parcels with Data
0 - 1.5 feet	0	0%	0%
1.5 - 3.0 feet	4	2%	2%
3.0 - 6.0 feet	51	25%	27%
6.0+ feet	146	73%	100%
Parcels with Data	**201**		
Parcels With No Specific Bedrock Data	**~1,224**		
Parcels with Unknown Bedrock Conditions[1]	~3,392		
Total Developed Parcels on Septic Systems	**4,817**		

[1]Information may exist in BOH records, but are not available electronically.

5.7.12 Perc Rates

Existing electronic perc rate information from the Board of Health is presented in Table 5-31.

TABLE 5-31: EXISTING ELECTRONIC BOH PERC RATE INFORMATION

Perc Rate	Number of Parcels	Percent of Parcels with Data	Cumulative Percentage of Parcels With Data
< 2	27	1.5%	1.5%
2 - 5	779	42.1%	43.5%
5 - 10	337	18.2%	61.8%
10 - 15	287	15.5%	77.3%
15 - 20	191	10.3%	87.6%
20 - 30	186	10.0%	97.6%
30 - 60	40	2.2%	99.8%
> 60	4	0.2%	
TOTAL RECORDS	**1,851**		
Developed Unsewered Parcels With No Data	**2,966**		
Total Developed Parcels on Septic Systems	**4,817**		

5.7.13 NRCS – BOH Data Correlation

In order to produce estimated design parameters for all parcels in the Town of Acton, necessary for the CWRMP Wastewater Needs Analysis, BOH data was correlated with NRCS soils. By correlating BOH design data with NRCS soil classifications, it is possible to significantly improve upon the design

parameter estimates published by the NRCS summarized in Section 5.7.8. The correlation process is outlined below:

1. NRCS soil types were assigned to every parcel in the Town. When multiple soil types were present on a single parcel, the predominant soil was assigned. NRCS soils were then ranked in order of prevalence within the Town.

2. Electronic BOH data for depth to groundwater, depth to bedrock, depth to mottling layer, and percolation rate were compiled into a database from existing non-electronic BOH records. When multiple data points were available, (as for multiple test pits), they were consolidated into a single representative design value. If provided, the actual design value was assigned, otherwise:

   - The highest perc rate recorded on the property was assigned.
   - The shallowest mottle / groundwater / bedrock depth was assigned.

3. Electronic BOH data was correlated with NRCS soil types. Within each NRCS soil type, statistics (minimum, average, maximum, standard deviation, number of data points, etc) were generated for the range of design parameters observed in the BOH records.

4. Based upon the statistics generated for each soil type, a representative value (or range of values) was assigned to each soil type for depth to groundwater, perc rate, and depth to bedrock.

5. For all parcels without specific BOH data, these correlated design parameters are used in the wastewater needs analysis. For depth to groundwater and percolation rate, the average data value obtained by the BOH-NRCS correlation was assigned. This value was determined to be the best estimator of actual design conditions, as described in the sensitivity analysis. Based upon existing available information, these correlated design parameters are the best estimate of actual site conditions on each parcel.

Figures 5-11 and 5-12 present the design parameters for the Town generated by this process.

- Figure 5-11 presents adjusted depth to groundwater.
- Figure 5-12 presents adjusted percolation rate.

These figures can be compared with Figures 5-9 and 5-10 (NRCS estimated perc rate and depth to groundwater) to evaluate the refinements realized by correlating the BOH and NRCS data sets.

FIGURE 5-11: ADJUSTED DEPTH TO GROUNDWATER

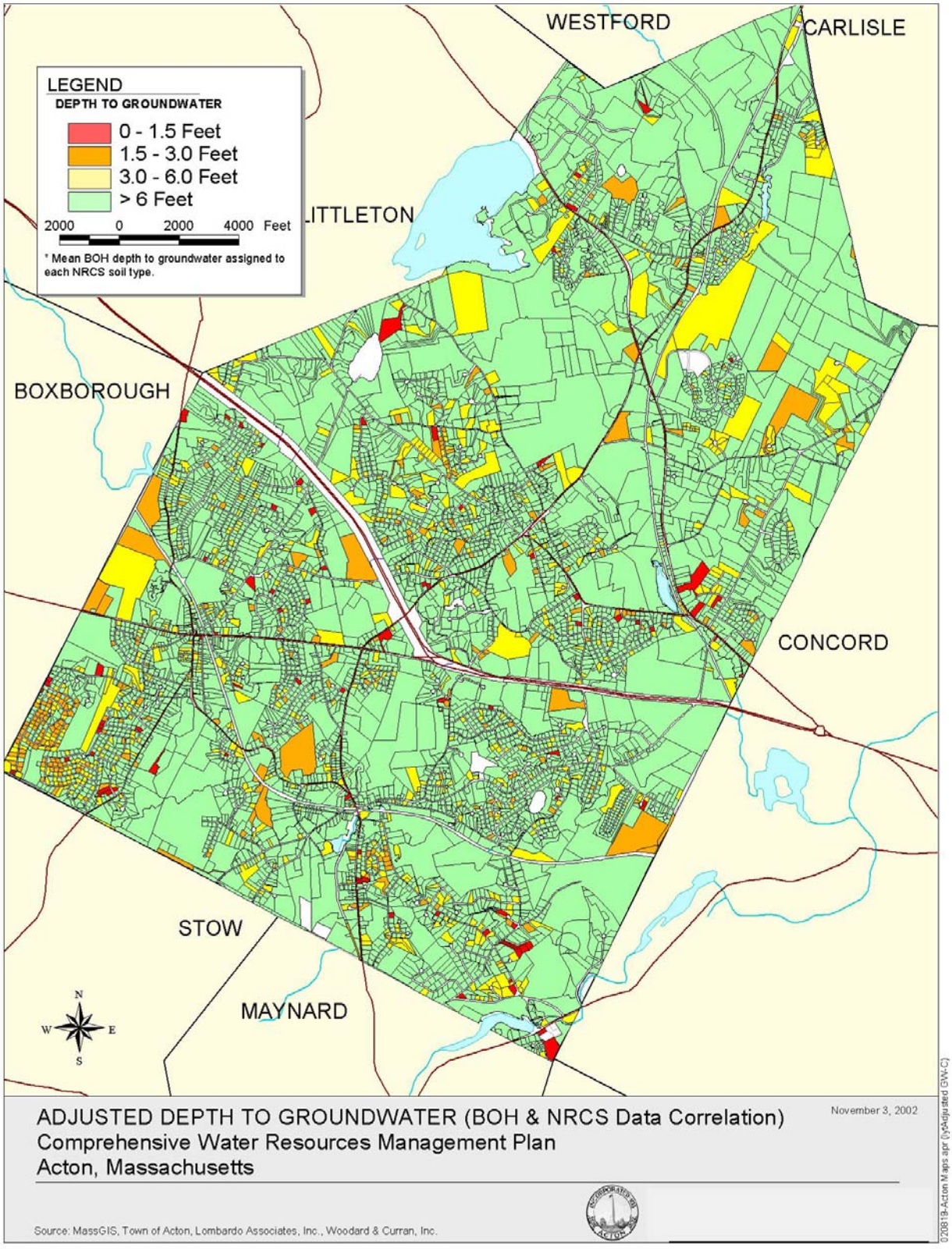
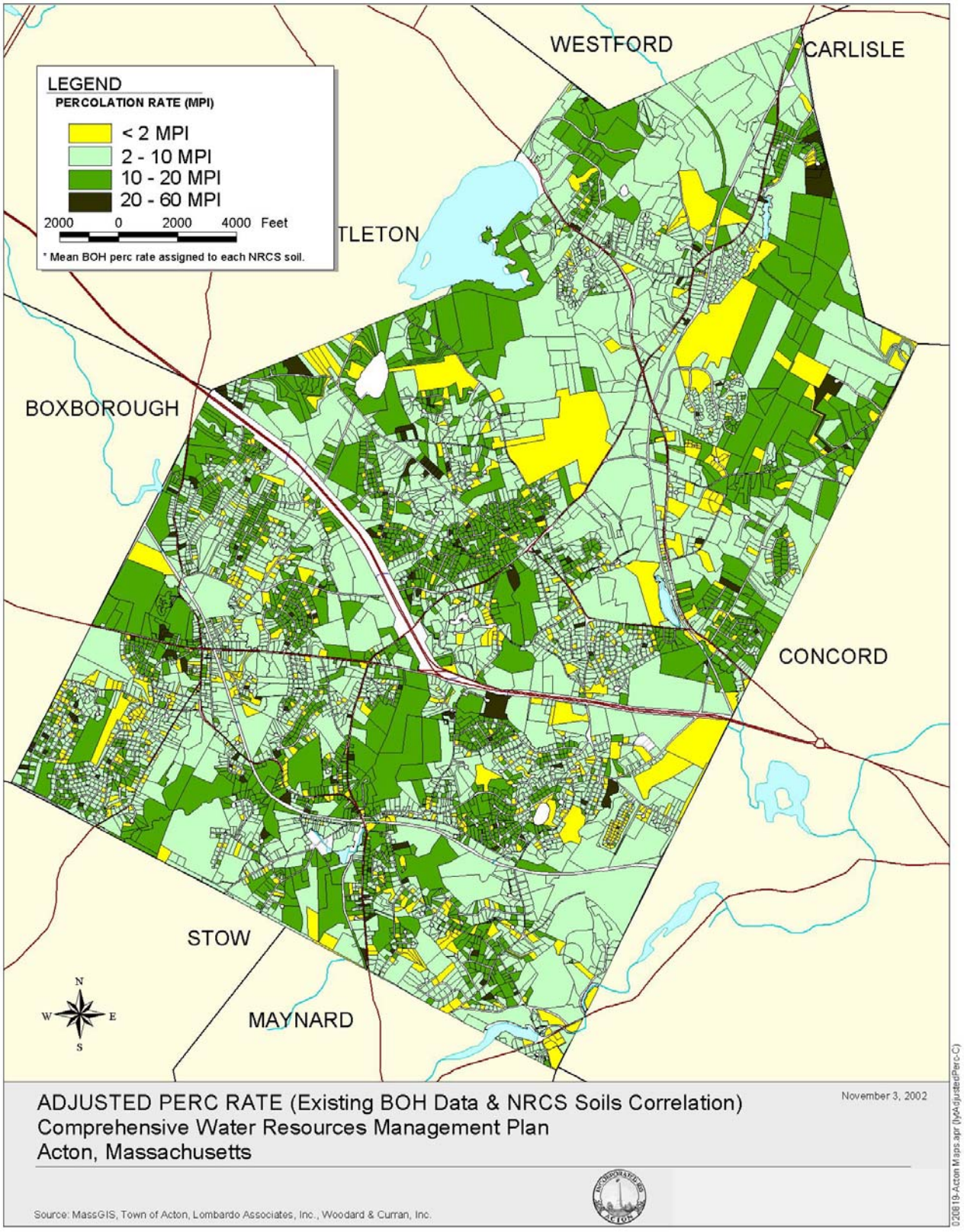


