Integrated Water Resource Management Plan

Lancaster, MA

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Prepared for:

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Town of Lancaster, Massachusetts
Integrated Water Resources Management Plan

Table of Contents

List of References

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List of Appendices

List of Tables

List of Figures

Executive Summary

Background

This report presents the results of an Integrated Water Resources Management Planning effort undertaken by the Town of Lancaster for a largely undeveloped northern section of town. This area is characterized by low density housing and open space mixed with large areas of undeveloped residential lands and the Town's most significant undeveloped commercial and industrial land. Major roadways, including Route 2 and Route 70 serve the area. The intersection of Route 2 and 70 could be a particularly attractive area for commercial and industrial development, but it currently lacks water and sewer to serve such development. Although Lancaster desires to increase its tax base and local jobs through building in the commercial and industrial zone, there are concerns that sewering the area for attracting commercial and industrial development may also attract significant and more dense residential development that the Town can not afford.

The Town is also concerned about its limited water resources and significant environmentally sensitive areas that occur throughout the area in the many tributaries and in the Nashua River itself. In particular, the Town is concerned about how future growth will affect streamflows, drinking water supplies, environmental resources, flooding and the Town's rural nature in general.

Water Balance

The project involved dividing the study area into nine subwatersheds. The existing conditions for hydrology were then established through calculation of a "water balance". The water balance was then again evaluated through buildout conditions under various scenarios that included additional pumping of drinking water supplies, more export of wastewater and various regulatory scenarios for stormwater controls. The result of this analysis showed that stormwater has the greatest impact on the overall water balance of the Town, and controlling the impacts of runoff from future development could have a dramatic impact on the overall water balance. Less important were drinking water withdrawals and wastewater exports to regional treatment plants. These have some localized effect, but were dwarfed by the impacts of stormwater.

Water Supply

The water supply system for Lancaster was evaluated as part of the IWRM. Currently, limitations are largely due to permitting requirements under the Water Management Act. However, buildout to the maximum extent possible will test the Town's water supply should that occur prior to finding additional sources of drinking water. CEI made a number of recommendations based on the existing water system, including:

1. Development of a more detailed Conservation Plan;
2. Performance of a Comprehensive Water Audit (which is now ongoing);
3. Provision of system redundancy by seeking additional water supply wells;
4. Acquisition of land for the potential of a future storage tank; and

5. Making certain modifications to the billing system to detail customer types for future reporting and to provide a basis for future conservation efforts.

The Town's stormwater system and compliance with existing regulations was also evaluated. Based on that evaluation, a number of recommendations were made, including:

1. Incorporate certain design standards into the Town's upcoming bylaw to help prevent additional flooding and water quality problems in the study area and downstream;
2. Complete compliance with Phase II stormwater regulations (which is now ongoing);
3. Further evaluate existing flooding areas by developing a more formal Stormwater Capital Improvement Plan;
4. Consider Best Management Practices that will improve recharge to reduce flooding areas and consider a future Stormwater Utility to pay for both stormwater improvements and Phase II compliance during the second round of Phase II permitting (beginning May of 2008).

Wastewater

The bulk of the project dealt with evaluating if and how to sewer North Lancaster. Analysis of existing parcels within the project area showed that roughly 64% of the total land area of North Lancaster is currently undeveloped. There are approximately 785 developed parcels, of which only 176 have actually been inspected for septic system failures. Of the total inspected systems, some 28% or nearly 50 of them failed. Extrapolating to the total number of developed parcels, there may be well over 200 systems that are potentially failing. There are a number of reasons for failures; the first and most important being small parcel size, even where soils are good, that does not allow for upgrades of systems to occur effectively. In other areas, there are poor soil conditions or shallow groundwater or other conditions not conducive to onsite disposal such as shallow bedrock. These failures and projected failures are particularly predominant in certain subwatersheds, including Spectacle Pond, Ballard Hill, the North Nashua River and White Pond.

Subwatersheds were ranked in terms of their inability to meet Title 5 requirements or to upgrade to a permittable system. In order of most need for sewers based on existing systems, the following subwatershed ranking identified areas most in need.

Rank and Subwatershed

1. Spectacle Pond
2. Ballard Hill
3. White Pond
4. North Nashua River
5. Wekepeke Brook
6. Fort Pond

7. Nashua River
8. Shaker Hill
9. McGovern Brook

From the above ranking, three major areas of concern were identified as follows:

Spectacle Pond & White Pond	Area 2 Spectacle Pond
White Pond/Fort Pond and Route 2 Commercial/Industrial Area	Area 1 Route 2 area
Ballard Hill, North Nashua River, Wekepeke Brook & Nashua River Subwatersheds	Area 3 North Main Street

Four main alternatives were evaluated:

1. 'No Action' or continued reliance on individual onsite wastewater treatment systems in total.
2. Wastewater Alternative 2 – full conventional sewering with offsite disposal to a regional wastewater treatment facility
3. Wastewater Alternative 3 – a combination of continued traditional onsite systems plus a package treatment plant for the commercial/industrial area and limited offsite disposal for other areas of town
4. Wastewater Alternative 4 – selective sewering of specific problem areas around White and Spectacle Pond and around North Main Street to minimize volume and allow existing treatment capacity to be used more effectively

Locations including Ayer, Bolton, Clinton, Leominster, Lunenburg, Shirley, Sterling, Lancaster and the study area were evaluated for potential wastewater treatment locations. Most were unavailable or not practical for wastewater disposal. Two areas have potential: the Town of Clinton Wastewater Treatment Plant to the south and Leominster Wastewater Treatment Plant to the west. Clinton has only limited capacity due to existing hydraulic overloading largely from infiltration/inflow. However, very limited off-peak flows might be allowed without upgrading the plant, particularly if they were separated permit-wise from existing Lancaster flows produced in the Lancaster Sewer District. One attractive option to do this for the North Main Street area would be the use of a STEP collection system, or Septic Tank Effluent Pressure system, which uses small diameter sewers to pump effluent to the treatment disposal site, with the resident's septic tank retained. The costs may be considerably less than with traditional gravity sewers. Using a STEP system with the limited effluent to the Clinton plant would be relatively minimal in cost in comparison with conventional options, and may be more feasible if off-peak pumping is used to limit the plant's hydraulic loading.

A similar system could be used for the Spectacle and White Pond areas to go to Leominster's Treatment Plant. Leominster has agreed to make a limited capacity available for the Route 2 area from existing sites, and it may be possible to add in a small volume of effluent from a STEP system from the most in need areas of Spectacle Pond. This would be cost-effective in that only those failing systems would be required to connect and could retain a portion of their system, the septic tank, to reduce the overall costs. The commercial/industrial area of Route 2 could be served through individual package plants built by the developers or could be included in transport of a larger volume of waste to the Devens Wastewater Treatment Facility. Estimated costs for all four alternatives are shown below.

Wastewater Alternative 1: Existing Conditions or No Action Option

This option has no direct cost to the Town in that no sewer is provided. Some land owners may see extraordinary expenses to upgrade their systems, others may be unable to do so.

Cost: $0

Wastewater Alternative 2: Full Sewering

This would involve major trunk lines constructed as gravity for the most part with STEP systems for White and Spectacle Pond subwatersheds and transport to either Devens or Clinton via gravity mains. This cost does not include any upgrades needed at Devens or Clinton Wastewater Treatment Plants and upgrade of the Clinton plant is likely to be needed. However, that information is not currently available from MWRA.

Cost (without Clinton Upgrade): $22,000,000

Wastewater Alternative 3: Sewering of North Commercial/Industrial Area to a Package Wastewater Treatment Plant with Onsite Recharge

STEP flows would go to the Clinton Wastewater Treatment Plant and to Leominster as in other alternatives. Upgrades to regional treatment plants would not be needed since only minimal diurnal STEP flows would be involved. However, a $5,000,000 1.0 mgd package plant has been included in this option.

Cost: $23,000,000

Wastewater Alternative 4: Selective Sewering

This option involves only a minimal amount of sewering to address the systems most in need from Spectacle and White Pond subwatersheds and from North Main Street. No upgrades to offsite treatment facilities are anticipated. Construction costs would be inclusive of pumps, tanks and lines, but there would be no package plant and no upgrades to regional offsite treatment plants.

Cost: $10,000,000

Another option could be to combine a package plant with the STEP collection systems of the worst areas. Alternatively, the STEP effluent could go to local area treatment via discharge to the ground. This would avoid costs of transport of the effluent to the area treatment plants, but would involve new O&M costs for maintenance of that facility.

CEI recommends that the Town further evaluate the political and technical feasibility of transport of STEP effluent to the Clinton and Leominster Treatment Plants, as well as the feasibility of onsite (local to Lancaster) disposal of that effluent. For collection, STEP/STEG systems appear to be the least costly, but there are many unanswered questions regarding political feasibility and how many systems would actually require service, versus the volume of effluent that could be taken by Clinton and Leominster treatment facilities. These should be evaluated further before proceeding.

1.0 Introduction

1.1 Overview and Project Goals

Lancaster is located just outside of I-495, about 35 miles northwest of Boston, MA. The Town is intersected by Route 2, a major commuting route to the greater Boston area, and Route 190, a major commuting route to the Worcester area for Lancaster and outlying communities. Neighboring towns include Leominster, Lunenburg, Shirley, Ayer, Harvard, Bolton, Clinton and Sterling. A locus map is shown on Figure 1-1.

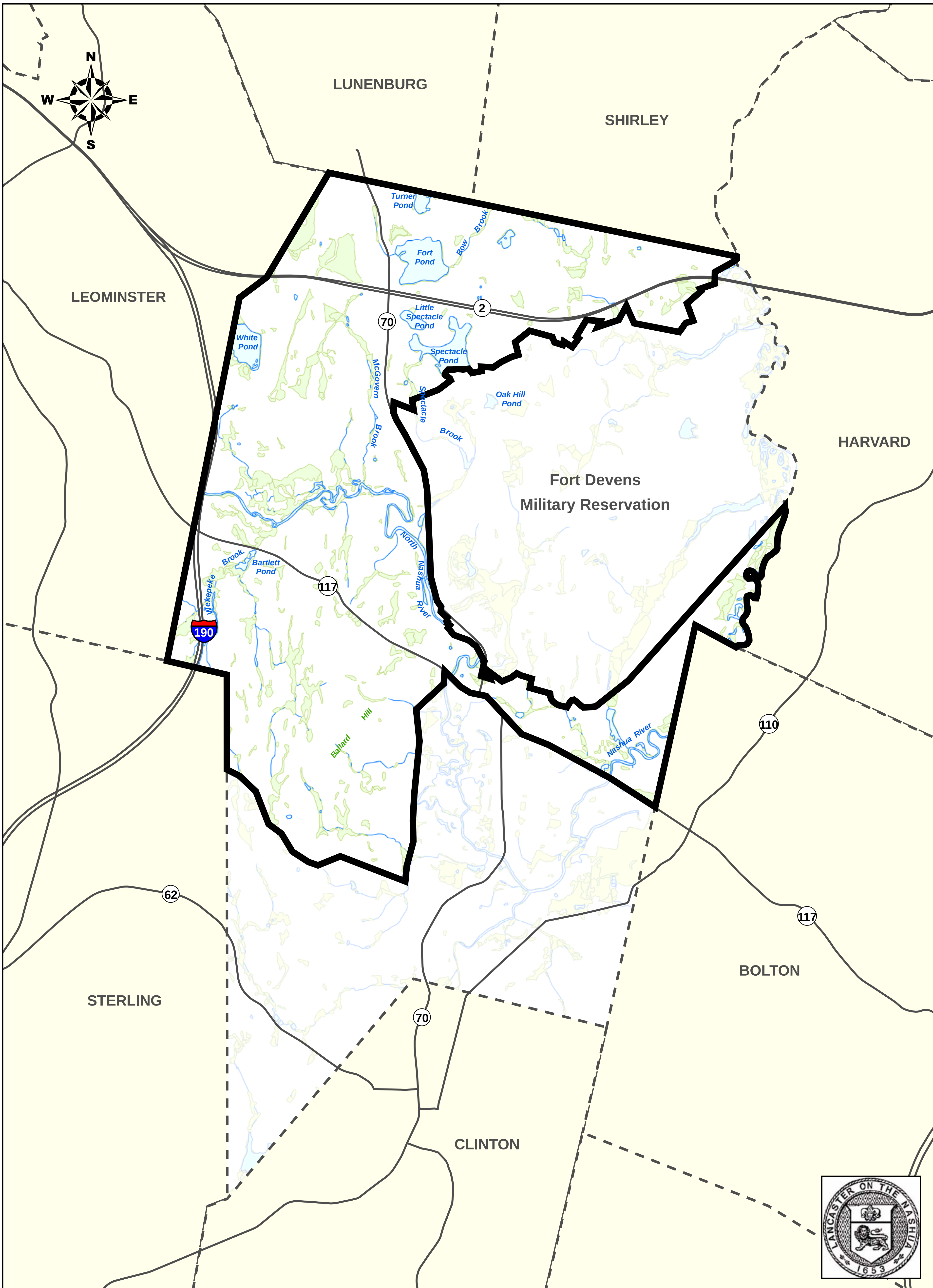
The Town of Lancaster, population 7,644, is a largely rural farm and residential community. The northeast portion of the Town, 8,345 acres, is occupied by the Fort Devens Prison & Military Base. This area also contains a large area of critical environmental concern (ACEC). To the south, the Town is more developed, with a central downtown area that is largely residential and already sewered or being sewered through the Lancaster Sewer District. Sewage from here is collected and transported to the Clinton Wastewater Treatment Plant. The subject of this evaluation is the northwest portion of Lancaster which is largely zoned industrial/commercial but which has very little development at present. In spite of the commercial/industrial zoning, the area is largely undeveloped due to a lack of sewer and water facilities. The limited development that has occurred has been of limited benefit to the Town due to a lack of employment opportunities for local residents. The Town of Lancaster seeks to benefit from the location of northeast Lancaster near Route 2 and Route 190 to improve economic development of this 8,500 acre area by planning for sewer service in one form or another. However, the Town is also conscious of the potential density impacts of sewering and desires to proceed cautiously to avoid bringing in excessive residential development with the sewers through 40Bs or other infill.

In 2005, Lancaster applied to the Division of Housing & Community Development (DHCD) for monies to prepare a Comprehensive Wastewater Management Plan under DEP’s guidelines. In that the Town was also concerned about water supply and impacts of development of the area on stormwater and its precious environmental resources, the Town selected Comprehensive Environmental Inc. (CEI) to prepare an Integrated Water Resources Management (IWRM) Plan which would consider more in-depth aspects of infrastructure issues in northeast Lancaster. The IWRM is a broad needs assessment for wastewater, stormwater and water supply along with an alternatives evaluation for wastewater. This phase will be submitted to MEPA with an Environmental Notification Form (ENF) to address potential additional permitting issues associated with future sewering.

1.2 Study Area

The Town lies in the Nashua River Basin, at the headwaters and confluence of the North and South branches of the river. Much of Lancaster thus drains to the 10,000 acre Central Nashua River Valley Area of Critical Environmental Concern (ACEC), home to a number of endangered species as well as the Fort Devens military reserve.

The study area consists of the central and northern portion of town, including 13 square miles or 46% of Lancaster. For this project, the study area has been divided into nine sub areas or subwatersheds, shown in Figure 1-2. These study areas are based on the local topography to major water courses and include town boundaries. This allows for an analysis of water budget by subwatershed. The Fort Devens military reserve is not included in the study area since Lancaster does not have any jurisdiction over the military reserve. The Lancaster Sewer District to the south is also not included as this is a separate organizational entity and not under the Town government's purview.