FIGURE 5-12: ADJUSTED PERCOLATION RATE



6. WASTEWATER NEEDS DEFINITION AND POTENTIAL TREATMENT AND DISPOSAL LOCATIONS

6.1 WASTEWATER NEEDS INTRODUCTION

The wastewater needs definition identifies, through the development and assessment of conceptual lot-specific septic system layouts, the suitability of properties for continued long term reliance upon on-site septic systems. The needs definition produces a lot-by-lot listing and map of parcels that are:

- Able to use conventional on-site septic systems for long term wastewater management
- Able to use on-site septic systems for long-term wastewater management – I/A and/or mounded systems may be required
- Will not be able to use on-site septic systems for long-term wastewater management – off-site solutions will be required.

Within each of these groups, specific reasons and details are provided for the wastewater needs designation for each lot. The needs definition methodology is explained below.

Additionally, existing private wastewater treatment facilities were surveyed and evaluated for continued suitability and potential inclusion in the needs analysis.

6.2 WASTEWATER NEEDS METHODOLOGY

The needs definition engineering analysis identifies specific parcels and areas that are currently exhibiting septic problems and/or are likely to require off-site solutions in the future. This process ensures that the Town will have a sustainable, comprehensive, viable plan as septic system problems occur in the future. The analysis defines problem areas in two ways; (1) existing problems and (2) long term problems.

6.2.1 Existing Problems Definition

This analysis identifies properties that are currently exhibiting septic system functional or performance-related problems. The databases are analyzed for symptoms of functional failure.

6.2.2 Long Term Problems Definition (Existing and Future Development)

This method is used to identify properties that can rely on on-site systems as a viable long term solution and those properties that will require an off-site solution when they fail. With this approach, a sustainable, comprehensive wastewater management plan can be developed for the Town.

For this method, suitability of on-site septic systems as a viable long term wastewater solution is assessed for each lot by individually evaluating septic system design criteria, parcel characteristics, and site restrictions. The following analytical procedure is followed for each lot:

1. Assume existing septic system fails, requiring complete replacement
2. Develop conceptual design for replacement system, using:
    a. Existing regulations
    b. Physical site conditions (perc rate, depth to groundwater/bedrock, setback restrictions, etc.)
    c. Current design flows

3. Evaluate feasibility of siting the replacement system on the parcel
    a. Consideration of environmental & other site restrictions
4. Based upon this analysis, the ability of the parcel to accommodate an on-site septic system is determined. Properties unable to accommodate a septic system under current regulations will be designated as requiring an off-site solution.

In addition to identifying parcels that require off-site solutions over the long term, this methodology identifies those parcels that, in the future, are likely to have problems that can be corrected on-site. The methodology produces a concise, lot-specific map and list of the problem properties in the study area(s). This list includes:

1. Parcels currently exhibiting septic problems and requiring immediate solution
2. Parcels that will require off-site solutions in the long term (when their existing systems fail) due to:
    a. Wetlands
    b. Floodplains
    c. Inadequate Space
3. Parcels that can rely on repairing septic systems on-site but will require:
    - Large Mounds (over 3 ¼' feet tall)
    - Small Mounds (under 1 ¾' feet tall)
    - Use of I/A technologies

The definition of the long term wastewater needs for a study area is then the basis used for developing wastewater solution alternatives that are technically, environmentally, and economically optimized for the area's specific needs over both the short and long term. When finalized, these solution alternatives will become the basis for the community's comprehensive sustainable wastewater management plan.

6.3 DESCRIPTION OF WASTEWATER NEEDS PARAMETERS

Spatial and design parameters were used in developing the wastewater needs analysis. Spatial parameters and the values used are listed in Table 6-1. Design parameters are listed in Table 6-2.

TABLE 6-1: SPATIAL PARAMETERS FOR WASTEWATER NEEDS ANALYSIS

Parameter	Value	Comment / Source Regulation
Property Line Setback	10’	Title 5
Building Setback	10 – 20’ [1]	Title 5
Wetlands Setback	75 – 100’ [2]	BOH 16-6,2,7, 11-7.2
Floodplain Setback	0 – 100’ [3]	BOH 16-6.2.7
Surface Water Setback	75 – 100’ [2]	BOH 16-6.2.7
Surface Water Setback – Nagog Pond (Public Water Supply)	400’	Title 5
Surface Water Setback – (Tributary to Public Water Supply)	200’	Title 5
Public Well Setback	100 – 400’	Title 5, varies by well yield
Private Well Setback	100’	Title 5
Vernal Pool Setback	100’	Title 5

[1] 10’ required for structures built on slab, 20’ required for structures with basements.
[2] 75’ required in Aquifer Zone IV, 100’ required in Zones I – III.
[3] Construction in floodplain allowed in Aquifer Zone IV, 100’ setback from floodplain required in Zones I – III.

TABLE 6-2: DESIGN PARAMETERS USED FOR WASTEWATER NEEDS ANALYSIS

Parameter	Source
Design Flow	BOH Records or Assessor’s Database. 4 bedrooms used as residential default if no data available.
Garbage Grinder	Uses BOH records. Defaults to no grinder if no data available.
Perc Rate	Uses BOH records. Defaults to correlated BOH-NRCS soil values if no specific BOH records available (average correlated value used).
Depth to Groundwater	Uses BOH records. Defaults to correlated BOH-NRCS soil values if no specific BOH records available (average correlated value used).
Depth to Bedrock	Uses BOH records. Defaults to correlated BOH-NRCS soil values if no specific BOH records available (average correlated value used).
Water Supply	Provides an allowance for 100’ setback from on-site drinking water wells. No setback allowance is provided for parcels that are fronted by an existing water main.
Separation to Groundwater	Follows Acton BOH regulations for minimum groundwater separation (See Table 5-27).