LEGEND

IWRM Study Area
Town Boundary

Hydrography
Lake, Pond
DEP wetlands
Stream, Brook

Data Sources: Town of Lancaster, MassGIS, CEI

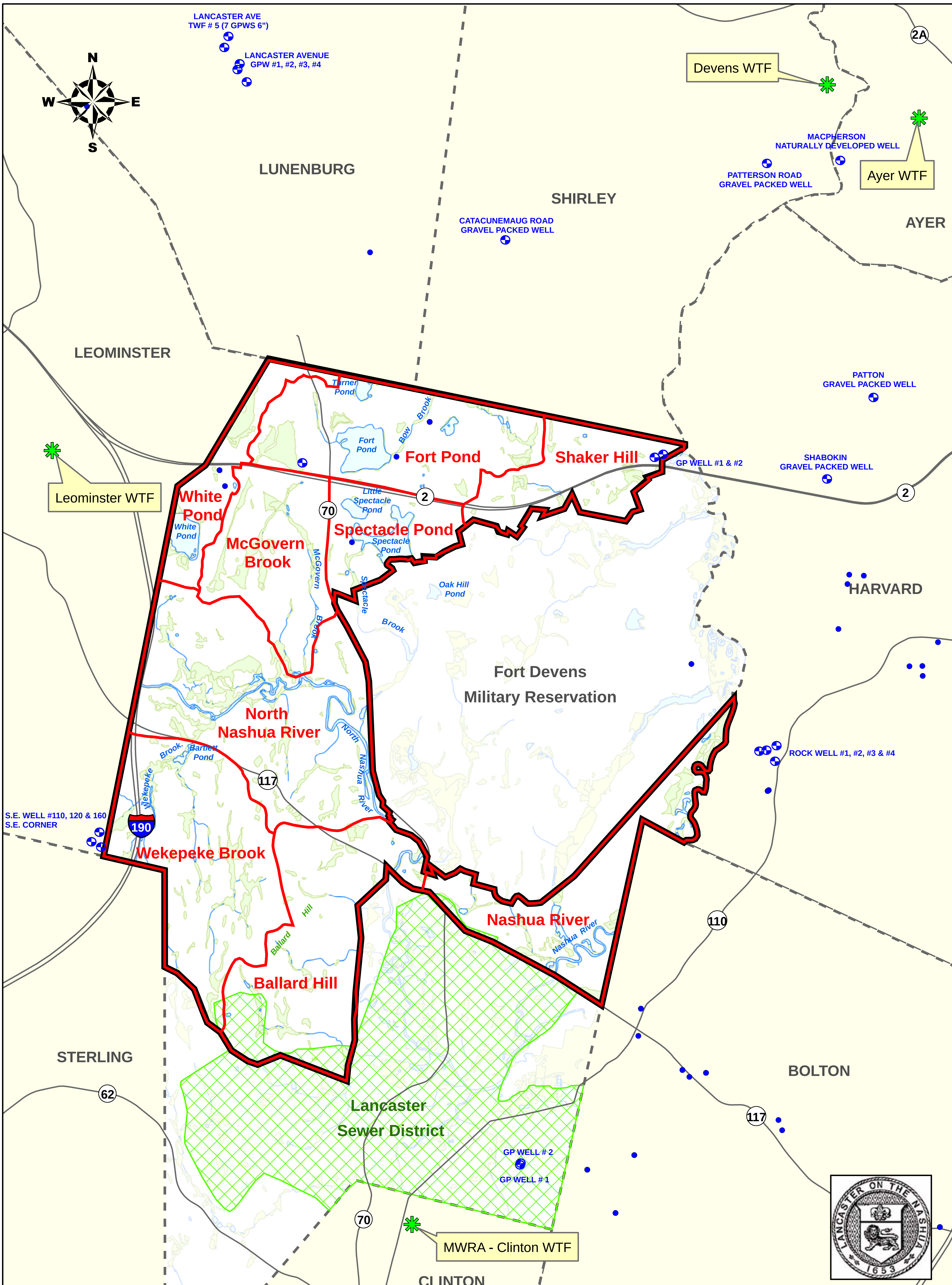
0 2,500 5,000 7,500 10,000 Feet

Figure 1-1

IWRM Locus Map

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Public Water Supply

- Community Source
- Non-Community Source
- Wastewater Treatment Facility
- Lancaster Sewer District
- Subwatershed Boundaries
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, Weston&Sampson, CEI

0 2,500 5,000 7,500 10,000 Feet

Figure 1-2

Study Area Subwatersheds

Lancaster, MA

Comprehensive Environmental Inc.

2.0 Community Profile

2.1 Natural Resources

Lancaster is situated in the Nashua River watershed. The Town of Lancaster is host to a wide variety of natural resources, many of which are protected. The resources include a portion of the North Nashua River and the Nashua River with their tributaries, Wekepeke Brook, McGovern Brook, Spectacle Brook, and Ponakin Brook. Associated with the riparian of the North Nashua River and Nashua River are wetlands and floodplains, as well as upland wildlife and rare and endangered species habitat, forest, farmlands, and publicly and privately owned protected open space. There are numerous other wetlands, certified vernal pools, estimated habitat of rare wildlife, and aquifers associated with the Water Resource District. These areas are presented on Figures 2-1, 2-2, and 2-3.

Natural resources and environmental conditions can greatly influence land use, water supply and wastewater management planning. The IWRM focuses on how to best manage the inevitable growth, while protecting the natural resources of the town. As a wastewater planning document, the choices available for sewage disposal are also dependent on these conditions.

Geology and Physiography[1]

Bedrock in Lancaster generally consists of low-grade metamorphic rocks of the Nashua belt and Worcester formations. The Nashua belt consists of Silurian and Devonian sedimentary rocks that are mainly devoid of igneous intrusions, the low grade metasedimentary rocks contain well-developed sedimentary structures. The Worcester formation contains carbonaceous slate and phyllite.

Lancaster is located within the Nashua Valley and the Glacial Lake Nashua. The Nashua Valley is the most prominent drainage area in Massachusetts east of the Connecticut Valley. The Nashua Valley follows the northeast trend of the easily eroded, low-grade metamorphic phyllites and schists of the Nashua belt. The tributaries all flow southeast, the same direction in which the ice sheet advanced across the Worcester upland toward the Long Island Sound.

Most of Lancaster is located within the Glacial Lake Nashua. Extensive sand and gravel plains throughout Devens and Lancaster indicate the glacier stood still for a while near the Nashua River. During the standstill, Glacial Lake Nashua deposited lake sediments that extended from Route 2 south about 10 miles to between Clinton and Boylston Center. Deposits of delta sands and gravels are up to 165 feet thick. Lake bottom silt and clay deposits are rare because Glacial Lake Nashua filled rapidly with coarse sediment. As the water level dropped, lake terraces developed in the Nashua Valley.

[1] Roadside Geology of Massachusetts by James W. Skehan, (2001); Soil Survey of Worcester County Massachusetts Northeastern Part, (December 1985).

The result of these geologic factors is that much of the study area has soils suitable for residential on-site systems, as long as they have adequate room, but that high density systems may fail or overload water resources with nutrients. Likewise, large commercial or cluster systems must be sited carefully to avoid aquifer contamination in the highly permeable soils. Bedrock is for the most part deep, so it likely will not be a restriction or cost factor for either on-site systems or sewer lines.

Soils[2]

Lancaster is located within the western highland, which is an upland controlled largely by the underlying bedrock that is exposed on hill sides and summits. Remnants of Glacial Lake Nashua exist as deposits of glacial outwash in the low lying areas and glacial till in the higher elevation. The bedrock of this region consists mainly of granite with localized areas of schist and phyllite and has an apparent north/south structural composition. Deposits of various types of sand and gravel are scattered throughout Lancaster and are described below:

- Till deposits cover about 30% of Lancaster. Till is generally a poorly sorted mixture of silt, sand, gravel, and boulders with a small amount of clay.
- Deposits from Glacial Lake Nashua are dispersed throughout Lancaster, and surrounding the Nashua Rivers. Several layers of sand, silt, gravel, small amounts of clay, and varying amounts of coarse sand make up these deposits.
- Alluvium deposits underlay most of the North Nashua River and Nashua River. These alluvium deposits consist mainly of fine sand, silt, and some coarse sand.
- Sand and gravel deposits are located sparsely throughout Lancaster with varying thicknesses.

A wide range of soil types make up the Lancaster study area[3]. The type of soil, along with depth to bedrock and seasonal high groundwater, dictates the suitability for on-site septic systems. The soil properties and site features that affect absorption of the effluent are: permeability, depth to bedrock, and susceptibility to flooding. Additionally, excessive slope can cause lateral seepage and surfacing of the treated wastewater, as well as soil erosion and soil slippage. In soils where the water table is seasonally high, seepage of groundwater into the leaching fields can seriously reduce their capacity for liquid waste disposal and allow high concentrations of pollutants to enter groundwater.

Five major soils (Hinckley, Paxton, Chatfield, Quonset, and Winooski/Suncook series) make up the study area. These are described further below:

1. The Hinckley series is predominant in the north part of Lancaster and consists of very deep and excessively drained soils on stream terraces, eskers, kames, and outwash plains. The soils are formed in glacial outwash plains. The Hinckley

[2] Montachusett Regional Planning Commission. (February, 2000). <u>Town of Lancaster, MA Open Space and Recreation Plan 1999 Update</u>.
[3] Worcester County Soil Survey, prepared by the United States Department of Agriculture Soil Conservation Service (December 1985).

soils are associated with Merrimac, Quonset, and Windsor soils, but have more gravel in the upper 40 inches than the Merrimac or Windsor soils. These soils are in Group “A” and are most suitable for stormwater recharge or on-site systems as long as there is adequate treatment provided.

2. The Paxton series is predominant north of Route 117 and consists of very deep, well drained soils on glacial till uplands. The soils formed in friable glacial till overlying firm glacial till. The Paxton soils do not have mottles in the column and have a very firm substratum. These are “C” soils that may have a perched water table that makes them typically unsuitable for either stormwater recharge or for on-site systems without considerable additional treatment. However, stormwater treatment through under-drained filtration or on-site systems that accommodate shallow groundwater may be used in some cases.

3. The Chatfield series is predominant south of Route 117 and consists of moderately deep, well drained and somewhat excessively drained soils on uplands. The soils formed in glacial till underlain by rock that is dominantly gneiss and schist. These are “B” soils and thus likely to be suitable for stormwater recharge or on-site systems.

4. The Quonset series is predominant in the areas of Turner Pond, Fort Pond, and Spectacle Pond. The Quonset series consists of very deep excessively drained soils on stream terraces, eskers, kames, and outwash plains. The Quonset soils are formed in glacial outwash. These are “A” soils so they are likely to be suitable for on-site systems and stormwater recharge with suitable treatment. However, these soils surround some of the ponds where housing density is especially high, so there is risk of water pollution due to their excessive percolation rates that do not allow for adequate treatment of sewage.

5. The Winooski/Suncook and Windsor series are predominant along the North Nashua River and the Nashua River. The Winooski/Suncook series are very deep, moderately to excessively drained soils on flood plains. These soils are formed in alluvial deposits. Most are flooded to some degree and/or have a high water table, so they are unlikely to be suitable for either stormwater recharge or on-site systems.

Soil types have also been classified according to their suitability for on-site septic disposal systems in the Soil Survey Reports. The classifications are slight limitations, moderate limitations, and severe limitations for the on-site sewage disposal. This classification is based on the broad performance of soil association rather than individual soil tests performed within a specific area. The soils present within the study area are classified as having a severe limitation due to soils being moderate to excessively drained. However, Title 5 and the Lancaster Board of Health regulations dictate the construction of wastewater disposal systems. As long as systems are sized in accordance with these regulations, they can be constructed on these soil types.

The soil classifications provided above and on Figure 2-4 are approximations and should not be used to determine the suitability of a particular parcel for a septic system. On-site tests are required for this determination. However, the above soil classifications are useful as a planning tool for the IWRM to help identify general areas for various types of wastewater disposal, as well as recharge potential for the water balance.

Topography

The topography of the study area in Lancaster is characterized by low lying areas and gently rolling hills. The elevation ranges from a low of about 69 meters (225 feet) along the Nashua River to a high of about 171 meters (562 feet) above sea level atop Pond Hill located near White Pond.

Climate

Lancaster is located in a temperate, inland area of Massachusetts. The town receives an average annual rain fall of approximately 49.50 inches, and has an average daily temperature of approximately 57.6°F.

Water Resources

Lancaster has several surface water bodies, including ponds, streams and rivers, extensive wetlands and some high value groundwater resources. The surface waters within Lancaster are used primarily for recreation and wildlife habitat, while the groundwater is used as a drinking water source for town residences, through public or private water supply wells. The wetlands associated with the surface waters and groundwater serves as wildlife habitat and provides containment and treatment of floodwaters and storm water runoff.

The Town recognizes the importance of water resources and has taken measures to protect them. Lancaster has a Water Resources District, which they are in the process of expanding to protect existing and future water supplies and natural resources. The Town of Lancaster's Zoning Bylaws indicate which uses are permitted and are not permitted within the Water Resource District and Flood Plain areas. Additional protection of wetlands throughout Lancaster is provided under the Wetlands Protection Act.

Surface Waters

Surface waters are an important natural resource in Lancaster. The major surface water bodies consist of White Pond, Fort Pond, Spectacle Pond, Little Spectacle Pond, Oak Hill Pond, the North Nashua River, the Nashua River, and their tributaries. These waters are used for recreation, such as boating, fishing, swimming, fisheries and wildlife habitat. Water quality is therefore a strong consideration in developing a wastewater management plan.

The Town of Lancaster is situated on both sides of the North Nashua River and the Nashua River. The confluence of these two rivers is located in the southern end of the town. The Nashua River flows north, in contradiction to the watershed's topography. Also the Nashua River's tributaries, including the north branch, Squannacook, and

Nissitissit Rivers all flow to the southeast and shift 90 degrees and then flow north upon discharging into the main stream of the Nashua River.

The three major tributaries to the North Nashua and Nashua Rivers in Lancaster are McGovern Brook, Spectacle Brook, and Ponakin Brook. McGovern Brook is a two mile long brook that discharges into the North Nashua River in the Cooks Conservation area. Spectacle Brook is an approximately 2.6 mile long brook that originates at Spectacle Pond and discharges into the North Nashua River a quarter mile south of the Cooks Conservation area. Ponakin Brook is an approximately 2.2 mile long brook that runs south through Devens South Post and discharges into the North Nashua River at Lancaster's North Village.

Groundwater and Wetlands

According to the Mass GIS resource area maps there are two medium yield aquifers on the western and eastern portion of the town that are associated with the North Nashua River and the Nashua River. The medium yield aquifers are estimated to yield 100-300 gallon/minute (gpm). There is also a small high yield aquifer in the southeast portion of town, which also runs into Clinton and Bolton, and another in the northern portion of Town adjacent to Turner Pond. The high yield aquifer is estimated to yield greater than 300 gpm. Refer to Figure 2-2 for groundwater resources in the Town.

The town's water supply consists of two gravel packed wells, which are situated in sand and gravel deposits in a medium to high yield aquifer in the southeastern portion of town. These wells provide approximately 76% of Lancaster's residents with drinking water. The remainder of Lancaster's residences and businesses, largely in northwest Lancaster in the study area for this project, rely on private wells or receive water through other sources. Combined, the approved pumping capacity of the two wells is about 1.44 million gallons per day (mgd). However, withdrawals are restricted to 0.63 mgd based on the well's registration under the Water Management Act. Recent average withdrawals have been in the range of 0.70 mgd due to increased demand.

The Zone II for the Town's municipal supply is also located in the southeast end of town, outside of the IWRM study area. This Zone II also runs into Bolton and Clinton. There are portions of two other Zone II's in town. One is located in the northeast corner of town. This is the Zone II for two wells located in Lancaster that are used to supply the prison in Shirley. The other is located at the western end of town and is the Zone II for Leominster's water supply.

Other drinking water sources in Lancaster include private wells that serve many individual homes, and a few non-transient non-community water systems (NTNC) and transient non-community water systems or TNCs. A typical NTNC is a factory that provides at least 25 of the same persons four or more days per week more than six months per year. A typical TNC is a public water system that serves 25 different people for at least 60 days of the year, for example a restaurant or golf course. The locations of these are shown on Figure 2-2.

There are several wetlands throughout Lancaster, which are associated with the North Nashua and Nashua Rivers, and their tributaries. The wetlands provide flood control and pollutant filtration and support biological diversity for the associated rivers or streams. The wetlands also provide an area of groundwater recharge to the underlying aquifers. There are many types of wetlands in Lancaster, ranging from sedge meadows and brush oxbow swamps, to forested wetlands and flood plains.

There are a total of 1,900 acres of wetlands within and abutting the town. The wetlands consist of five major areas: Ft Devens South Post (700 acres), Cook Conservation (100 acres), Atlantic Union College (200 acres), Bolton Flats (400 acres), and Oxbow Refuge (500 acres). Only the wetlands associated with the Cook Conservation area and a portion of the wetlands abutting the Bolton Flats are located within Lancaster.[4]

Fisheries and Wildlife Resources

Fisheries and wildlife resources in Lancaster are associated with estimated habitats of rare wildlife, certified vernal pools, and priority habitats of rare endangered species. The Nashua River supports most of the sensitive habitats. Along the North and Nashua Rivers are examples of high-quality natural riverside communities and riparian habitats that support several species of turtles and salamanders. The area also provides habitat for endangered plant species, such as wild senna and invertebrates like the elderberry long-horned beetle.

Habitats along the North Nashua and Nashua Rivers support the most diverse assemblages of rare vertebrate animals in the state. This habitat supports the highest known population of Blanding’s Turtles remaining in Massachusetts. This type of habitat contains an extensive area of high-quality, low-energy riverbank along the North Nashua and Nashua Rivers. The low-energy riverbanks are open herbaceous communities occurring in sandy or silty mineral soils of river and stream banks that do not experience severe flooding or ice scour. This habitat also contains riparian woodland and gravel bar communities. An example of this type of riparian community is an alluvial red maple swamp which occurs along the Nashua River. This is a type of red maple swamp that occurs in low lying areas along rivers and streams. Regular flooding enriches the soil with nutrients, resulting in an unusual set of tress and plants.

The Nashua Rivers also contain a number of seep communities. A riverside seep is a mixed herbaceous community that occurs at the base of steep riverbanks where groundwater seeps out of the bottom of the upland slope. The enrichment of seeping groundwater into the rivers leads to a high species diversity. One of the communities found would be Black Ash seepy areas, which occur along the slopes above the floodplain forests of the North and Nashua Rivers. The North Nashua and Nashua Rivers also support a diverse group of freshwater mussels, including five of the state’s twelve species. The rare Triangle Floater is found in the Nashua Rivers, anchored in the firmer sands and gravels beneath river runs.

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[4] Massachusetts Geographical Information System (MassGIS).

Turner Pond which is located adjacent to wetlands and meadows and extends into Lunenburg is habitat for the Elderberry Long-horned Beetle. Although mostly surrounded by development, this habitat is itself unfragmented and located within close proximity to other habitats to disperse between areas.

A large portion of Lancaster (10,100 acres) is located within an Area of Critical Environmental Concern (ACEC). The ACEC includes surface waters, wetlands, floodplains, open fields (farmlands), and forest. The extent of the ACEC area is depicted on Figure 2-1. The ACEC is part of the Central Nashua River Valley ACEC, which is designed to protect groundwater supply and private water supplies, for the prevention of pollution, flood control, the prevention of storm damage, the protection of fisheries, and the protection of wildlife habitat. The designation process is intended to foster greater public awareness and appreciation of the unique values of the ACEC. The designation also notifies regulatory agencies and the public that most development activities under the state jurisdiction within the ACEC area must meet the highest environmental quality standards.

Projects located with ACEC's are subject to a greater level of regulation under MEPA (301 CMR 11.00); Chapter 91 (Waterways) Regulations (310 CMR 9.00) and the Wetlands Protection Act (310 CMR 10.00) among others. In the case of the Wetlands Protection Act, a higher performance standard is applied and a Notice of Intent must be filed.

According to the Natural Heritage and Endangered Species Program, the Town of Lancaster has nine certified vernal pools, which are also associated with the ACEC area. These are depicted on Figure 2-1.

According to the Massachusetts Division of Fisheries and Wildlife, several rare and endangered species of vertebrates, invertebrates, and vascular plants have been observed in Lancaster over several years. Table 2-1 includes the observed rare and endangered species found in Lancaster.

Table 2-1. Observed Rare & Endangered Species

Taxonomic Group	Scientific Name	Common Name	State Rank
Amphibians	*Ambystoma laterale*	Blue-Spotted Salamander	SC
	Hemidactylium scutatum	Four-toed Salamander	SC
Birds	*Accipiter striatus*	Sharp-shinned Hawk	SC
	Ammodramus henslowii	Henslow's Sparrow	E
	Ammodramus savannarum	Grasshopper Sparrow	T
	Asio otus	Long-eared Owl	SC
	Bartramia longicauda	Upland Sandpiper	E

	Circus cyaneus	Northern Harrier	T
	Pooecetes gramineus	Vesper Sparrow	T
	Rallus elegans	King Rail	T
Insects	*Desmocerus palliatus*	Elderberry Long-horned Beetle	SC
	Itame sp. inextricata	Pinee Barrens Itame	SC
	Lycia rachelae	Twilight Moth	E
	Psectraglaea carnosa	Pink Sallow	SC
	Zanclognatha martha	Pine Barrens	T
	Enallagma laterale	New England Bluet	SC
	Stylurus scudderi	Zebra Clubtail	E
	Stylurus spiniceps	Clubtail Dragonfly	T
Mammals	*Sorex palustris*	Water Shrew	SC
Mussel (freshwater)	*Alasmidonta undulata*	Triangle Floater	SC
Reptiles	*Clemmys gutta*	Spotted Turtle	SC
	Clemmys insculpta	Wood Turtle	SC
	Emydoidea blandingii	Blanding's Turtle	T
	Terrapene carolina	Eastern Box Turtle	SC
Vascular Plants	*Liatris scariosa*	NE Blazing Star	SC
	Arceuthobium pusillum	Dwarf Mistletoe	SC
	Carex typhina	Cat-tail Sedge	T
	Cyperus houghtonii	Houghton's Flatsedge	E
	Eleocharis ovata	Ovata Spike-sedge	E
	Eragrostis frankii	Frank's Lovegrass	SC
	Amelanchier sanguinea	Roundleaf Shadbush	SC
	Panicum philadelphicum	Philadelphia Panic-grass	SC
	Petasites frigidus	Sweet Coltfoot	E
	Plantanthera dilatata	Leafy White Orchis	T
	Platanthera flava	Pale Green Orchis	T
Source: Massachusetts Natural Heritage Program (Rare Species, Lancaster). Retrieved February 20, 2007 from the World Wide Web: http://www.mass.gov/dfwele/dfw/nhesp/townl.htm#lancaster			

Notes: SC = Special Concern
T = Threatened
E = Endangered

2.2 Human Factors

Historical

Lancaster is the oldest town in Worcester County and was founded in 1653. For many years it was a frontier settlement within the Nasawogg Indian territory. In 1642 the Nasawogg Indians sold some of their land to traders from Watertown and Boston. Lancaster was developed out of this land. In the late 1800's there were several mills built which included sawmills, gristmills, and fulling mills. During this time, Lancaster slate was mined for building and for gravestones. In 1917, the United States Army established Camp Devens. By 1931, over 2,270 acres of land had been acquired for Fort Devens, which included land from Lancaster and other surrounding towns. By the beginning of World War II, the fort was being used as a recruiting center for all of New England. It was closed in 1995.

Town Government

Lancaster has an open town meeting government. All of Lancaster's boards play an important role in guiding various activities in the Town. An organizational chart is shown on Figure 2-5. Nearly all of Lancaster's residences rely on groundwater as a drinking water source from both public and private wells. The municipal water is operated by the Town government through the Department of Public Works, while existing sewer in southern Lancaster is currently operated by the Lancaster Sewer District Commission (LSDC), a separate governmental entity with commissioners elected by voters within the Sewer District. New sewers outside the Sewer District could be operated by the Town's government through the Department of Public Works, or the Sewer District could potentially be expanded.

Zoning and Land Use

Lancaster has four zoning districts within the study area, which include Residential (R), Highway Business (HB), Limited Office (LO), and Light Industrial (LI). Most of north Lancaster is occupied by Light Industrial and Residential, with smaller areas of Light Office and a small portion of Highway Business Districts north of Route 2. Minimum lot size in the LI and HB zones is 64,000 square feet. The LO zone is a minimum of 3 acres, and the R zone has a minimum lot size of two acres. However, to compensate for the large lot size, Lancaster developed the Flexible Development bylaw. The flexible development bylaw indicates that upon approval from the Lancaster Planning Board, densities are to be increased by as much as 50% when preserving areas of critical importance with a Conservation Restriction or deed transfer to the Town.

The Town also has a Development Rate Limitation that limits building permits to a single owner to 8 over time without a special permit, which can only be granted if the development has unusually low impacts on public services. More rapid developments can occur only if the townwide number of new units in the previous 2 year period is less than 60 units.

Lancaster also has a section on Environmental Controls in the Zoning Bylaw. It contains Landscaping Requirements for parking lots and other commercial/industrial buildings; Erosion Control for construction projects disturbing more than 60,000 square feet, and a Water Resources District that overlays all other districts.

The Water Resource District prohibits landfills and open dumps; storage of petroleum products with some exceptions; storage or landfilling of sludge or septage; storage (unless controlled) of deicing chemicals, animal manure, hazardous waste facilities, automobile graveyards and junkyards. Additionally, the Water Resources District prohibits earth removal within 6 feet of historical high groundwater except for foundations, roads or utility works. Individual sewage disposal systems that receive more than 110 gallons of sewage per ¼ acre under one owner, or 440 gallons of sewage per acre are also prohibited except for replacement or repair of existing systems. Secondary containment is required for any fertilizer, chemical or oil storage. Snow dumps from outside the area are also prohibited if it contains deicing chemicals. Septic system cleaners that contain hazardous or toxic chemicals are also prohibited.

The Water Resource District also requires a Special Permit for certain activities, including a broad range of fertilizer, pesticide and rodenticide applications; drainage modifications; and uses that render impervious more than 15% or 2,500 square feet of any lot, whichever is greater.

Finally, the Floodplain District restricts buildings for residential use within the Flood Plain District, which includes flood hazard areas designated as Zone A.

Population and Demographics

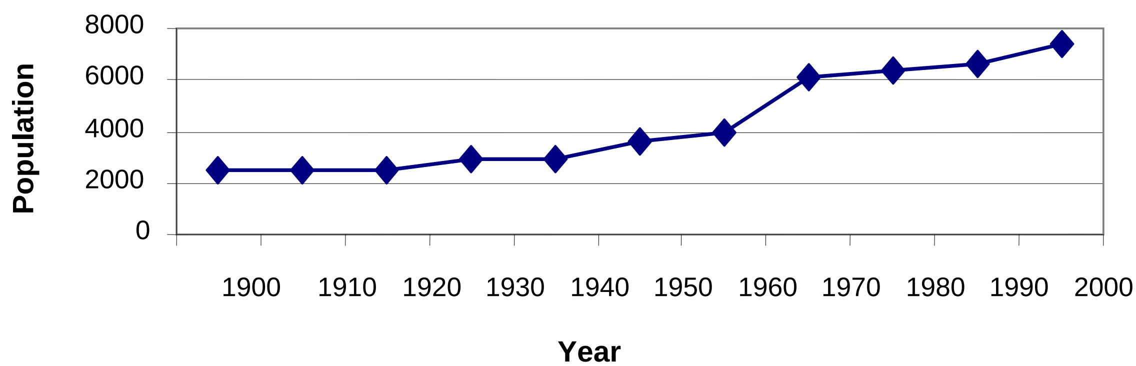
Existing Population

According to the US Census, the population in 2000 was 7,310 residents. Lancaster's historical population, as obtained from the U.S. Census, is provided in Table 2-2 and depicted graphically in Figure 2-6.

Table 2-2. Historical Population of Lancaster			
Year	**Total Population**	**Percent Change**	**Annualized Percent Change**
1900	2478		
1910	2464	-0.6%	-0.06%
1920	2461	-0.1%	-0.01%
1930	2897	17.7%	1.65%
1940	2963	2.3%	0.23%
1950	3601	21.5%	1.97%
1960	3958	9.9%	0.95%
1970	6095	54.0%	4.41%
1980	6334	3.9%	0.39%
1990	6661	5.2%	0.51%
2000	7380	10.8%	1.03%

Source: U.S. Census Bureau, 2000-1920 census

Figure 2-6 Historical Population of Lancaster



This represents town-wide population, not the study area. CEI prepared an estimate of the population in the study area by counting the number of existing developed residential parcels in the study area. This analysis was performed using the 2003 parcel layer and the 2006 parcel database. This database identified the year parcels were developed, allowing for easy identification of developed and undeveloped parcels. The existing zoning classifications were applied to each parcel to determine whether the parcel was developed as residential, limited office or industrial. An average household size of 2.8, as obtained from the 2000 U.S. Census was applied to obtain the total population for each parcel. This was compared to EOEA data and it was assumed that the difference between EOEA data and the CEI analysis was the population in the southern portion of Lancaster. A summary of this analysis is provided in Table 2-3.

Table 2-3. Comparison of Existing Residents and Residential Units

	Residents	Residential Units
EOEA	7,380	2,141
CEI Analysis for Study Area (Central & Northern)	2,405	859
Southern Area (EOEA minus Central & Northern)	4,975	1,282

Projected Population

Population projections for the Town of Lancaster have been performed by the Massachusetts Institute for Social and Economic Research (MISER) and the Montachusett Regional Planning Commission. These are summarized in Table 2-4 and Figure 2-7. MRPC projects population through 2020 and shows an overall decline in population through 2020. MRPC projects population through 2030 and shows an initial decline followed by a slight increase.

Based on historical growth, as provided by the U.S. Census, population has continued to increase from 1920 to present. The average annual growth for the most recent decade, 1990-2000, was 1.03%. Based on this historical growth trend, it seems unlikely that the population will decrease over the next 15 years. As a result, CEI has estimated future population through 2035 using an annual growth rate of 1.03%. This same growth rate was also applied to the study area to determine population trends over the 30-year planning period, 2005-2035. These estimates are also provided in Table 2-4 and Figure 2-7.