6.4 NEEDS DEFINITION RESULTS

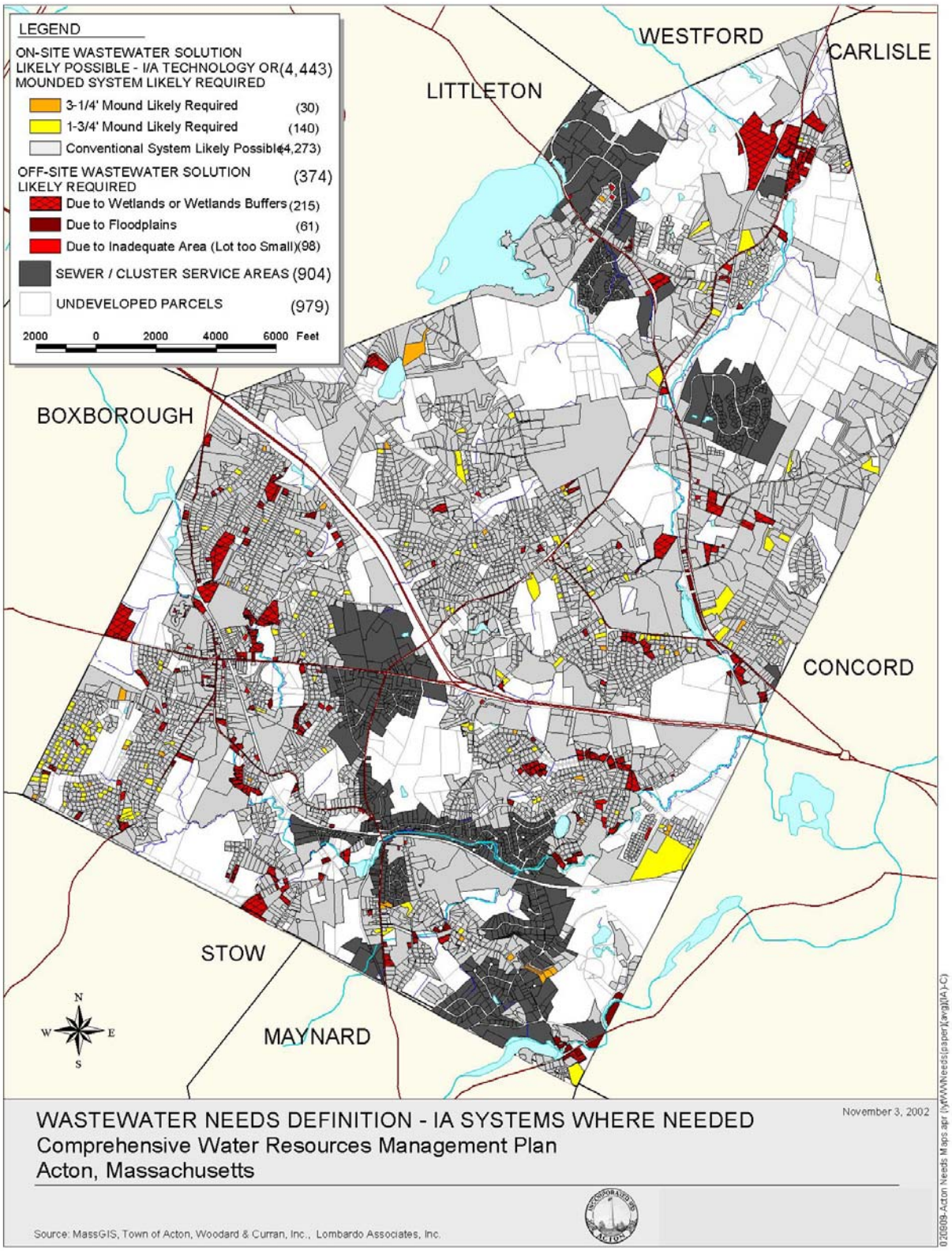
Table 6-3 and Figure 6-1 present the results of the wastewater needs analysis.

TABLE 6-3: WASTEWATER NEEDS ANALYSIS RESULTS

Needs Classification	I/A Systems Where Needed *	
	# Parcels	**% of Studied Parcels**
OFF SITE LIKELY REQUIRED		
Due to Wetland Buffers	215	4.5%
Due to Floodplains	61	1.3%
Due to Inadequate Space	98	2.0%
TOTAL OFF SITE LIKELY REQUIRED	**374**	**7.8%**
ON-SITE LIKELY POSSIBLE		
3 ¼' Mound May Be Required	30	0.6%
1 ¾ Mound May Be Required	140	2.9%
Conventional Septic System Likely Possible	4,273	88.7%
TOTAL ON-SITE POSSIBLE	**4,443**	**92.2%**
TOTAL EXISTING PARCELS ON SEPTIC SYSTEMS	4,817	
Undeveloped Parcels *(Developable / Undevelopable)*	979 *(451 / 528)*	
Parcels Served By Existing Cluster / Sewer Systems	904	
TOTAL PARCELS	6,700	

Title 5 allows 2' reduction in separation to groundwater when a secondary treatment system ("I/A system") is installed. For the wastewater needs analysis, this rule has also been applied to Acton BOH groundwater separation regulations.

FIGURE 6-1: WASTEWATER NEEDS ANALYSIS RESULTS (IA SYSTEMS WHERE NEEDED)



6.5 WASTEWATER NEEDS SENSITIVITY ANALYSIS

6.5.1 Spatial Parameters

A base value was adopted for all spatial parameters used in the wastewater needs definition. Base values were derived from existing State and Town regulations. To evaluate the sensitivity upon these spatial parameters, all base values were adjusted to a "maximum variance" level and the wastewater needs definition was calculated using these adjusted values.

Table 6-4 lists the base value applied "maximum variance" value for each of the spatial parameters. Table 6-5 lists the aggregate impact upon the wastewater needs definition results.

TABLE 6-4: SENSITIVITY ANALYSIS FOR SPATIAL PARAMETERS

Feature	Acton GW Zone	Title 5 Req'mt	Buffer Distance (ft) (BOH Reg)	BASE VALUE - Existing Regulations	MAXIMUM VARIANCE	Source	Comments
Parcels		10	10	10	5	Title 5, 15.211	
Buildings		10/20	10/20	20	10	Title 5, 15.211	20' with basement, 10' if slab
Wetlands	Zone I	50	100	100	50	BOH 16-6.2.7	
Wetlands	Zone II	50	100	100	50	BOH 16-6.2.7	
Wetlands	Zone III	50	100	100	50	BOH 16-6.2.7	
Wetlands	Zone IV	50		75	50	BOH 11-7.2	
Wetlands	< 2,000 gpd	50	75	75	75	BOH 11-7.2	
Wetlands	> 2,000 gpd	50	100	100	100	BOH 11-7.3	
Floodplains	Zone I-III		100	100	0	BOH 16-6.2.7	septic system not prohibited by Title 5
Floodplains	Zone IV		0	0	0		
Vernal Pools		100		100	50	Title 5, 15.211	
Surface Waters	Zone I	50	100	100	50	BOH 16-6.2.7	
PWS Surface Water	(all)	400	400	400	400	Title 5, 15.211	
Tributary to PWS	(all)	200	200	200	200	Title 5, 15.211	
Surface Waters	Zone II	50	100	100	50	BOH 16-6.2.7	
Surface Waters	Zone III	50	100	100	50	BOH 16-6.2.7	
Surface Waters	Zone IV	50	50	75	50	BOH 11-7.2	
Private Wells	Zone I		300	300	300	BOH 16-4.2.7	
Private Wells	Zone II		150	150	150	BOH 16-4.2.8	
Private Wells	Zone III	100	100	100	100	Title 5	
Private Wells	Zone IV	100	100	100	100	Title 5	
Public Wells	Zone I	not allowed	400	400	400	Title 5, 15.211	(BOH 16-4.2.7 is 300, but title 5 is 400 / not allowed - also, varies by well yield)
Public Wells	Zone II	varies by yield	150	150	150	BOH 16-4.2.8	varies with yield, 150 IS MINIMUM
Public Wells	Zone III	varies by yield		100	100	varies with yield	varies with yield
Public Wells	Zone IV	varies by yield		100	100	varies with yield	varies with yield

TABLE 6-5: SENSITIVITY ANALYSIS FOR SOILS PARAMETERS

Needs Classification	Base Spatial Parameters (IA Systems Where Needed)		Maximum Variance Spatial Parameters (IA Systems Where Needed)		Change in Wastewater Needs	
	# Parcels	% of Studied Parcels	# Parcels	% of Studied Parcels	# Changed Parcels	% Change
OFF SITE LIKELY REQUIRED						
Due to Wetland Buffers	215	4.5%	66	1.4%	+ 149	+ 69.3%
Due to Floodplains	61	1.3%	17	0.4%	+ 44	+ 72.1%
Due to Inadequate Space	98	2.0%	59	1.2%	+ 39	+ 39.8%
TOTAL OFF SITE LIKELY REQUIRED	**374**	**7.8%**	**142**	**2.9%**	**+ 232**	**+62.0%**
ON-SITE LIKELY POSSIBLE						
3 ¼' Mound May Be Required	30	0.6%	35	0.7%	- 5	- 16.7%
1 ¾ Mound May Be Required	140	2.9%	149	3.1%	- 9	- 6.4%
Conventional Septic System Likely Possible	4,273	88.7%	4,491	93.2%	- 218	- 5.1%
TOTAL ON-SITE POSSIBLE	**4,443**	**92.2%**	**4,675**	**97.1%**	**- 232**	**- 5.2%**
TOTAL EXISTING PARCELS ON SEPTIC SYSTEMS	4,817					
Undeveloped Parcels *(Developable / Undevelopable)*	979 *(451 / 528)*					
Parcels Served By Existing Cluster / Sewer Systems	904					
TOTAL PARCELS	6,700					

6.5.2 Design Parameters

6.5.2.1 Soils Data

Three different techniques were used to assign design values to parcels without BOH data using the NRCS-BOH data correlation:

1. **Average**: The average BOH value for each NRCS soil type was assigned to all parcels with that soil. It is expected that approximately 50% of parcels will have better design conditions, and approximately 50% will have worse design conditions.