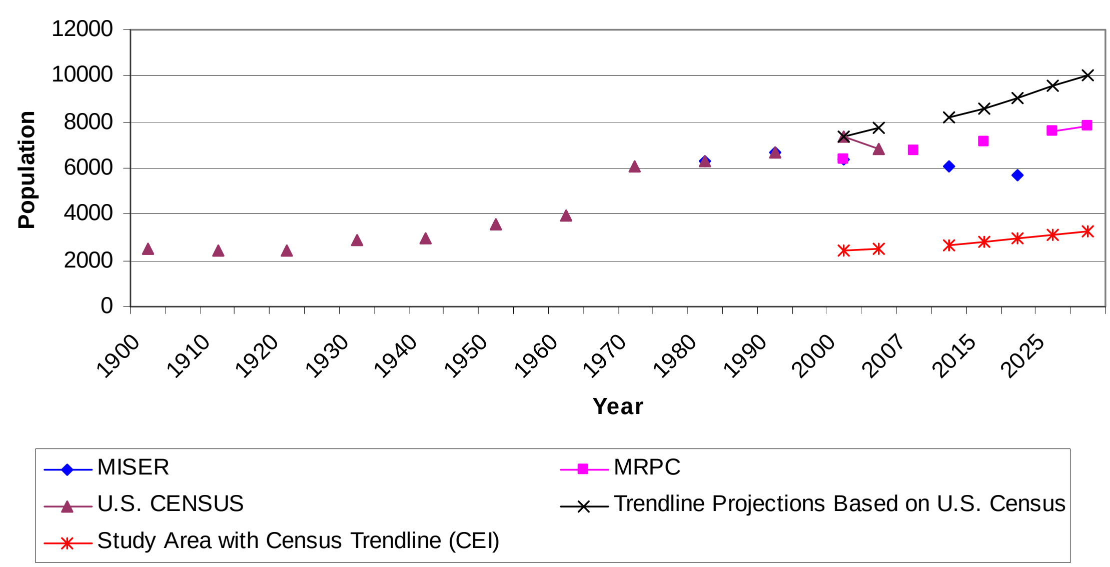
Table 2-4. Population Projections

Year	MISER	MRPC	Trendline Projections Based on U.S. Census (CEI)	Study Area with Census Trendline (CEI)
2000	6382	6382	7380	2405
2010	6068	6068	8177	2665
2015		7118	8607	2805
2020	5696		9060	2953
2025		7557	9537	3108
2030		7820	10,039	3272
2035			10,567	3625

As with the historical population information, the population projections are for the entire town, rather than the study area. As a result, CEI performed its own population projections for the study area by applying recent growth trends, based on the U.S.

Census, to the current population estimated for the study area by CEI. The projections for the study area are provided in Table 2-4 and shown in Figure 2-7.

Figure 2-7 Historical and Projected Population



Buildout Summary

The Massachusetts Executive Office of Environmental Affairs (EOEA) estimated demographic projections at buildout for the Town of Lancaster, along with buildout impacts. These are summarized in Table 2-5.

Although these projections are available from the State, they represent buildout for the entire Town of Lancaster, whereas the IWRM only applies to a portion of the Town. To address this issue, CEI prepared a buildout analysis for the study area using EOEA[5] buildout assumptions. However, a more detailed analysis of parcels was performed. Zoning, land use, wetlands and floodplain data layers were obtained from MA GIS. The 2003 parcel layer was obtained from the Montachusett Regional Planning Commission (MRPC). The 2006 assessor's database was obtained from the Lancaster Assessing Office.

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[5] J. Pfister, GIS/Web Coordinator, EOEA (personal communication, February 2, 2006)

Table 2-5. EOEA Buildout Analysis Summary	
Demographic Projections	
Residents	
1990	6,661
Current	7,380
Buildout	14,732
Students (K-12)	
1990	817
Current	999
Buildout	2,114
Residential Units	
1990	1,910
Current	2,141
Buildout	4,513
Water Use (gpd)	
Current	551,200
Buildout	2,843,884
Buildout Impacts	
Additional Residents	7,352
Additional Students (K-12)	1,115
Additional Residential Units	2,372
Additional Developable Land Area (sq. ft.)	311,757,130
Additional Developable Land Area (acres)	7,157
Additional Commercial/Industrial Buildable Floor Area (sq. ft.)	23,216,717
Additional Water Demand at Buildout (gpd)	2,292,684
Residential	551,430
Commercial and Industrial	1,741,254

A parcel level analysis was performed to determine existing parcel sizes, which parcels were already developed and which parcels remained to be developed within the study area. This analysis was performed using the 2003 parcel layer and the 2006 parcel database. This database identified the year parcels were developed, allowing for easy identification of developed and undeveloped parcels. The existing zoning classifications were applied to each parcel to determine whether the parcel was or would be developed as residential, limited office or industrial.

Undeveloped parcels were then analyzed further under current zoning to determine the potential number of residential lots that could be developed for each parcel in a residential scenario, and the total square footage of building that could be developed in a commercial/industrial scenario. The following assumptions were applied.

Residential Zoned Parcels – The amount of wetlands and floodplains on each parcel was determined using GIS. As with EOEA, it was assumed that 75% of wetlands and floodplains in the residential district would be included in lot sizing. Based on this, 75% of the wetlands and floodplains were added to the dry upland land. This was multiplied by a factor of 0.839, taken from EOEA, which accounts for roadway right of ways and property setbacks. The number was then divided by two acres to determine the number of new homes that could be developed on each parcel. Homes were rounded to a whole number. An average household size of 2.8, as obtained from the 2000 U.S. Census was applied to obtain the total population for each parcel.

Developed parcels that were greater than four acres were assumed to develop further at buildout. In these cases, one two acre lot was subtracted from the parcel and the remainder was assumed to be developable under the same assumptions identified above.

Limited Office/Industrial – The assumptions used in the EOEA buildout analysis for commercial/industrial development were applied. Wetlands were subtracted from each parcel and Floor Area Ratios (FAR) were applied to the remaining undeveloped land. These were obtained from the EOEA buildout analysis, which considered building height and parking restrictions. A separate FAR was applied for land within and out of floodplains. The FARs used are included in Table 2-6:

Table 2-6. Floor Area Ratios

Limited Office District:	**FAR**
Inside 100-Year Flood Zone:	0.39
Outside Wetland Area & 100-Year Flood Zone:	0.53
Light Industry District:	
Inside 100-Year Flood Zone:	0.32
Outside Wetland Area & 100-Year Flood Zone:	0.42
General Industry District:	
Inside 100-Year Flood Zone:	0.34
Outside 100-Year Flood Zone:	0.46

The results of this analysis compared to the town-wide EOEA buildout analysis is provided in Table 2-7. It was assumed that difference between the EOEA town-wide estimates, and CEI's study area estimates, represented the southern area not included in the IWRM.

Table 2-7.Comparison of EOEA & CEI Buildout Analysis		
	Residents	**Residential Units**
EOEA		
Current	7,380	2,141
Additional	7,352	2,372
Buildout	14,732	4,513
CEI Analysis for Study Area (Central & Northern)		
Current (public supply and wells)	2,405	859
Additional	3,931	1,404
Buildout	6,336	2,263
Southern Area (EOEA minus Central & Northern)		
Current	4,975	1,282
Additional	3,421	968
Buildout	8,396	2,250

Age Distribution

Age distribution in Lancaster for 2000 is presented in Table 2-8.

Table 2-8. Lancaster Age Distribution		
Age Range	**2000**	
	Population	**% of Population**
Under 5 years	367	4.97%
5 to 17 years	1238	16.78%
18 to 20 years	354	4.80%
21 to 24 years	466	6.31%
25 to 34 years	1130	15.31%
35 to 44 years	1481	20.07%
45 to 54 years	1029	13.94%
55 to 59 years	330	4.47%
60 to 64 years	252	3.41%
65 to 74 years	377	5.11%
75 to 84 years	234	3.17%
85 years and over	122	1.65%
TOTAL POPULATION	**7380**	
Median age (years)	35.9	

Data from 2000 U.S. Census

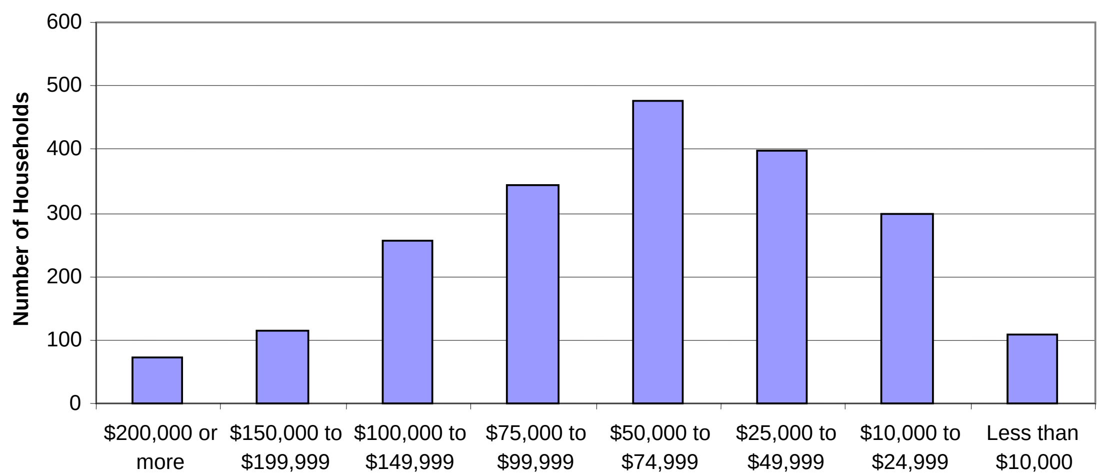
Median Income Distribution

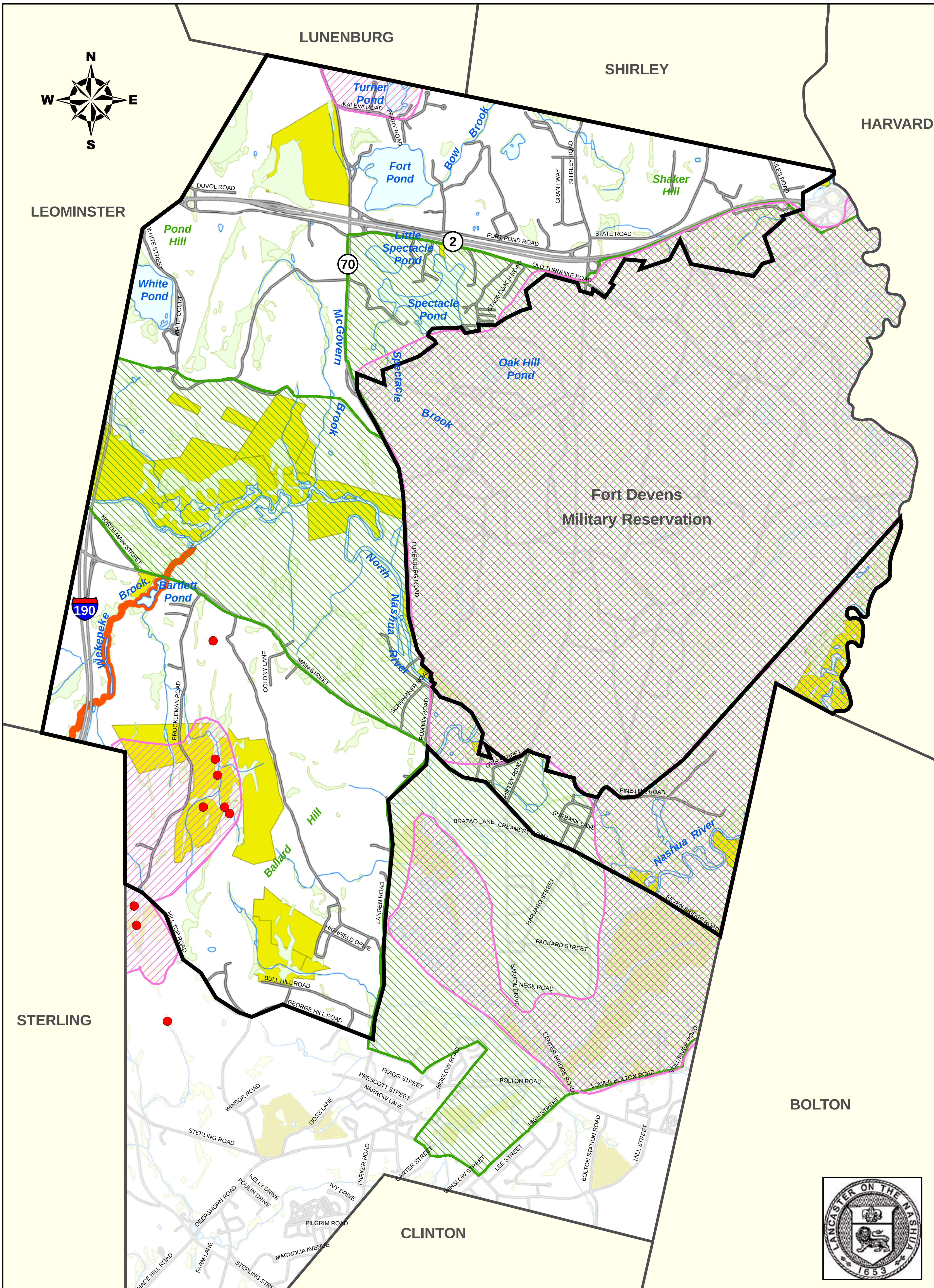
Lancaster is mostly a bedroom community for the surrounding cities and towns. There is little commercial and industrial business in Lancaster. Lancaster's household income distribution, as reported by the 2000 U.S. Census, is presented in Table 2-9 and graphically as Figure 2-8.

Table 2-9. Lancaster Household Income Distribution, 2000			
Household Income	**Number of Households**	**Percent of Total**	**Cumulative Percent**
$200,000 or more	73	3.53%	3.53%
$150,000 to $199,999	116	5.60%	9.13%
$100,000 to $149,999	257	12.42%	21.55%
$75,000 to $99,999	344	16.62%	38.16%
$50,000 to $74,999	477	23.04%	61.21%
$25,000 to $49,999	397	19.18%	80.39%
$10,000 to $24,999	297	14.35%	94.73%
Less than $10,000	109	5.27%	100.00%
TOTAL	**2,070**		
Median Income $	60,752		

Data from U.S. Census

Figure 2-8 Lancaster Household Income Distribution, 2000





LEGEND

- Certified Vernal Pool
- Priority Habitats of Rare Species
- ACEC
- Protected and Recreational Open Space
- Cold Water Fishery
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, CEI

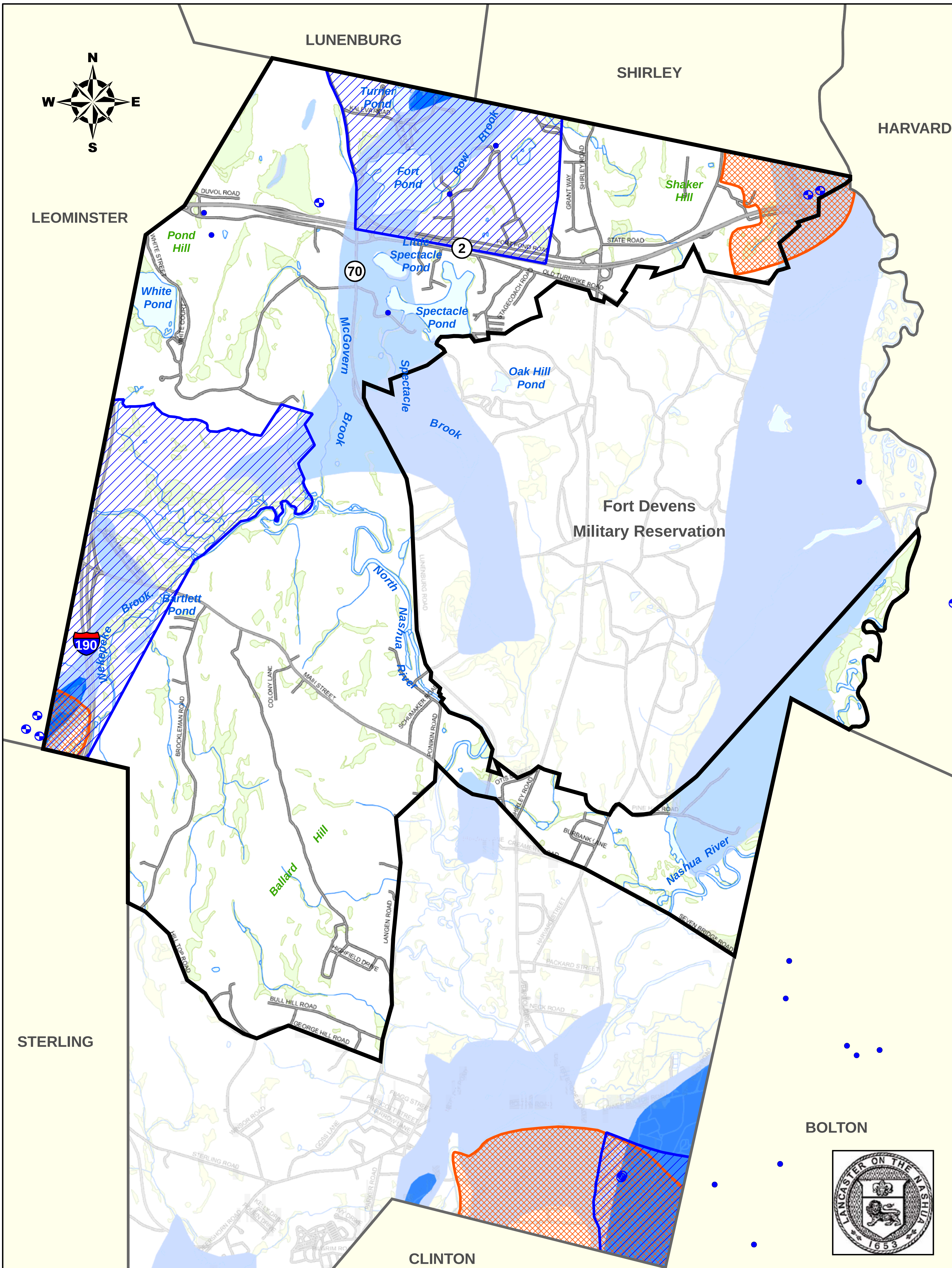
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 2-1

Critical Habitats

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Public Water Supply

- Community Source
- Non-Community Source
- ZONE II - Recharge Area
- Water Resource District
- IWRM Study Area

Aquifer Yield (Gallons per Minutes)

- 100-300
- >300

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

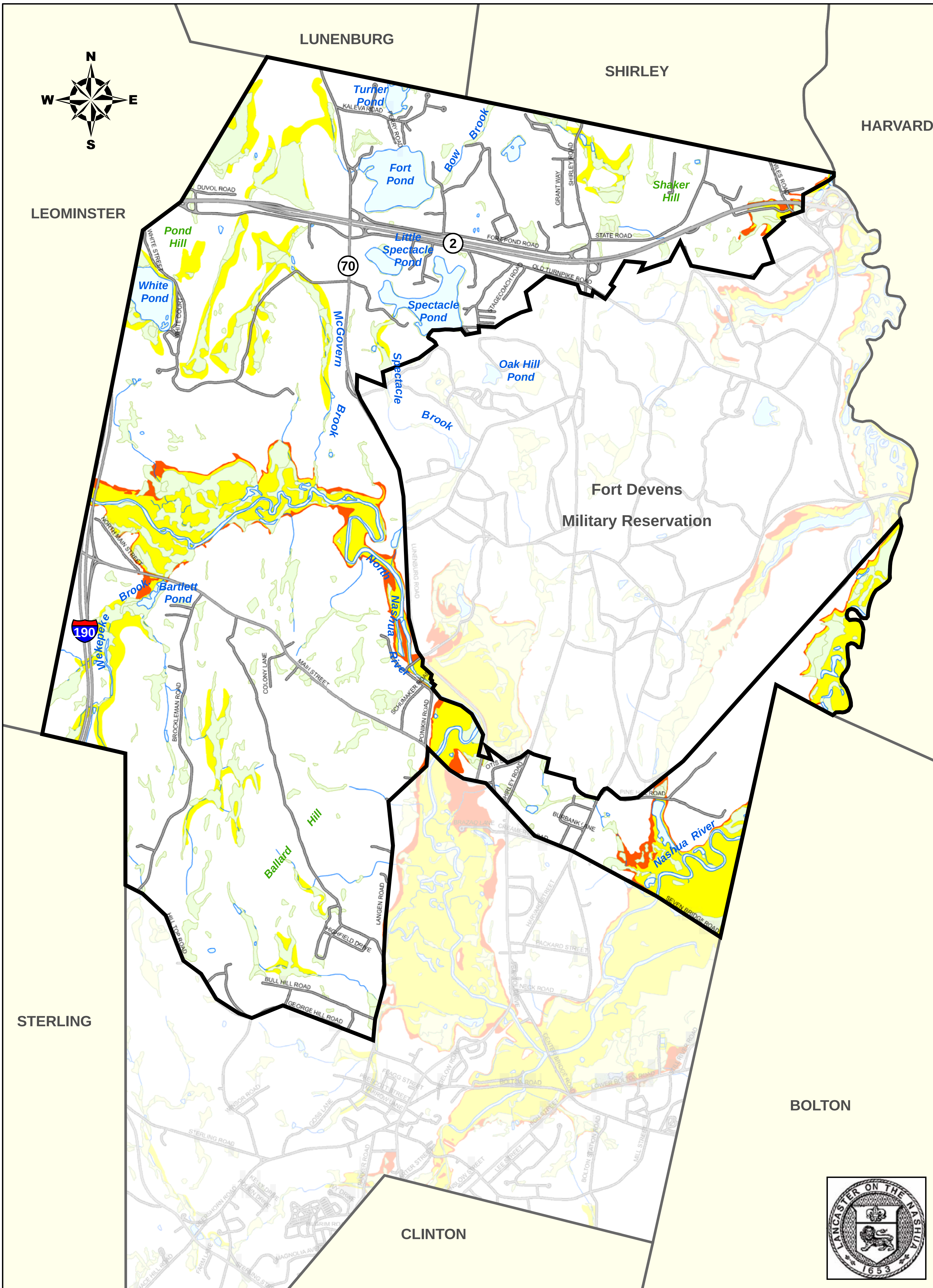
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 2-2

Water Resources

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

FEMA Flood Zones

- Inundated by 100-Year Storm
- Inundated by 500-Year Storm
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP, FEMA

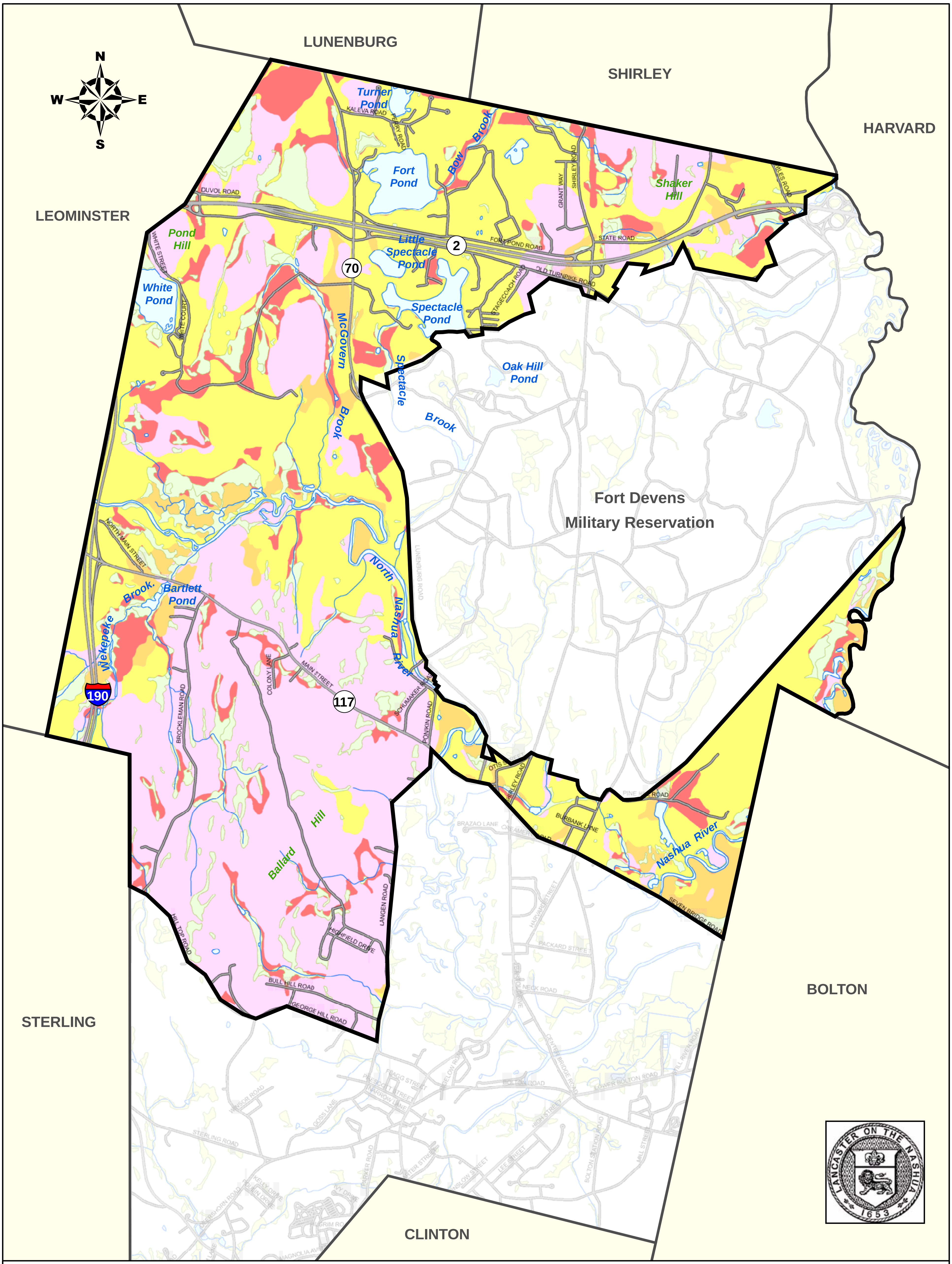
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 2-3

Flood Zones

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Soils - Hydrologic Group

- A (High Permeability)
- B
- C
- D (Low Permeability)

IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP, USGS

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 2-4

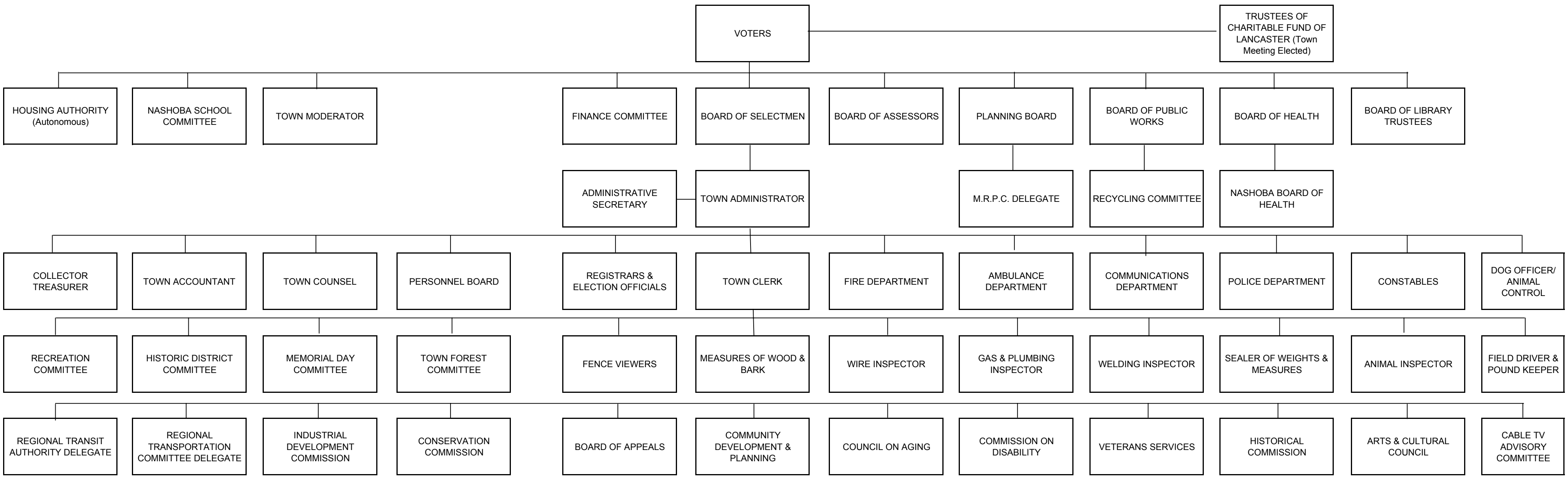
Soils Hydrologic Classification

Lancaster, MA

Comprehensive Environmental Inc.

Figure 2-5

Town of Lancaster
Table of Organization



3.0 Water Balance

3.1 Overview

Water is quickly becoming scarcer in the Northeast, largely due the interruption of the hydrologic cycle caused by new development. As asphalt and other impervious surfaces spread, and other soils are compacted by human activity, our generous 40+ inches of rainfall no longer seems able to provide us with all the water we need for human use, irrigation and water resources such as fishable/swimmable water bodies and clear running streams. The increased imperviousness, even from lawns, creates more runoff and interferes with recharge. In addition, many of the land uses are not vegetated, so the large evapotranspiration component of natural woods is replaced by a large amount of "new" runoff.

For each acre of land, the natural rainfall is roughly 1 million gallons per year. Of this 1 mg, about half is evapotranspiration and about half (in an A or B soil) is recharge. So the same acre developed still receives 1 mg of rainfall, but it may ALL be runoff even where none existed (in A and B soils) before. This new runoff causes flooding damage to infrastructure, private property and natural habitats.

The Town of Lancaster, through funding provided by the Commonwealth of Massachusetts Riverways Program, underwent a study to develop an Environmental Overlay District (EOD) in 2006 to better protect water resources from development impacts. Since the Town is still quite small and expected to grow significantly in population and imperviousness, the purpose was to set up regulations that would control the impacts of development thus protecting water resources more effectively.

The Environmental Overlay District (EOD) that was developed is a single or series of overlays that can be applied to specific portions of a Town and requires that certain performance standards be met in these areas. In Lancaster, the focus of the EOD was on providing a better hydrologic balance in developing areas, focusing on the central and northern portions of Lancaster. Emphasis was on keeping more water in the basin to offset water supply withdrawals and wastewater discharges associated with development, while simultaneously improving water quality.

Finally, the water balance model that was developed is used in this Integrated Water Resources Management Program (IWRM) to assess the differences between the feasible alternatives. The full report from EOD project, including the Water Balance is in Appendix A. The drainage areas assessed for the report are described below as they will be used for the wastewater assessment as well.

3.2 Study Area Subwatersheds

Lancaster was divided into 9 subwatersheds or subdrainage areas to evaluate development impacts and the local water budget for each area. This allows for evaluation of each subarea for impacts to tributaries and the larger receiving streams and provides a more manageable scale to evaluate the study area, providing more localized information on which to base decisions.

The subwatershed boundaries are natural boundaries dictated by the local topography. These boundaries generally follow ridgelines or high points and represent the area that drains to the furthest downgradient point, which was typically chosen where a stream intersected another stream. Since Lancaster does not have jurisdiction in other towns or the Fort Devens military reserve, these boundaries were also used to delineate subwatersheds, even though the natural topographic boundary may extend into adjacent towns and Fort Devens. However, the water balance is focused on assessing water management in a holistic way based on the starting point of total rainfall falling on the study area.

Entering and exiting streamflows were not considered because it can lead to misleading “balance” information where large rivers overwhelm land use impacts to the extent that human actions appear unimportant, while on small drainages the human impact seems beyond management. In truth, all human impacts on the riverine system are important and cumulative wherever they occur and affect hydrology and quality.