2. **Average + 1 Standard Deviation**: The average plus one standard deviation of the BOH values for each soil type was assigned to all parcels with that soil type (e.g., if average perc rate is 15 mpi, and standard deviation is 8 mpi, then design value is 23 mpi). If the average plus standard

deviation is greater than the maximum value, then the maximum value is assigned. It is expected that approximately 85% of parcels will have better design conditions, and approximately 15% will have worse design conditions.

3. **Maximum:** The maximum BOH value recorded for each soil type was assigned to all parcels with that soil type. It is expected that approximately 100% of parcels will have better design conditions, and no parcels will have worse design conditions.

For each of the three scenarios above, parcels with specific BOH records and design values retained their specific data. The correlated values were only used for parcels without specific data. Also, it is important to note that the estimated percentages of parcels expected to have better and worse design conditions are only estimates. Unusual distribution of BOH data for a given soil type or limited data could skew the correlation significantly from these estimates. These estimates are the best possible given available information, and are suitable for the purposes of the needs analysis.

Correlated soils data developed under each of these three techniques was applied to the wastewater needs analysis methodology. The results of the different correlation techniques are presented in Table 6-6.

TABLE 6-6: SENSITIVITY ANALYSIS FOR SOILS PARAMETERS

Needs Classification	**SCENARIO 1 *** Average of Correlated Values		**SCENARIO 2** Average + Standard Deviation of Correlated Values		**SCENARIO 3** Maximum of Correlated Values	
	# Parcels	% of Studied Parcels*	# Parcels	% of Studied Parcels*	# Parcels	% of Studied Parcels*
OFF SITE LIKELY REQUIRED						
Due to Wetland Buffers	215	4.5%	257	5.3%	287	6.0%
Due to Floodplains	61	1.3%	74	1.5%	81	1.7%
Due to Inadequate Space	98	2.0%	143	3.0%	166	3.4%
TOTAL OFF SITE LIKELY REQUIRED	**374**	**7.8%**	**474**	**9.8%**	**534**	**11.1%**
ON-SITE LIKELY POSSIBLE						
3 ¼' Mound May Be Required	30	0.6%	30	0.6%	2,437	50.6%
1 ¾ Mound May Be Required	140	2.9%	707	14.7%	474	9.8%
Conventional Septic System Likely Possible	4,273	88.7%	3,606	74.9%	1,372	28.5%
TOTAL ON-SITE POSSIBLE	**4,443**	**92.2%**	**4,343**	**90.2%**	**4,283**	**88.9%**
TOTAL EXISTING PARCELS ON SEPTIC SYSTEMS	4,817					
Undeveloped Parcels *(Developable / Undevelopable)*	979 *(451 / 528)*					
Parcels Served By Existing Cluster / Sewer Systems	904					
TOTAL PARCELS	6,700					

***** Scenario 1 was used for the base wastewater needs analysis.

All parameters aside from soil design data are set to base analysis.

6.5.2.2 Water Supply

There are relatively few on-site individual drinking water wells located in Acton. As indicated in Table 5-20, 775 developed parcels with on-site septic systems are not served by the public water system (369 + 406). At most 16.5% (775 / 4,817) of the developed, septic system parcels in the Town are served by on-site wells. To evaluate the impact of assumptions regarding the location and number of on-site wells on the needs definitions, the following scenarios were performed:

A. All 775 parcels use on-site wells (includes those fronting water mains but not connected)
B. Only 406 parcels not fronting water mains use on-site wells

For each of these two categories the following three criteria were applied:

1. Maximum well setback (100' radius = 31,400 sq. ft.)
2. Moderate well setback (100' radius / 2 = 15,700 sq. ft.)
3. Minimum setback (100' radius / 4 = 7,850 sq. ft.)

Table 6-7 summarizes the impacts of these six approaches.

TABLE 6-7: SENSITIVITY ANALYSIS OF WATER SUPPLY

Water Supply Scenario	Number of Parcels Requiring Off-Site Solutions	
	775 On-Site Wells	406 On-Site Wells
Maximum well setback area (31,400 sf)	753	555
Moderate setback area 15,700 sf)	610	477
Minimum setback area (8,000 sf)	506	**435***

* Parameters used for base needs analysis

6.5.2.3 Separation to Groundwater BOH vs. Title 5

A simple sensitivity analysis was performed to evaluate the impact of the Acton Board of Health' s groundwater separation rule as compared to standard Title 5 groundwater separation requirements. The same 2' separation credit allowed under standard Title 5 regulations with the use of IA technologies was also applied under the BOH regulations where needed. Table 6-8 presents the results of this sensitivity analysis.

The sensitivity analysis only evaluated whether on-site solution would be possible. The number of mounded systems required under the two different regulations was not evaluated, as Title 5 can be used instead of the more stringent BOH regulation simply by obtaining direct BOH approval for a septic system design. On properties where the BOH regulations would require extensive mounding or other costly system components, it is expected that direct BOH approval of the design would be obtained to reduce system costs.

TABLE 6-8: SENSITIVITY ANALYSIS OF BOH SEPARATION TO GROUNDWATER REGULATIONS

Needs Classification	Conventional Title 5 Groundwater Separation		BOH Groundwater Separation Rule	
	# Parcels	% of Studied Parcels	# Parcels	% of Studied Parcels
TOTAL OFF SITE LIKELY REQUIRED	**371**	**7.7%**	**374**	**7.8%**
TOTAL ON-SITE POSSIBLE	**4,446**	**92.3%**	**4,443**	**92.2%**
TOTAL EXISTING PARCELS ON SEPTIC SYSTEMS	4,817			
Undeveloped Parcels *(Developable / Undevelopable)*	979 *(451 / 528)*			
Parcels Served By Existing Cluster / Sewer Systems	904			
TOTAL PARCELS	6,700			

Use of IA Systems & Groundwater Separation Credit

Wastewater needs were calculated using two approaches:

1. Using only conventional septic systems
2. Using IA systems where needed to reduce mounding requirements

The impact of IA systems on wastewater needs was evaluated. Results are summarized in Table 6-9.

TABLE 6-9: SENSITIVITY ANALYSIS FOR IA TECHNOLOGY & GW SEPARATION CREDIT

NEEDS CLASSIFICATION	CONVENTIONAL SEPTIC SYSTEMS ONLY		I/A SYSTEMS WHERE NEEDED *	
	# Parcels	% of Studied Parcels	# Parcels	% of Studied Parcels
OFF SITE LIKELY REQUIRED				
Due to Wetland Buffers	233	4.8%	215	4.5%
Due to Floodplains	68	1.4%	61	1.3%
Due to Inadequate Space	114	2.4%	98	2.0%
TOTAL OFF SITE LIKELY REQUIRED	**415**	**8.6%**	**374**	**7.8%**
ON-SITE LIKELY POSSIBLE				
3 ¼' Mound May Be Required	30	0.6%	30	0.6%
1 ¾ Mound May Be Required	139	2.9%	140	2.9%
Conventional Septic System Likely Possible	4,232	87.9%	4,273	88.7%
TOTAL ON-SITE POSSIBLE	**4,402**	**91.4%**	**4,443**	**92.2%**
TOTAL EXISTING PARCELS ON SEPTIC SYSTEMS	4,817			
Undeveloped Parcels *(Developable / Undevelopable)*	979 *(451 / 528)*			
Parcels Served By Existing Cluster / Sewer Systems	904			
TOTAL PARCELS	6,700			

6.6 NEEDS ASSESSMENT OF CLUSTER SYSTEMS

6.6.1 Private Wastewater Treatment Facilities

Existing privately-owned wastewater treatment facilities were surveyed and evaluated to assess the needs of these systems and include the potential impacts in the planning process. Most systems are located in the northern half of Acton, which has many condominium and cluster development.

Table 6-10 summarizes the status of the ten private wastewater treatment facilities discharging wastewater within Acton's borders. All private facilities in Acton, except for the Powdermill Plaza treatment facility, discharge to subsurface disposal fields. The private facilities are permitted for a total of 452,770 gallons per day of wastewater flow. This flow could have a considerable impact on wastewater planning if these facilities exhibited significant problems.