Most water bodies within Lancaster drain to the North Nashua and Nashua Rivers. The subwatershed divisions were chosen to represent each of the major tributaries draining to the North Nashua and Nashua Rivers, as well as those water bodies that drain out of town. Figure 3-1 shows the subwatershed boundaries. The names, sizes and surface water attributes of each subwatershed are listed in Table 3.1.

Table 3-1. Subwatershed Attributes

Subwatershed Name	Subwatershed Area (acres)	Surface Water Attributes
Shaker Hill	571	• Unnamed stream flowing easterly into Slate Rock Pond • Unnamed stream flowing easterly into the Nashua River
Fort Pond	1089	• Turner Pond • Fort Pond and its unnamed tributary • Bow Brook flows north out of Fort Pond through Tophet Swamp into Catacunemaug Brook, which ultimately discharges into the Nashua River • Three small ponds with no tributaries
Spectacle Pond	462	• Little Spectacle Pond • Spectacle Pond • Spectacle Brook flow out of Spectacle Pond southward and eventually discharges into the North Nashua River a quarter mile south of the Cook Conservation Area
McGovern Brook	785	• McGovern Brook starts in a wetland west of Spectacle Pond and flows north around a hill and south through the Cooks Conservation Area and discharges into the North Nashua River
White Pond	402	• White Pond • White Pond outlets west into Leominster and discharges into the North Nashua River
North Nashua River	1657	• North Nashua River flows from the west to the southeast across the subwatershed • McGovern Brook and unnamed tributaries flow south into the North Nashua River • Tributary from Bartlett Pond and unnamed tributaries flow north into the North Nashua River adjacent to the Cooks Conservation area
Wekepeke Brook	1306	• Bartlett Pond discharges into the North Nashua River • Wekepeke Brook and unnamed brook flow north into Bartlett Pond
Ballard Hill	1199	• Three unnamed tributaries flow east into the North Nashua River
Nashua River	877	• Nashua River flows north • Two unnamed tributaries discharge into the Nashua River

3.3 Water Balance Methodology

The purpose of performing a water balance is to evaluate the impacts various alternatives will have on the water reaching groundwater to maintain baseflow. This allows for the objective comparison of various alternatives and their impacts on the overall water balance. The first step in preparing the water balance is to establish baseline alternatives. For this study, baseline water balances included virgin conditions, existing conditions and buildout conditions assuming all future development is on private water supply wells and septic systems. This sets the benchmark for evaluating other alternatives, such as sewering and outside water supplies.

Existing and virgin conditions are relatively easy to generate as they represent what is currently there or assume all land cover is completely forested. However, buildout conditions involve more evaluation and assumptions to determine what might be developed under existing zoning. A buildout analysis to determine potential densities and land uses was thus performed before applying the water balance methodology.

Baseline Buildout Analysis

The majority of the study area is currently undeveloped, so the buildout analysis is particularly important in evaluating and mitigating the impacts of future growth on the water balance. Prevention is a far more cost-effective approach than trying to reestablish a reasonable hydrologic balance when the land has already been developed. The methodology used to perform the buildout analysis is presented in Section 2.

The number of developed lots under existing conditions and the additional number of lots that could be developed under a buildout condition are provided in Table 3-2.

Table 3-2. Number of Developed Residential Properties

	Existing	Additional at Buildout
Shaker Hill	23	160
Fort Pond	238	126
Spectacle Pond	148	114
McGovern Brook	7	32
White Pond	41	39
North Nashua	99	496
Wekepeke Brook	68	473
Ballard Hill	137	425
Nashua River	98	284
Total	**859**	**2,149**

The additional square footage of building space that could be developed under buildout conditions is included in Table 3-3.

Table 3-3. Additional Commercial Buildout Space at Buildout (sq.ft.)	
	Additional at Buildout
Shaker Hill	170,810
Fort Pond	8,174,296
Spectacle Pond	-
McGovern Brook	7,600,640
White Pond	1,841,811
North Nashua	3,623,017
Wekepeke Brook	-
Ballard Hill	-
Nashua River	-
Total	**21,410,574**

Water Balance Methodology

A water balance was performed for virgin (undeveloped), existing and buildout conditions to evaluate the impacts of development on the water cycle and to evaluate how the proposed alternatives affect the water balance.

The water balance considered of three factors: 1) precipitation and stormwater (stormwater runoff, recharge and evapotranspiration); 2) wastewater imports and exports; and 3) water withdrawals. A simple mass balance equation was used to evaluate recharge as follows:

$$Re = P - ET - Q$$

Where:

Re = Recharge
P = Annual precipitation
ET = Evapotranspiration
Q = Runoff

The water balance was then evaluated using the following simplified mass balance equation:

$$GW = Re + WWG - WS - WWE$$

Where:

GW = Available groundwater for baseflow
Re = Recharge
WWG = Total wastewater generated (includes wastewater generated from septic systems that remain within the study area, as well as sewer systems that export water from the study area)

WS = Water supply withdrawals
WWE = Wastewater exports out of subwatershed (this is the sewered portion that leaves the study area)

The following explains the assumptions used to calculate each of these three factors:

Precipitation and Stormwater

Average annual precipitation is 49.5 inches/year on average[1]. Precipitation was converted into gallons of water entering the study area on an annual basis by multiplying the precipitation by the total land area for each zoning district in each subwatershed. The remaining developable land areas calculated for existing conditions and buildout analysis with GIS were then broken up into typical components, including impervious, lawn and forest. The assumptions used in these calculations are provided in Table 3-4.

Table 3-4. Percent Land Type Used in Water Balance

	Residential	Limited Office	Light Industry
Land Type			
Impervious	14%	85%	64%
Lawn	36%	15%	30%
Forest	50%	0%	6%

Runoff coefficients were then developed for each land use and soil type. These are summarized in Table 3-5.

Table 3-5. Runoff Coefficients Used in Water Balance

Soil Type	Forested	Impervious	Lawn Residential	Lawn Limited Office & Light Industrial	Wetland	Flood Plain	Roads	Water
A	0.059	0.95	0.18	0.05			0.75	0.95
B	0.11	0.95	0.20	0.10			0.75	0.95
C	0.15	0.95	0.23	0.13			0.75	0.95
D	0.20	0.95	0.25	0.17	0.75	0.2	0.75	0.95

Notes:
1. The lawn runoff coefficients for Limited Office and Light Industrial assume the majority of greenspace will be landscaped areas, which have a lower runoff coefficient than residential lawns.
2. The roads runoff coefficient represents roadways and right of ways within the study area as identified by MassGIS.

The runoff coefficients were applied to the appropriate land uses using the equation:

[1] Yahoo Real Estate, (Neighborhood Profiles, Lancaster, MA). Retrieved February 20, 2007 from the World Wide Web: http://realestate.yahoo.com/Neighborhoods/detail.html?csz=Lancaster,MA

$$Q = C*P*A*27{,}154$$

Where:

Q = total runoff (gal/year)
C = runoff coefficient (unitless)
P = annual precipitation (inches)
A = land area (acres)
27,154 = conversion factor (43,560 sq.ft./acre*7.4805 gal/ft^3÷12 inches/ft)

Evapotranspiration was assumed to be 40% for forested areas and 25% for lawns and wetlands of the annual precipitation. This was calculated and both the runoff and evapotranspiration were subtracted from the total precipitation to estimate annual recharge for a given area. The results are summarized in Table 3-6 by subwatershed.

Table 3-6. Precipitation Water Balance (gal/yr)								
	Precipitation		**Runoff**		**Evapotranspiration**		**Recharge**	
	Existing	**Buildout**	**Existing**	**Buildout**	**Existing**	**Buildout**	**Existing**	**Buildout**
Shaker Hill	772,854,532	772,854,532	275,326,231	348,224,721	210,257,906	159,159,491	287,270,395	265,470,320
Fort Pond	1,465,485,926	1,465,485,926	465,611,494	836,464,129	437,647,308	246,566,041	562,227,124	382,455,755
Spectacle Pond	616,960,568	616,960,568	235,267,477	268,910,682	147,229,946	125,103,934	234,463,145	222,945,953
McGovern Brook	1,030,903,190	1,030,903,190	308,706,164	598,314,558	329,539,731	170,648,843	392,657,295	261,939,789
White Pond	536,398,305	536,398,305	245,054,214	324,190,824	131,011,693	86,712,852	160,332,398	125,494,629
North Nashua	2,248,130,858	2,248,130,858	528,199,517	845,430,792	799,309,845	597,970,096	920,621,496	804,729,971
Wekepeke Brook	1,762,767,291	1,762,767,291	435,290,965	609,140,732	636,772,414	501,970,755	690,703,913	651,655,804
Ballard Hill	1,599,483,281	1,599,483,281	376,287,505	532,915,261	577,204,033	452,969,476	645,991,743	613,598,544
Nashua River	1,156,610,198	1,156,610,198	267,586,003	364,653,397	409,160,475	344,608,369	479,863,720	447,348,432
Total	**11,189,594,149**	**11,189,594,149**	**3,137,329,570**	**4,728,245,096**	**3,678,133,350**	**2,685,709,856**	**4,374,131,229**	**3,775,639,196**

Water Withdrawals

There are no municipal public water supply wells within the study area. Most of the drinking water is supplied through private wells, and/or community and non-community transient and non-transient wells however, there are several existing properties located along Route 117 that are on the municipal water supply. Additionally, properties along Grant Way receive water from the Shirley Water District. The municipal water supply source is located outside of the study area, therefore water consumption associated with these properties was excluded from the water balance. It was assumed for baseline buildout purposes that future development would be supplied with private water supply wells. To estimate the withdrawals occurring from private systems, it was assumed that 75 gallons per capita per day was consumed. This is an assumption used by EOEA in their buildout analysis. DEP is encouraging 65 gpcpd in high and medium stressed basins, but this can be difficult and may take some time to achieve. A summary of the results of this analysis is provided in Table 3-7.

Table 3-7. Water Withdrawals (gal/yr)

	Existing	Buildout
Shaker Hill	142,119,091	159,059,015
Fort Pond	33,461,224	266,890,473
Spectacle Pond	11,344,200	20,082,300
McGovern Brook	43,284,688	253,805,002
White Pond	47,214,650	100,623,569
North Nashua	6,479,090	143,677,593
Wekepeke Brook	3,832,500	40,087,950
Ballard Hill	8,661,450	41,237,700
Nashua River	383,250	22,151,850
Total	**296,780,145**	**1,047,615,452**

Wastewater Imports and Exports

Wastewater imports and exports into the study area were also evaluated. Actual wastewater generation of properties within the watershed was first developed as shown in Table 3-8.

Table 3-8. Wastewater Generation (gal/yr)

	Existing	Buildout
Shaker Hill	113,930,333	129,117,472
Fort Pond	29,201,340	217,232,458
Spectacle Pond	10,587,920	18,743,480
McGovern Brook	34,699,290	203,442,582
White Pond	38,190,740	81,316,455
North Nashua	10,548,772	125,376,694
Wekepeke Brook	4,864,720	38,703,140
Ballard Hill	9,800,980	40,205,480
Nashua River	7,010,920	27,328,280
Total	**258,835,016**	**881,466,041**

The receiving point for these discharges was then evaluated when looking at the overall water balance components under existing and buildout conditions. Currently, all but one development within the study area uses an on-site wastewater disposal system. The Division of Youth Services in the Shaker Hill subwatershed discharges their waste to the Devens Community wastewater treatment facility. Both wastewater imports and wastewater exports are reflected in the water balance components tables, Tables 3-9 through 3-11, to show how much is retained within the study area and the quantity that leaves the study area. It was assumed for baseline buildout purposes that no additional sewering would be provided and all wastewater would be handled on-site, resulting in no additional losses from wastewater. Other alternatives that consider sewering will be considered in Section 8.

A complete water balance for the study area was completed using the individual stormwater, water and wastewater analyses. The components involved in the water balance under virgin, existing and buildout conditions are provided in Tables 3-9 through 3-11. Table 3-12 shows the total water balance by subwatershed based on the equation provided above and represents the amount of water that would be recharged into the groundwater.

Table 3-9. Water Balance Components Under Virgin Conditions (gal/yr)

Subwatershed	Recharge	Wastewater Imports	Runoff	Evapo-transpiration	Withdrawals	Wastewater Exports
Shaker Hill	350,782,404	0	120,265,474	301,806,654	0	0
Fort Pond	606,435,253	-	342,829,367	516,221,307	-	-
Spectacle Pond	261,766,445	-	152,670,254	202,523,869	-	-
McGovern Brook	432,864,036	-	204,441,608	393,597,547	-	-
White Pond	192,052,958	0	166,331,030	178,014,318	0	0
North Nashua	936,992,474	0	470,927,501	840,210,883	0	0
Wekepeke Brook	705,602,626	0	383,268,371	673,896,295	0	0
Ballard Hill	661,970,572	0	316,748,739	620,763,969	0	0
Nashua River	492,310,694	0	230,027,532	434,271,972	0	0
Total	**4,640,777,461**	**0**	**2,387,509,875**	**4,161,306,812**	**0**	**0**

Table 3-10. Water Balance Components Under Existing Conditions (gal/yr)						
Subwatershed	Recharge	Wastewater Imports	Runoff	Evapo-transpiration	Withdrawals	Wastewater Exports
Shaker Hill	287,270,395	1,645,420	275,326,231	210,257,906	142,119,091	112,284,913
Fort Pond	562,227,124	29,201,340	465,611,494	437,647,308	33,461,224	-
Spectacle Pond	234,463,145	10,587,920	235,267,477	147,229,946	11,344,200	-
McGovern Brook	392,657,295	34,699,290	308,706,164	329,539,731	43,284,688	-
White Pond	160,332,398	38,190,740	245,054,214	131,011,693	47,214,650	0
North Nashua	920,621,496	10,548,772	528,199,517	799,309,845	6,479,090	0
Wekepeke Brook	690,703,913	4,864,720	435,290,965	636,772,414	3,832,500	0
Ballard Hill	645,991,743	9,800,980	376,287,505	577,204,033	8,661,450	0
Nashua River	479,863,720	7,010,920	267,586,003	409,160,475	383,250	0
Total	**4,374,131,229**	**146,550,102**	**3,137,329,570**	**3,678,133,350**	**296,780,145**	**112,284,913**

Table 3-11. Water Balance Components Under Buildout Conditions (gal/yr)						
Subwatershed	Recharge	Wastewater Imports	Runoff	Evapo-transpiration	Withdrawals	Wastewater Exports
Shaker Hill	265,470,320	16,832,559	348,224,721	159,159,491	159,059,015	112,284,913
Fort Pond	382,455,755	217,232,458	836,464,129	246,566,041	266,890,473	-
Spectacle Pond	222,945,953	18,743,480	268,910,682	125,103,934	20,082,300	-
McGovern Brook	261,939,789	203,442,582	598,314,558	170,648,843	253,805,002	-
White Pond	125,494,629	81,316,455	324,190,824	86,712,852	100,623,569	0
North Nashua	804,729,971	125,376,694	845,430,792	597,970,096	143,677,593	0
Wekepeke Brook	651,655,804	38,703,140	609,140,732	501,970,755	40,087,950	0
Ballard Hill	613,598,544	40,205,480	532,915,261	452,969,476	41,237,700	0
Nashua River	447,348,432	27,328,280	364,653,397	344,608,369	22,151,850	0
Total	**3,775,639,196**	**769,181,128**	**4,728,245,096**	**2,685,709,856**	**1,047,615,452**	**112,284,913**

Table 3-12. Total Groundwater Balance by Subwatershed (gal/yr)			
	Virgin	**Existing**	**Buildout**
Shaker Hill	350,782,404	146,796,724	123,243,864
Fort Pond	606,435,253	557,967,239	332,797,741
Spectacle Pond	261,766,445	233,706,865	221,607,133
McGovern Brook	432,864,036	384,071,897	211,577,368
White Pond	192,052,958	151,308,488	106,187,515
North Nashua	936,992,474	924,691,178	786,429,072
Wekepeke Brook	705,602,626	691,736,133	650,270,994
Ballard Hill	661,970,572	647,131,273	612,566,324
Nashua River	492,310,694	486,491,390	452,524,862
Total	**4,640,777,461**	**4,223,901,187**	**3,497,204,873**

Figure 3-2 summarizes the annual water balance components for the study area under virgin, existing and baseline buildout conditions.