TABLE 6-10 CLUSTER SYSTEM STATUS

Cluster System	Year Built	Permitted Flows (gpd)	Orders	Description of Issue
Acorn Park	1997	33,380		
Brookside Apts	1983	11,000		Leachfield breakout – high groundwater
Farmbrook	1978	105,000		
Great Road Condos	1978	27,720		
North Acton	1973	200,000	ACO NON	Breakout Phosphorus Removal
Powdermill	1982	12,000		Loading to Assabet River
Robbins Brook	2001	22,420	ACO	Monitoring well – as-built plans
Suburban Manor	1988	24,450		
Woodvale	1978	12,400		
Yankee Village	1982	4,400		
TOTAL		**452,770**		

Several cluster treatment and disposal facilities were built over 20 years ago. Great Road Condominiums is subject to a Notice of Noncompliance (NON). Two facilities, North Acton and Robbins Brook Assisted Living, are subject to Administrative Consent Orders (ACO).

The most direct and obvious private contributor of nutrient and organic loading to the Assabet River is the Powdermill Plaza wastewater facility, which discharges directly to the river. This system is under review for decommissioning with diversion of wastewater to the town's WWTF.

The private facilities with subsurface discharges are permitted and monitored by DEP, and despite some problems the facilities are not showing signs of impending failure. The status of these facilities is being considered as part of the planning effort.

6.6.2 Small-Medium Cluster Systems and Large Septic Systems

Twelve small-medium cluster systems serving condominiums with design flows of approximately 10,000 gallons per day were identified. These systems contribute a total of approximately 100,000 gpd of wastewater treatment and disposal capacity. Most are large septic-type systems. Table 6-11 lists the systems.

TABLE 6-11 SMALL-MEDIUM CLUSTER SYSTEMS

Facility	Design Flow	Year Built	Location	Treatment	Type of Ownership
North Acton Woods	9,900	1998	Harris Street	Modular FAST	SFR Detached Condos
Handley Woods	6,600	1995	Harris Street	N/A	SFR Detached Condos
Audubon Place S	7,800	1989	High Street	N/A	Condominiums
Audubon Place N	6,951	1989	High Street	N/A	Condominiums
Piper Ridge	6,180	1997	Piper Road	N/A	SFR Shared System
Colonial Acres IV	9,900	Proposed	Summer Street	Tertiary w/ N < 10 mg/l	SFR Detached Condos
Harris Street Village	5,280	2000	Harris Street	N/A	Condominiums
Mill Corner	15,000	1989	Nylander Way	N/A	SFR Detached Condos
Marshall Crossing	7,200	1995	Carlisle Road	N/A	SFR Detached Condos
Hillside Terrace	7,700	2001	Great Road	N/A	Condominiums
New View	7,920	1995	Central Street	N/A	Condominiums
Meadowbrook	9,900	1997		N/A	Condominiums

SFR = Single Family Residence

Several large septic systems serving apartment complexes are located throughout town and listed in Table 6-12.

TABLE 6-12 LARGE SEPTIC SYSTEMS

Facility	Design Flow	Location	Description
Dover Heights Apts	15,180 gpd	Central Street	Probable need for new plant
Strawberry Hill Apts	11,880 gpd	Great Road	Probable need for new plant
Spring Hill Commons Apts	20,750 gpd	Great Road	Probable need for new plant, limited soils space

Several large septic systems are located on properties with individual public water supply (PWS) wells. Table 6-13 lists these systems. The Strawberry Hill Apartments noted in Table 6-12 as having a probable need for a new treatment plant is located on a property with an individual public water supply well.

TABLE 6-13 SEPTIC SYSTEMS ON PROPERTY WITH AN INDIVIDUAL PWS

System	Location	Design Flow (gpd)
Pine Hill Condominiums	209 Great Road	9,240
Strawberry Hill Apartments	18 Strawberry Hill Road	11,880
Richmond House	420 Great Road	4,510
Somerset Apartments	10 Wampus Ave.	7,810

Additionally, the recent Wellhead Protection Study (2002) identified 47 septic systems over 2,000 gpd in Zone IIs that may impact water quality. These septic systems are included in the Acton Water District's GIS database available to the Town.

6.7 AREAS IN NEED OF OFF-SITE WASTEWATER SOLUTIONS

Figures 6-2 and 6-3 illustrate the probable grouping of the needs areas resulting from the needs assessment. Identified in the figures are:

- Parcels requiring offsite solutions,
- Parcels requiring mounded systems, and
- Large septic systems.

Lots identified as requiring offsite solutions to wastewater disposal problems are dispersed throughout the community. Attempting to service only the dispersed lots with off-site solutions would be technically impractical and cost prohibitive. Grouping "needs" lots geographically is more feasible technically and financially. Still, wastewater infrastructure constructed to serve the "needs" lots will also create links to other adjacent lots, creating potential service areas. Therefore, preliminary service/study areas have been developed that link nearby "needs" lots with lots not exhibiting pending needs.

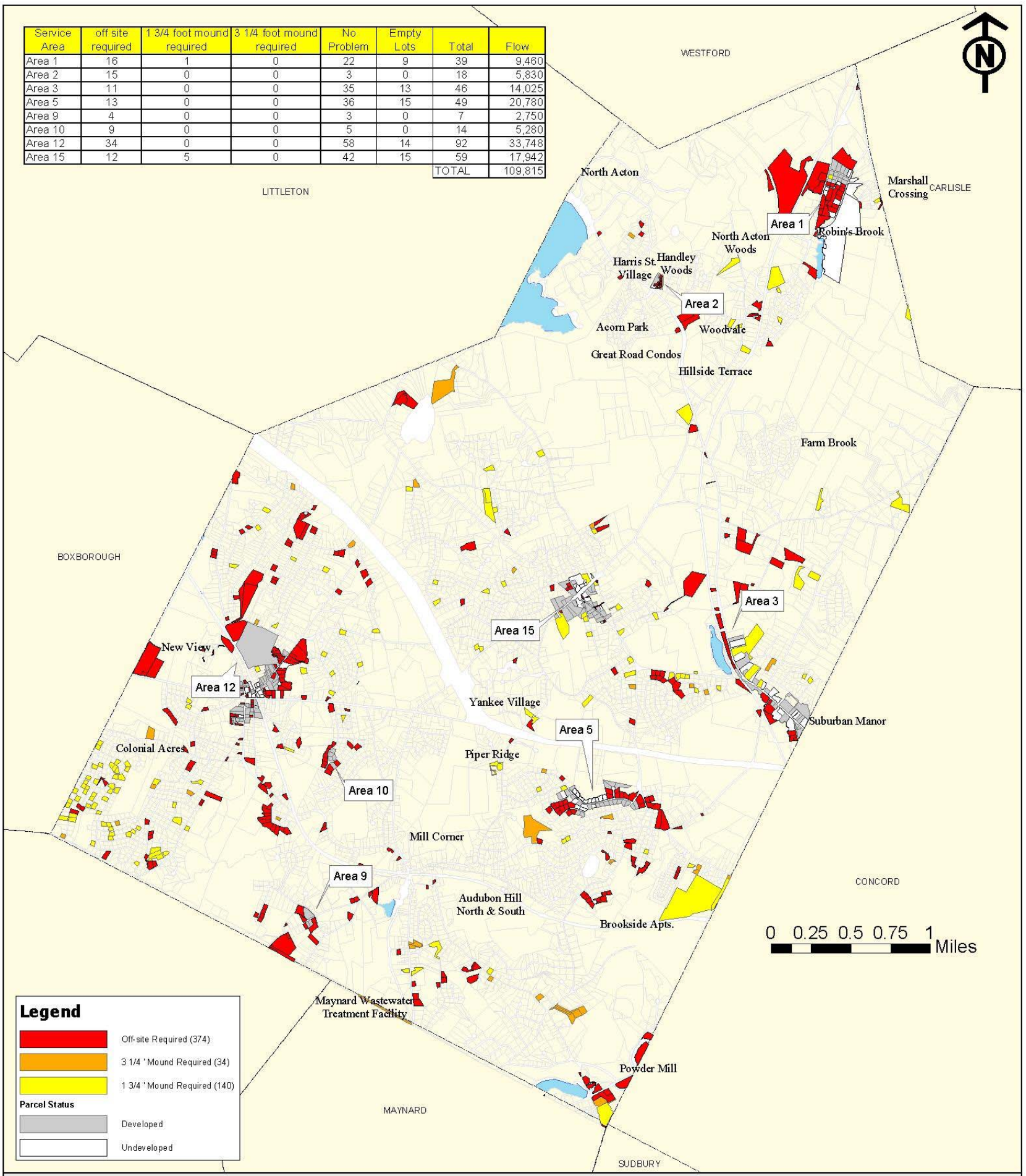
All the identified "needs" parcels require offsite solutions. Therefore, each area reflects the same priority as determined by the methodology presented in this report. However, the order in which the Town addresses the needs areas may be developed by several methods including assigning the highest priority to the largest needs areas first or by prioritizing the needs areas that lend themselves to solving the wastewater disposal problem most quickly and inexpensively.

Figure 6-2 displays the minimum study areas based on combining closely grouped areas determined to require off-site solutions. Lots adjacent to the "needs" lots are also included to maximize the cost-effectiveness of the system. The table included with the figure lists the number of parcels in the study area and the expected wastewater flow from each parcel grouping. Total estimated flow from the minimum study areas is approximately 110,000 gallons per day.

Figure 6-3 displays the maximum study areas based on combining closely grouped areas requiring off-site solutions and adjacent parcels requiring mounded systems. Total estimated flow from the maximum study areas is approximately 265,000 gallons per day. There are several other areas where mounded systems will most likely be required but the analysis has not identified these areas as requiring off-site solutions.

FIGURE 6-2: MINIMUM SERVICE AREAS

Service Area	off site required	1 3/4 foot mound required	3 1/4 foot mound required	No Problem	Empty Lots	Total	Flow
Area 1	16	1	0	22	9	39	9,460
Area 2	15	0	0	3	0	18	5,830
Area 3	11	0	0	35	13	46	14,025
Area 5	13	0	0	36	15	49	20,780
Area 9	4	0	0	3	0	7	2,750
Area 10	9	0	0	5	0	14	5,280
Area 12	34	0	0	58	14	92	33,748
Area 15	12	5	0	42	15	59	17,942
						TOTAL	109,815



TITLE FIVE DESIGN FLOW
MINIMUM SOLUTION AREAS-BASE CRITERIA

Acton, Massachusetts

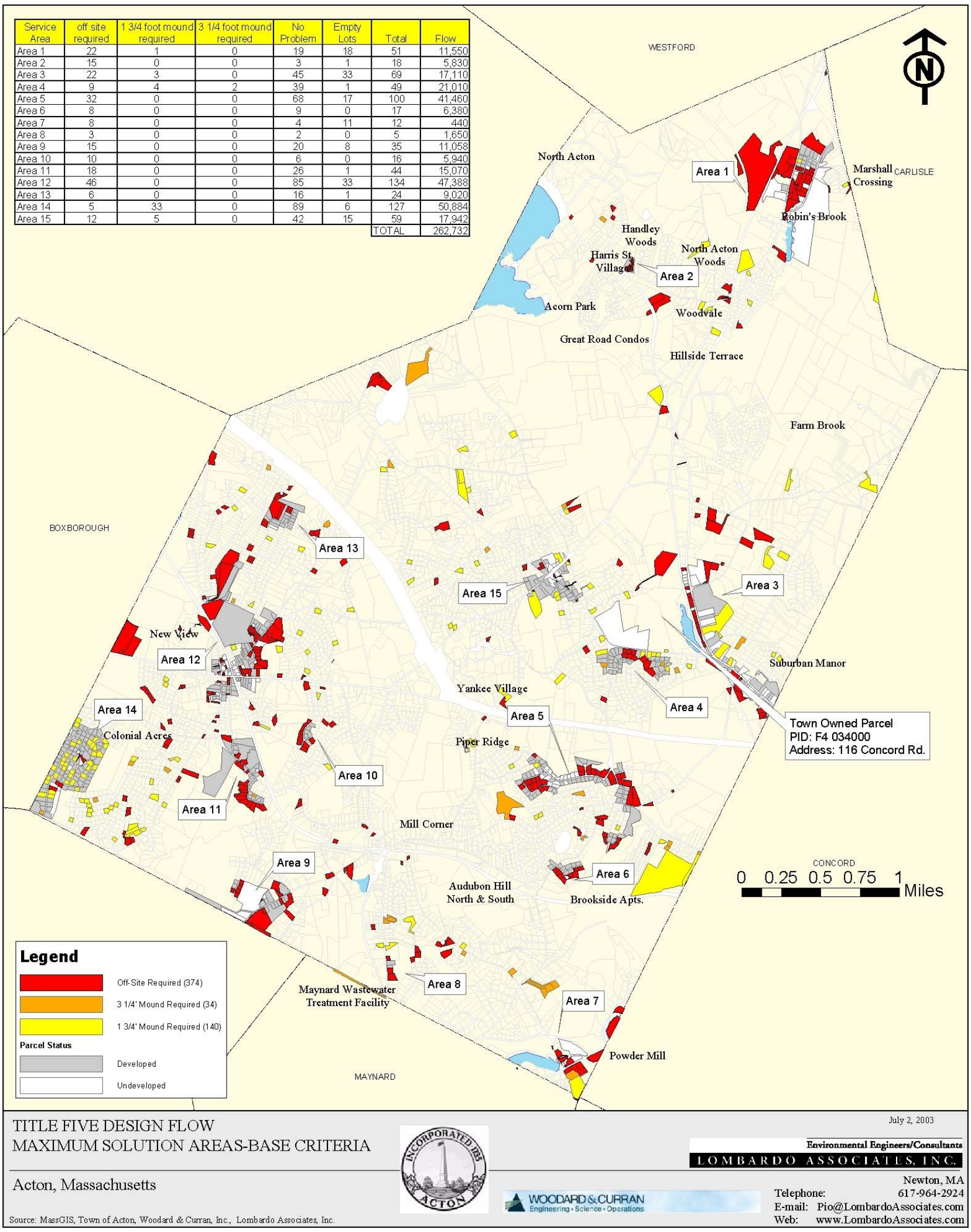
Source: MassGIS, Town of Acton, Woodard & Curran, Inc., Lombardo Associates, Inc.

July 3, 2003

Environmental Engineers/Consultants
LOMBARDO ASSOCIATES, INC.
Newton, MA
Telephone: 617-964-2924
E-mail: Pio@LombardoAssociates.com
Web: www.LombardoAssociates.com

FIGURE 6-3: MAXIMUM SERVICE AREA

Service Area	off site required	1 3/4 foot mound required	3 1/4 foot mound required	No Problem	Empty Lots	Total	Flow
Area 1	22	1	0	19	18	51	11,550
Area 2	15	0	0	3	1	18	5,830
Area 3	22	3	0	45	33	69	17,110
Area 4	9	4	2	39	1	49	21,010
Area 5	32	0	0	68	17	100	41,460
Area 6	8	0	0	9	0	17	6,380
Area 7	8	0	0	4	11	12	440
Area 8	3	0	0	2	0	5	1,650
Area 9	15	0	0	20	8	35	11,058
Area 10	10	0	0	6	0	16	5,940
Area 11	18	0	0	26	1	44	15,070
Area 12	46	0	0	85	33	134	47,388
Area 13	6	0	0	16	1	24	9,020
Area 14	5	33	0	89	6	127	50,884
Area 15	12	5	0	42	15	59	17,942
						TOTAL	262,732



The grouping of study areas are the result of the GIS and database analysis of the needs criteria, interviews with town staff, CAC input, field review, and literature research. These groupings form a framework for discussing and evaluating the minimum and maximum number of parcels included in off-site systems. The boundaries of these areas will be refined and the requirement for off-site solutions will be reviewed in conjunction with potential treatment and disposal options in the next phase of the planning process.

6.8 POTENTIAL SATELLITE WASTEWATER DISPOSAL LOCATIONS

6.8.1 Introduction

The principal tool used in identifying Areas of Interest (AOI's) with potential for wastewater disposal has been the database available from the Town of Acton's GIS system and data from MassGIS. These data bases have allowed the important and limiting characteristics of soil type, such as depth to groundwater, and level of development to be combined in eliminating all areas of the Town which are inappropriate for further consideration.

All evaluations of areas eliminated or included under the various criteria below were conducted on a parcel base map available from the Acton GIS system. Physical characteristics of parcels, the areas of parcels and linking to the developed status for each parcel were carried out using GIS tools.

6.8.2 Criteria

Soil Type

The most significant characteristic in eliminating portions of Town unsuitable for wastewater effluent disposal is soil type. Areas without water-lain deposits of sands and gravels are not expected to be able to infiltrate wastewater effluent quickly enough to be of value in a small municipal disposal program. Thus areas without these soil characteristics are eliminated from consideration.

Seasonal High Groundwater

Another significant hydrogeologic characteristic for wastewater disposal is the depth to seasonal high groundwater. MA DEP regulations require a minimum of four feet of unsaturated soils below the wastewater effluent discharge facility, after any groundwater mounding has occurred. As an initial criterion, to allow for limited mounding and some embedment of the facility, areas with 6 feet or less to seasonal high groundwater are rejected. This criteria may be revisited in subsequent phases if a parcel is identified that meets all other criteria and would benefit from some effort in adding soil to increase the surface elevation above the groundwater level.

Developed land

Development or building on parcels, particularly residential development on small lots, is not desirable when selecting wastewater effluent disposal locations due to potential disruption of residents during construction and frequent resistance and concern about having a nearby facility. Thus an initial evaluation is to eliminate all but vacant parcels.

However, an additional analysis was conducted at the request of the CAC and Health Department. The CAC identified several parcels that are largely unused, with one or a few buildings, on large lots. The Health Department identified additional lots based on knowledge of the local soils and groundwater. The

analysis included a GIS search of parcels fitting these criteria, first searching for development on larger parcels in excess of 5 acres with single buildings, and then identifying specific lots selected by the CAC and Health Department regardless of acreage.