Figure 3-2 Water Balance Components for Entire Study Area

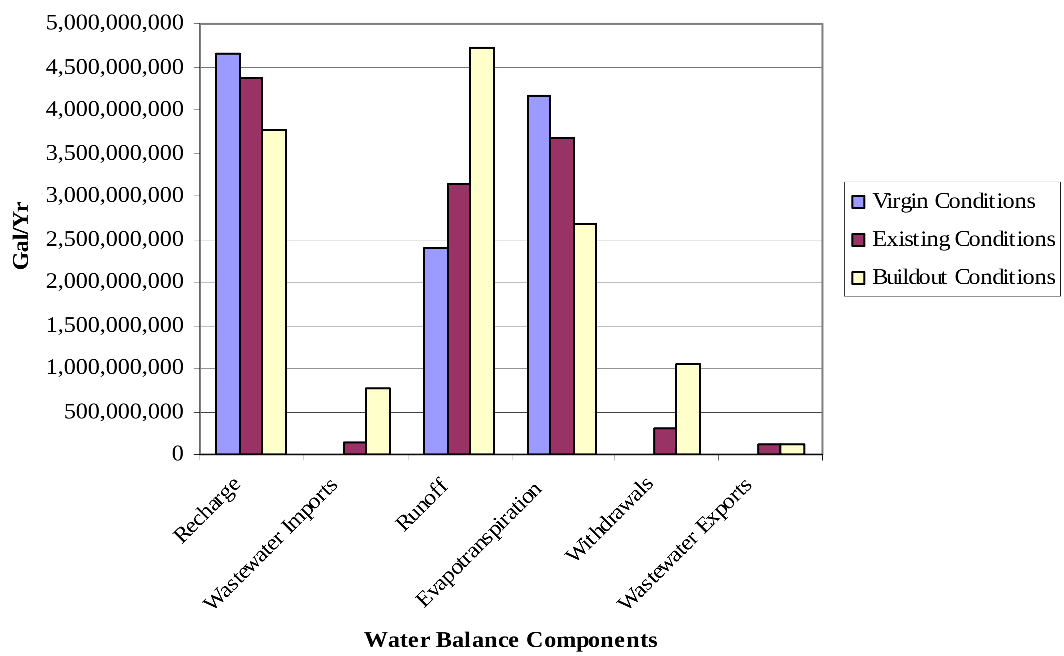


Figure 3-3 shows the groundwater balance for the entire study area and represents the amount of water that would normally infiltrate through the ground to replenish groundwater.

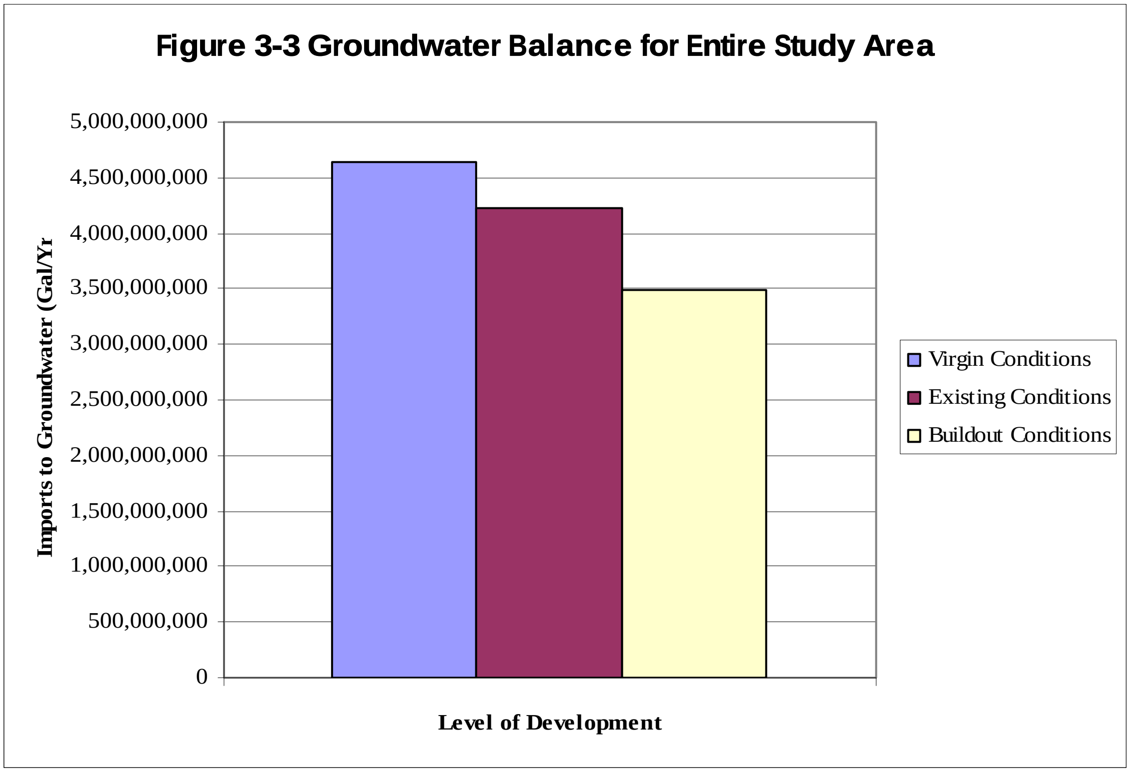
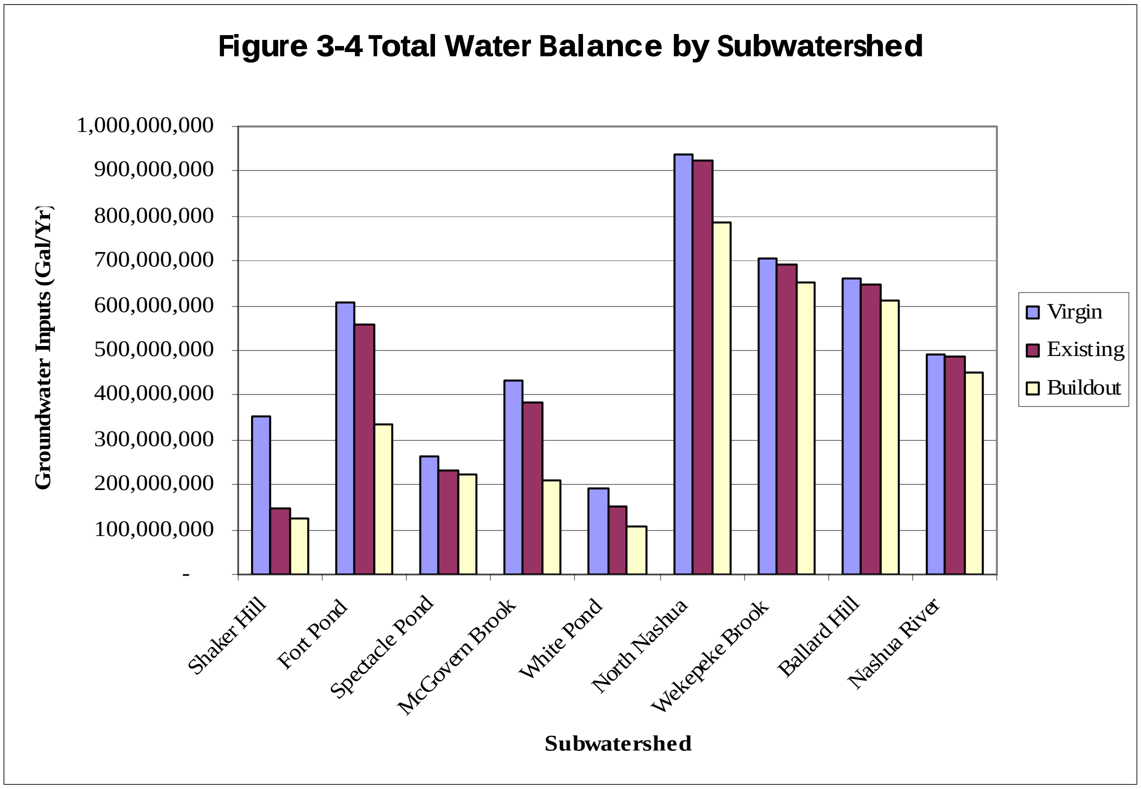
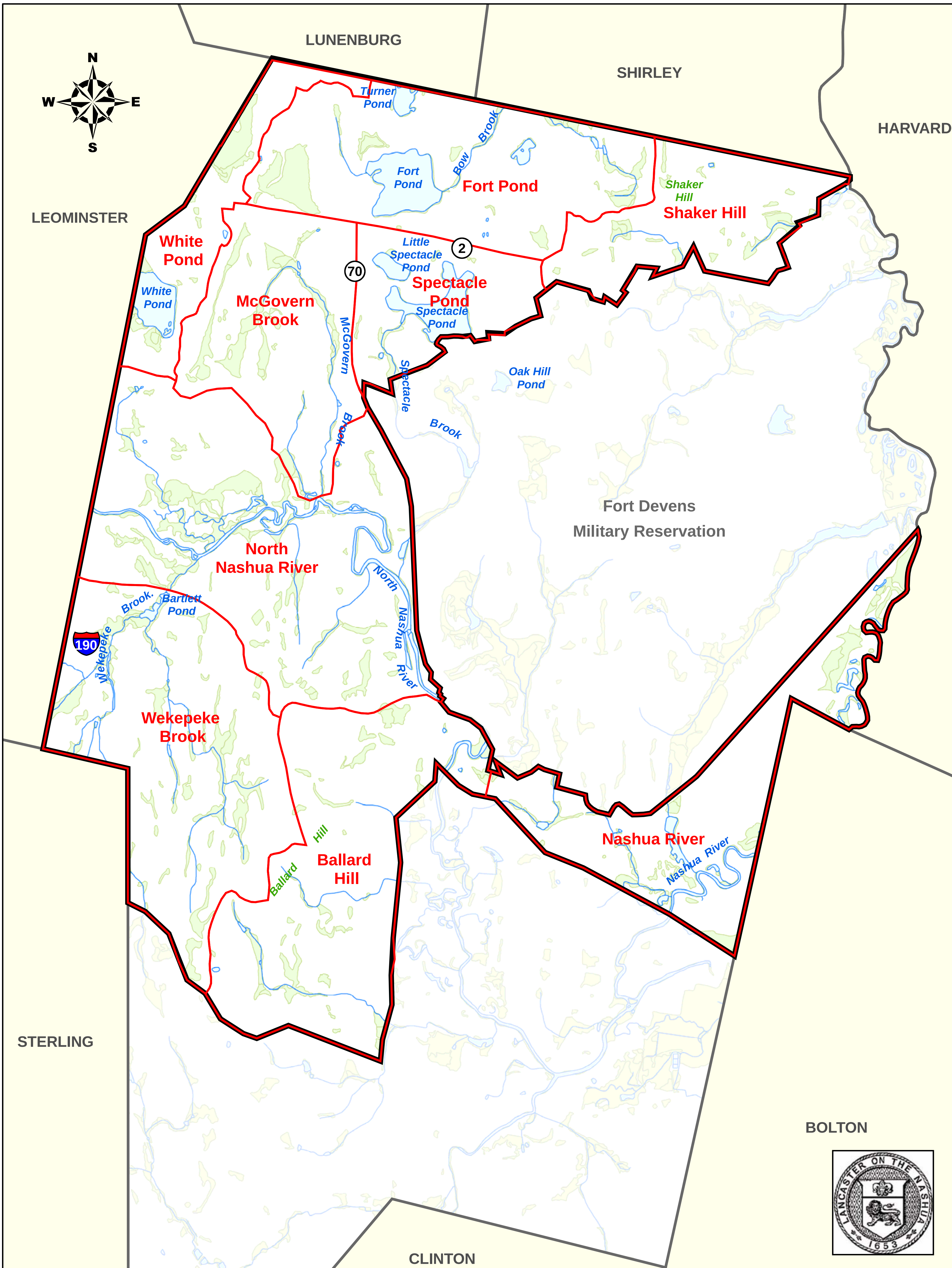


Figure 3-4 shows a breakdown of the water balance by subwatershed for virgin, existing and buildout conditions. The detailed analyses by subwatershed are provided in the Environmental Overlay District Project.



This data will be incorporated into the alternatives analysis performed under Section 8.



LEGEND

- IWRM Study Area
- Subwatershed Boundaries

Hydrography
- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 3-1

Subwatershed Boundaries

Lancaster, MA

Comprehensive Environmental Inc.

4.0 Public Participation Summary

4.1 Introduction

As part of the scope of the Integrated Water Resources Management Plan, the Town of Lancaster is conducting an extensive public education program to inform the public of the scope and progress of the planning study, to describe the results of the Wastewater Needs Analysis and to encourage public input throughout the entire planning process. The following meetings and public participation efforts have occurred to date:

- On 02.23.06, Public Meeting was held in the library. The Town sent 32 individual invitations to various board members and also invited the public. About 30 people were in attendance. A number of Spectacle Pond residents were at the meeting, and several expressed concern about water quality impacts on Spectacle Pond of nearby developments. Others noted that they were not enthusiastic about betterment fees when their septic system was working quite well. There was some concern about the disconnect between the Water and Sewer District Comprehensive Wastewater Management Plan (CWMP) being done by Weston & Sampson and the North Lancaster Integrated Water Resources Management (IWRM) Plan being done by Comprehensive Environmental Inc. (CEI). The two part IWRM was described by CEI. Jonathan Gulliver, Sewer District Administrator for the Lancaster Sewer District gave a brief update of the Weston & Sampson CWMP project. Steve Mullaney presented the proposal that had been submitted by his firm for the North Lancaster Development District. Mike Mitchell from Devens Community presented wastewater capacity for Devens.
- On 08.21.06, a presentation on the project was given to the Board of Selectmen and the public. It included a discussion of the draft Environmental Overlay District Report that was Part 1 of the IWRM and a description of Part 2, the Integrated Water Resources Management Plan. The Board of Selectmen had a number of questions which were addressed and the report was accepted.
- On 03.08.07, an additional public meeting was held in the library. The representatives of the Lancaster DPW, Conservation, Board of Health, Town Administrator, Planning Department and CEI met to discuss the draft IWRM and to present the alternatives. A number of comments centered on which towns might be able to provide additional water supply and/or receive sewage. The Town agreed to review the report in depth and get comments back to CEI within a few weeks.
- A final public meeting will be scheduled and will involve the Board of Selectmen, Planning Board, Board of Public Works, Conservation Commission, Sewer District and television for local access. The public will also be invited.

- All draft and other documents have been put on the Town's website for review by citizens and for obtaining additional comments.
- Comments on the draft report have been housed at the Public Library.

5.0 Water Supply Demand Projections and Supply Sources

Northern Lancaster is mostly undeveloped, with only a small portion of residents on the Town's water distribution system. There is an estimated nine miles of water main, or 25% of the total distribution piping within or on the edge of the study area and about 14% of the population served within the study area. The remainders of the distribution piping, along with the water supply wells are located within the southern portion of town, which is not part of the study area for this IWRM.