Sensitive Resources

The Acton GIS database provided information on the location of various sensitive natural resources. These include municipal water supply wells sites, wellhead protection areas as mandated by Town zoning and MA DEP regulations, vernal pools, and surface water bodies and wetlands. Well sites, water body margins, and wetlands are unsuitable as potential areas for wastewater effluent disposal. Wellhead protection areas are a special case where some areas may be acceptable for wastewater which has been treated sufficiently and where no surface water "short circuits" exist to shorten travel time between discharge site and wells.

Additional data was gathered on sensitive human resources as discussed in Section 2. The next phase will conduct a more detailed analysis of the potential disposal locations, which will include impacts on sensitive receptors. Thus, the review of any limiting aspects which result from the location of disposal sites in relation to sensitive receptors such as wellhead protection areas will be considered in the next phase of this project. However, in preparation for that phase, sensitive receptors have been identified and included in the GIS database. Wellhead protection areas are printed on the AOI maps with this report.

6.8.3 Data Sources

Information on soils type is available to this study from two sources:

1. The US Geological Survey (USGS) has completed mapping of the surficial geology deposits (the distribution of sands and gravels for all of Massachusetts) and this data is retrieved through the MassGIS system.

2. The National Resource Conservation Service (NRCS) has mapped various soil groups in the Town and each of these soil groups is associated with specific types of surficial geologic deposits as parent material.

The USGS and NRCS data and inferences on surficial geologic deposits were compared and found to agree fairly closely, though the NRCS data is defined in more specific boundary shapes and in greater detail. Soil types and the elimination of unsuitable areas were drawn from the NRCS data for this work.

Depth to seasonal high groundwater information is available from NRCS soils group mapping. Each soil type is associated with a typical depth to seasonal high groundwater.

The distribution of seasonal high groundwater based on NRCS soil type, and as adjusted by Health Department data, was mapped onto the parcel base map and prepared for evaluation along with other criteria.

The Acton Town GIS data base provided information on parcel size and which parcels are developed and how many buildings are involved. From this information, inappropriate (small) parcel residential areas in Town could be eliminated.

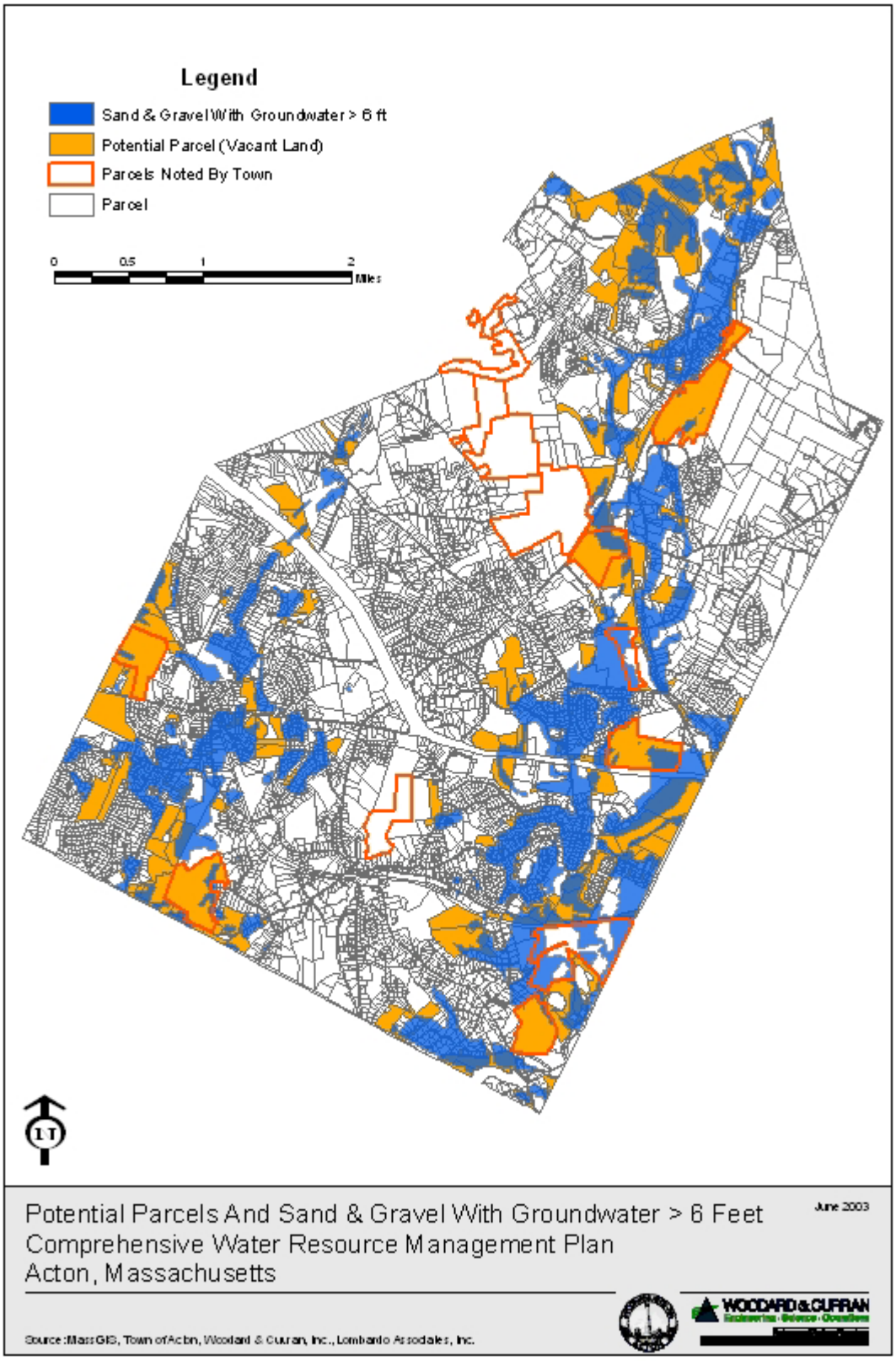
As mentioned above, the location of sensitive resource areas was drawn from the Acton GIS database. It was applied to the Acton base map with parcel designations available underlying the data layer.

6.8.4 Results of Parcel Evaluation

The first criterion applied to locating potential AOI's was to eliminate portions of Town where soils are not suitable for infiltration of wastewater. The remaining soils are sands and gravels which constitute about 38% of the area of Acton (approximately 5,000 acres). The resulting distribution map of sands and gravels versus other soils is shown on Figure 6-4.

The next filter applied to eliminating unsuitable areas was data on where the depth to seasonal high groundwater was six feet or less. The resulting map of areas with greater than six feet to seasonal high groundwater and with sand and gravel soils is shown on Figure 6-4. The criterion of depth to groundwater effectively removes unsuitable areas under the water body and wetland resources criteria.

FIGURE 6-4: POTENTIAL PARCELS AND SAND & GRAVEL WITH GROUNDWATER



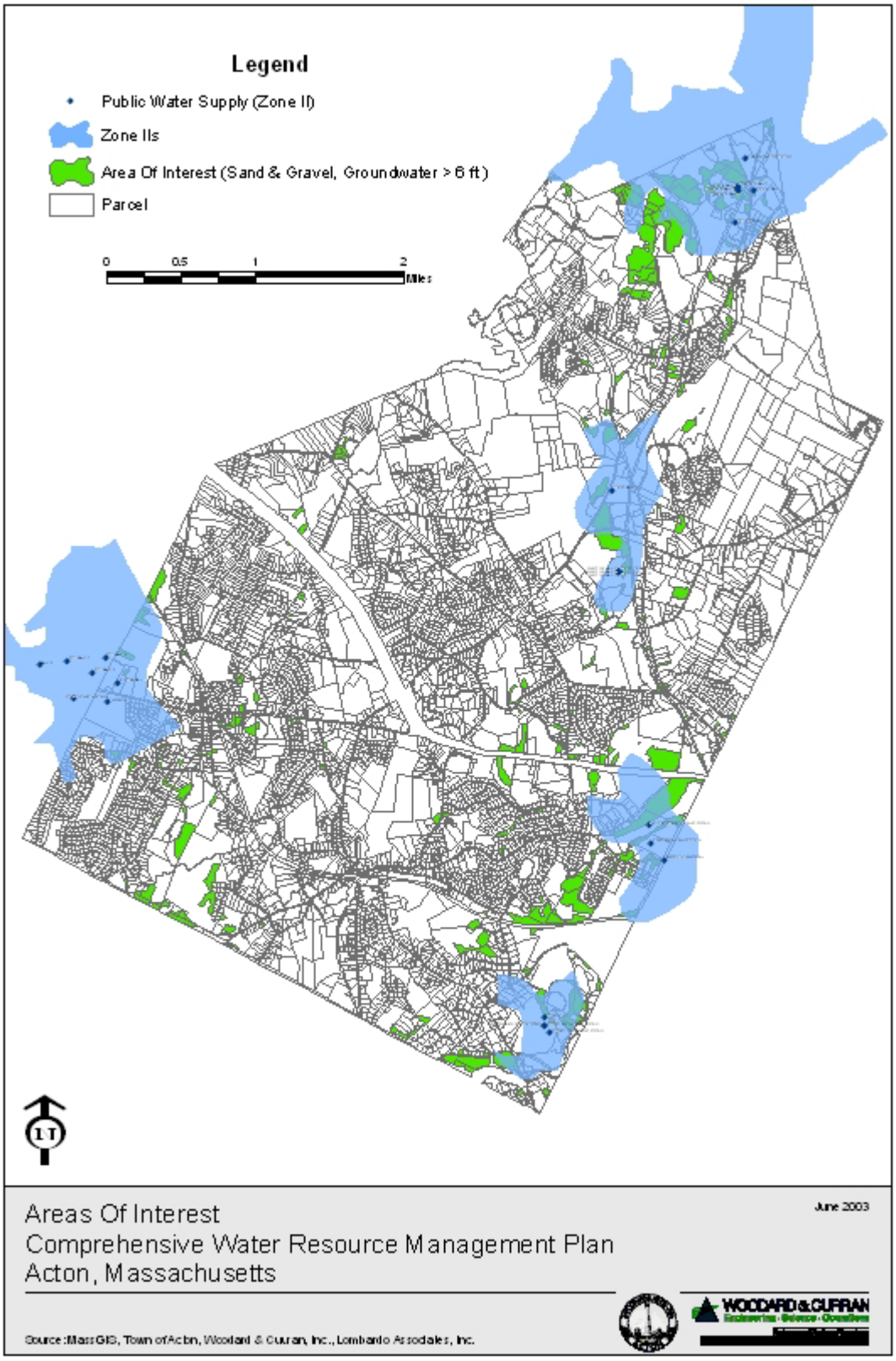
Screening for the depth to groundwater creates a significant reduction in the size of areas that might be suitable for wastewater disposal. About 2,407 acres of Acton remain as potential Areas of Interest.

Figure 6-4 also shows the parcels identified by the CAC and Health Department has having potential for locating a wastewater effluent disposal facility. These lots are not always located in areas that are identified as meeting both criteria of favorable soils and groundwater conditions. Once the wastewater needs areas are finalized and probable wastewater flows are estimated, the potential wastewater disposal areas will be prioritized for further investigation. Parcels not exhibiting favorable soils and groundwater conditions will most likely need additional field investigation and will be reviewed as needed.

When the development criteria for eliminating unsuitable areas are applied it yields a map of AOI's as shown on Figure 6-5. On this figure potential areas for wastewater disposal have shrunk to approximately 620 acres.

The final attribute mapped in this phase of the CWRMP is the location of wellhead protection areas. As mentioned above, these wellhead protection areas (Zone II's), though not absolutely excluding wastewater dispersal, are incorporated into the mapping of this phase to allow for planning of the next phase of the project.

FIGURE 6-5: AREAS OF INTEREST



6.9 IMPACT OF WATER CONSERVATION ON WASTEWATER VOLUMES

The needs analysis in this Phase 1 of the CWRMP/EIR follows accepted planning convention, assuming wastewater volumes are in line with Title 5 flows. Wastewater flows based on actual water meter readings are preferred to provide more refined data for sizing wastewater infrastructure once planning efforts lead to conceptual/preliminary designs. In addition, several factors related to water conservation should be considered when preparing final design flow estimates as part of future planning and preliminary design efforts.

1. Peak water usage has remained constant despite an increase in water connections.
2. Average daily water use in the sewer district shows a downward trend.
3. The wastewater flows from the connected properties is less than design flows, allowing the WWTF to operate below capacity.

Water conservation practices in Acton have shown a reduction in peak flows that may reflect in cost savings for wastewater infrastructure by reducing the size of collection, treatment and disposal facilities.

6.10 POTENTIAL SECONDARY GROWTH EFFECTS IN SERVICE AREAS

Sewering can result in both undesirable and desirable secondary growth effects. Sewering can increase development on lots previously undevelopable due to onsite wastewater disposal limitations. While growth can be triggered by sewering it is managed through strong master planning and the instruments of planning and zoning.

Acton has a strong plan for focusing development in specific areas as discussed in Chapter 2. Central to the Master Plan is the concept of village centers with mixed use focusing on smaller scale businesses. Larger commercial and industrial development is targeted for specific districts. Growth is managed throughout town, and particularly in the village centers, through proactive zoning aimed at maintaining the character of Acton. For example, the East Acton Village Plan includes provisions for economic development but seeks to control the extent. A recommendation was made to change some areas zoned for business to residential.

A strong master plan such as the East Acton Village Plan can be supported by wastewater planning to limit undesirable secondary growth impacts by:

1. Concentrating wastewater infrastructure in dense areas to maintain consistency with the Town's Master Plan, which emphasizes the character of the village centers, development of business and industrial districts, and maintaining the rural character of Acton.
2. Limiting extension of sewers through major rural areas to reach remote densely developed areas. Instead, focus on decentralized approach to wastewater solutions.

Positive secondary impacts of sewering can be realized by creating infrastructure to optimize the economic growth within areas targeted by planning to be centers of this growth. The potential wastewater solutions include in their evaluation consideration for the goals and objectives in the 1998 Master Plan, 2002 Open Space and Recreation Plan, and other local planning documents.

Estimated wastewater volumes for the service areas include provisions for development of undeveloped lots within the service area boundaries as shown in Figure 6-2 and Figure 6-3. The reasons the lots are not developed are not always obvious and may not always be attributed to poor onsite wastewater disposal options. However, if a service area is sewered within the planning period, currently empty lots

could be developed and connected to the system, especially if located in an area targeted for economic growth.

In particular, six areas (1, 3, 5, 7, 12, and 15) have a significant portion of empty lots within the proposed service areas. Each area could potentially have secondary growth impacts from sewering.

Area 1, North Acton:	The largest undeveloped lot is currently under development and will include provisions for onsite disposal systems
Area 3, East Acton Village:	This area has a strong planning document and is targeted for economic development.
Area 5, Brucewood Estates:	Additional residential development may reduce the cost per lot for use of wastewater infrastructure but may impact the character of the neighborhood.
Area 7, Powdermill Plaza area:	A mixture of commercial and residential properties may see an increase in mixed development. Part of this area is located in a Zone II.
Areas 12, West Acton Village:	This area is a targeted economic development area with strong growth planning. In 1995 it was designated by the MAPC as a Concentrated Development Center, making it a priority area for regional infrastructure improvement funding
Area 15, Acton Center:	This area is listed on the National Register of Historic Places. The rural nature of this area could be altered if secondary growth (development on available empty parcels) occurred due to sewering.

6.11 CONCLUSIONS

Over 90% of the existing septic systems can remain as on-site systems for the planning period, with approximately 3.5% of these requiring I/A technology and/or mounded systems. The sensitivity analysis, which gives a measure of the accuracy of the data and appropriateness of the conclusions, changes the results insignificantly.

The lots identified as needing off-site solutions could be joined by adjacent lots to create service/study areas. These areas will be further reviewed by the project team, with input from DEP, Town staff, CAC and general public as part of the public review process.

The range of wastewater flows projected to be collected from the service/study areas, treated and dispersed is between 110,000 gpd and 265,000 gpd. Potential solutions to locating facilities and selecting appropriate technology, whether decentralized/cluster facilities or expansion/extension of the existing wastewater collection and treatment system, will be derived in forthcoming phases of the study. A critical component of this evaluation is the determination of potential locations for wastewater effluent disposal within Acton.

Preliminary analysis of selection criteria concludes that approximately 620 acres are available within Acton for locating wastewater treatment and disposal facilities. Additional parcels identified by the Town and CAC may provide effective alternatives to the lots selected from the analysis.

Alternatives for solutions to wastewater needs include decentralized/cluster systems, partnerships with existing and potential private facilities, expansion of the existing collection and treatment system, and continued use of onsite disposal systems.

Phase II of the CWRMP will include an evaluation of the WWTF loading to maximize the potential number of connections to the facility and optimize the potential solutions to wastewater needs. The first service/study area under consideration for extension of the existing wastewater collection system is the Powdermill plaza area, currently served by an older RBC treatment facility that discharges directly to the Assabet River.

Phase II of the CWRMP/EIR includes pairing of the needs areas with potential disposal locations, including subsurface investigations as needed. The additional site investigation is particularly important if the most advantageous locations are the parcels identified by the Town and CAC. Many of these lots do not meet the initial screening criteria.

Collection and treatment technologies will be evaluated and presented for each needs area. Analysis will include an evaluation of technical, operational and management alternatives. Additional analysis may be required for existing cluster system alternatives including evaluation of possible public/private partnerships to combine "needs" parcels with existing cluster systems, alternative management of facilities, or construction of new facilities.

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