Since such a small portion of the existing distribution system lies within the study area, this section focuses on source capacities for future expansion. An overall water balance will also be performed with each of the alternatives to evaluate general impacts to baseflow recharge. Only a limited review of the system is included in this review.

5.1 Existing Sources

The Town of Lancaster has two groundwater supply wells, Well 1 and Well 2 located in the southeast corner of town on Bolton Station Road in a medium to high yield aquifer. The wells supply about 5,500 residents or 75% of the town's population, primarily in the southern end of town, outside of the IWRM study area.

Groundwater Supply

Capacity

According to the 2005 Public Water Supply Comprehensive Report, the combined approved pumping capacity of the wells is 1.44 million gallons per day (MGD). More information on each of the wells is provided in Table 5-1 below.

Table 5-1 Well Information

Well Names	Source IDs	Approved Daily Pump Volume (MG)	Gallons Produced (MG)	Construction Type	Pump Setting (ft)	Casing Depth (ft)	Screen Length (ft)
Well 1	2147000-01G	0.57	127.717	Gravel	100	78	20
Well 2	2147000-02G	0.87	133.177	Gravel	123	78	20

Zone II and Source Water Assessment and Protection (SWAP) Report

The Zone II for the water supply spans the Towns of Lancaster, Bolton and Clinton (see Figure 5-1) and occupies about 2.31 square miles, with 0.77 square miles in Lancaster, 1.23 square miles in Clinton, and 0.31 square miles in Bolton.

Under the federal Safe Drinking Water Act, the State of Massachusetts must assess the susceptibility of drinking water sources to contamination from land uses within the recharge area of all public water sources. The last assessment for the Lancaster public water system was completed in February 2002. Table 5-2 summarizes land use and protection issues within the Zone II and recommendations proposed under the SWAP.

Table 5-2 Land Use and Protection Issues Within the Zone II

	Issues	Recommendations
Inappropriate Activities in Zone Is	Both wells have a portion of a ball field in its Zone I.	• Remove non water supply activities from Zone I to extent possible. • Keep new non water supply activities out of the Zone Is. • Do no use fertilizers or pesticides in the Zone Is.
Residential Land Uses	About 30% of the Zone II consists of residential areas. There are concerns of potential contamination from residential areas including household hazardous materials, heating oil storage and stormwater.	• Educate residents on BMPs for water supply protection. Distribute the fact sheet “Residents Protect Drinking Water. • Work with planners to control new residential developments in the Zone II. • Promote BMPs for stormwater management and pollution controls.
Transportation Corridors	Route 110 runs through the Zone II.	• Identify stormwater drains along transportation corridors. Discharge outside of Zone II. • Clean catch basins on a regular schedule. • Work with local emergency response teams for effective containment of potential spills. Review storm drain maps together.
Hazardous Materials Storage and Use	14% of the Zone II consists of commercial and industrial areas. These types of businesses often work with hazardous materials.	• Educate local businesses on BMPs for protecting water supplies. Distribute the fact sheet “Businesses Protect Drinking Water”. • Work with businesses to register as hazardous waste generators. • Educate businesses on floor drain requirements.
Presence of Oil or Hazardous Material Contamination Sites	There are DEP Tier Classified Oil/Hazardous Material Release Sites in the Zone II.	• Monitor progress of remedial actions.
Protection Planning	The Town does not have water supply protection controls that meet DEP’s Wellhead Protection regulations.	• Develop a Wellhead Protection Plan. • Adopt controls that meet DEP’s Wellhead Protection regulations. • Incorporate floor drain controls into local regulations. • Work with Clinton and Bolton to protect the Zone II.

Water Quality

Lancaster is not required to treat its groundwater supply due to the good quality of the water.

Withdrawal Constraints

The Water Management Act (M.G.L. c.21G) became effective in March 1986, authorizing the Massachusetts DEP to regulate the quantity of water withdrawn from both surface and groundwater supplies from any source withdrawing more than 100,000 gpd. The purpose of the regulations (310 CMR 36.00) is to ensure adequate water supplies for current and future water needs.

All systems were initially required to file a registration statement, providing information on historical withdrawals. Under Lancaster's registration, Lancaster may withdraw an average of 0.53 mgd and a "threshold volume" of 100,000 gpd without a permit. Any increases in withdrawal require the filing of a Water Management Act permit.

Lancaster exceeded this threshold in 1999 and 2001 through 2005, and as a result is in the process of preparing a WMA permit requesting an increase in withdrawals. This application is being prepared simultaneously with a new source approval for a new well that is undergoing testing as a future supply.

To help manage water withdrawals, The Town of Lancaster recently adopted an Outdoor Water Use Bylaw to restrict or prohibit water use as necessary. Restrictions include limiting outdoor watering to daily periods and particular days of the weeks, while prohibited water uses include filling swimming pools and use of automatic irrigation sprinklers.

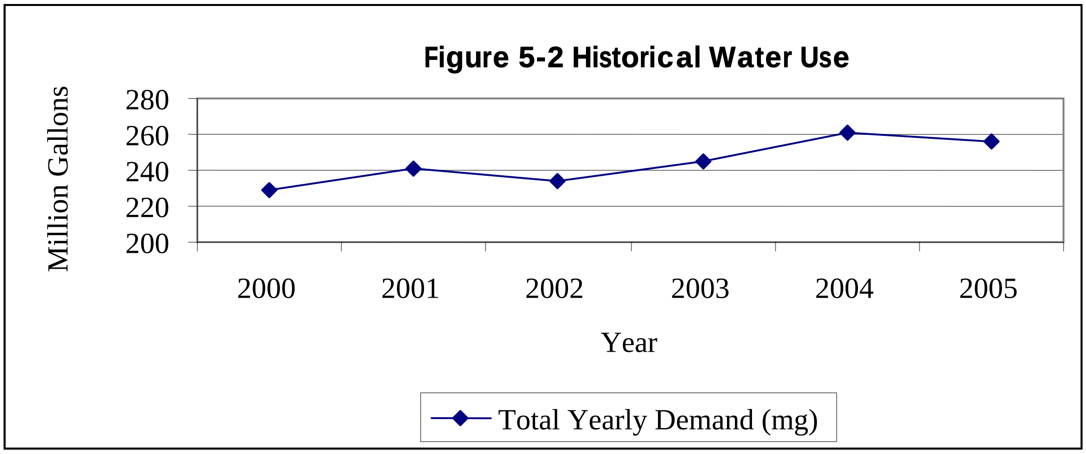
Historical Demand and Service Population

Historical Water Use

Table 5-3 summarizes historical water usage within Lancaster, based on the amount pumped from the wells. Yearly historical water use is shown on Figure 5-2. Over the last six years, Well 1 has provided an average of 48% of the water and Well 2 has provided an average of 52% of the water.

Table 5-3 Historical Water Demand Based on Pumping Records

Year	Total Yearly Demand (mg)	Average Day Demand (mgd)	Maximum Day Demand (mgd)	Peak Demand Ratio
2000	229	0.63	1.19	1.89
2001	241	0.66	1.13	1.72
2002	234	0.64	1.35	2.10
2003	245	0.67	1.39	2.06
2004	261	0.72	1.22	1.71
2005	256	0.70	1.19	1.69



Average and Maximum Day Demands

Average and maximum day demands are also provided in Table 5-3. Average day demand serves as a gauge of general systems demand and is useful in ensuring compliance with permit limitations, which are also gauged with average day demands. Maximum day demand represents the largest amount of water pumped over a 24-hour period within a year. Maximum day demand is important when evaluating pumping capacity and distribution system needs, since these need to be sized to meet maximum day demand.

Demand ratios are used to determine if the summer demand from irrigation and increased summer population create wide fluctuations. The ratio of historic maximum day demand to average day demand has fluctuated over the last six years, with an average ratio of 1.86:1. This indicates large demand fluctuations during dry, summer months, likely associated with summer outdoor watering. Maximum day demands typically increase with increased development and water usage. This ratio can be used as a peaking factor for future water use projections.

Historical average and maximum day demands between 2000 and 2005 are shown in Figure 5-3.

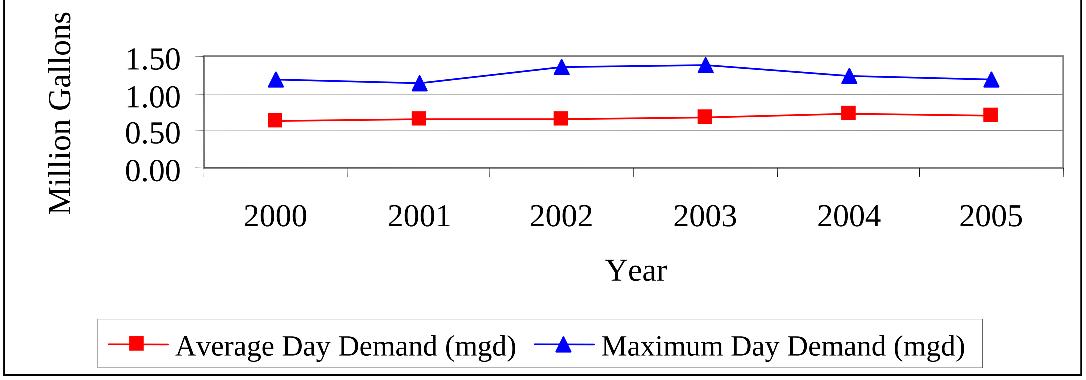


Figure 5-3 Historical Average and Maximum Day Demand

Water Use by User Class

Historical water use by user class is presented in Table 5-4. Residential use comprises the greatest water consumption, followed by commercial water users. There are some inconsistencies in the data with a significant decrease in residential water use noted in 2005. The Town currently does not classify water users (e.g., residential, commercial, agricultural, etc.) within the billing software, making it difficult to obtain accurate water use by user class.

Table 5-4 Percent Historical Water Use by User Class

Year	Residential	Commercial/ Business	Agricultural /Industrial	Municipal	Others	Other (Unmetered Estimate)	Unaccounted Water
2000	85%	0.2%	0.1%	0.1%	---	---	14%
2001	77%	0.1%	0.1%	0.1%	---	---	22%
2002	78%	0.1%	0.2%	0.2%	---	---	21%
2003	64%	8.0%	5.6%	---	2%	---	20%
2004	73%	8.1%	0.6%	---	0.2%	---	18%
2005	52%	18.1%	---	3.0%	---	10%	17%

Per Capita Consumption

Per capita consumption identifies average water use per person. It requires knowledge of the service population, as well as the amount of water used solely by residents. Existing average per capita data can be used to estimate future water consumption based on projected populations.

It is difficult to estimate the service population when the entire town is not provided with public water. Residential connections are one method to estimate population. However, in Lancaster the residential connections reported between 2000 and 2003 were higher than the actual number of connections due to some double counting of connections and accounting for connections that had been taken out of service. It wasn't until 2004 that this problem was corrected. Additionally, there are some multi-family units in Lancaster that are supplied by one connection, which makes it difficult to estimate population based on connections alone.

In a Consent Order and Notice of Noncompliance dated September 20, 2004, DEP ordered Lancaster to obtain an accurate estimate of residents served in their 2005 Annual Statistical Report, which was completed. The 2005 data is believed to be the most accurate data in terms of population served, and therefore in terms of the per capita water usage. The available information between 2000 and 2005 is provided in Table 5-5.

Table 5-5 Per Capita Water Usage

	Residential Connections	Estimated Population Served	Residential Water Used (mgy)	Daily Per Capita Water Usage (gal/capita-day)
2000	1,600		196	
2001	1,800		187	
2002	1,800	6,500	183	77
2003	1,800	6,500	156	66
2004	1,335	7,000	233	91
2005	1,355	5,523	133	66

The data indicates a low per capita use in 2005, which is close to the 65 gpcd targeted by DEP in medium and high stressed basin, of which the Nashua River Basin is classified (medium stress). However, there are some inconsistencies in the residential consumption data between 2000 and 2005, with a significant decrease in 2005 from a historical 80% to about 50% residential use. This accounts for the lower per capita use in 2005. Since there are inconsistencies in the data, CEI has used a per capita rate of 75 gpcd for water use projections, which is consistent with EOEA's water consumption projections for build out scenarios.

Seasonal Water Use

Seasonal water use was evaluated as a summer to winter demand ratio. Summer use was based on the amount of water withdrawals between May and September, while winter use was based on water withdrawals between November and March. Table 5-6 summarizes the seasonal withdrawals and summer to winter ratio.

Table 5-6 Seasonal Withdrawals (gallons)

	2003	2004	2005
Summer Withdrawals (May-Sept)	117,642,000	122,127,000	126,172,000
Winter Withdrawals (Nov-Mar)	90,514,400	97,164,000	91,985,000
Summer : Winter Ratio	1.30	1.26	1.37

DEP uses the summer to winter demand ratio as a default means to control outdoor watering, allowing water suppliers to choose between default water use restrictions based on the summer to winter demand ratio, or water restrictions based on monitored streamflows in a nearby stream. Water suppliers with ratios greater than 1.2 must impose stricter restrictions than those with ratios less than 1.2 (two days of watering per week versus one day a week). However, the summer to winter demand ratio applies specifically to high stressed basin, therefore would not come into play in Lancaster, although restrictions on outdoor water use will still be required.

Unaccounted for Water

Unaccounted for water in the Town has historically been around 20%. However, 2005 was the first year Lancaster estimated unmetered water uses such as flushing and fire flows. With these adjustments, unaccounted for water has decreased to 17%. DEP requires 10% unaccounted for water in medium and high stressed basins for systems regulated under the Water Management Act. The historical percent unaccounted for water is provided in Table 5-4.

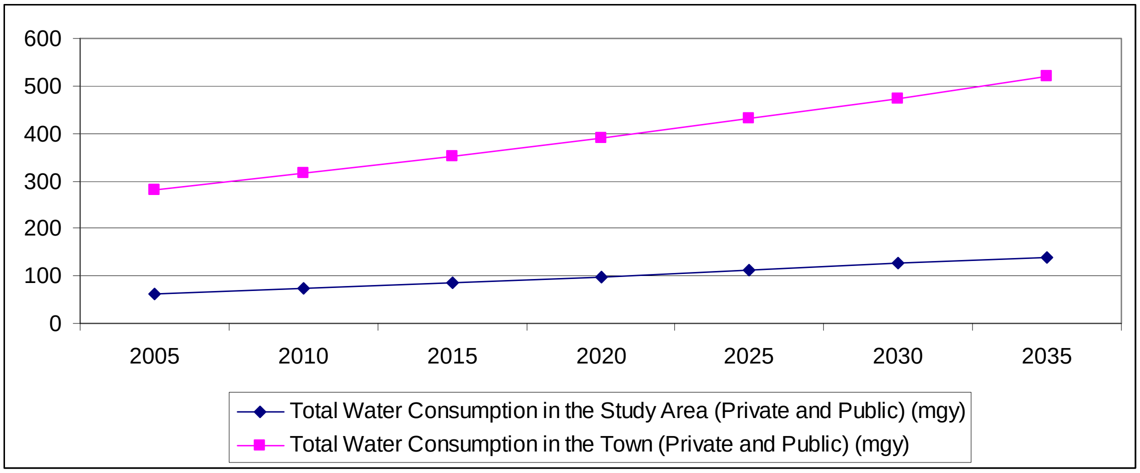
5.2 Future Water Demand

The population projections prepared under Section 2 were used to estimate future water demands for the 30-year planning period. The 1.03% growth rate used to estimate population projections was also used to estimate when buildout would occur on a population basis. The estimated additional water consumption was divided by the estimated additional population at buildout to determine a per capita consumption rate that accounted for all water consumption (i.e., residential, commercial, industrial, municipal) within the Town. This per capita rate was applied to the residential growth projections to estimate total water consumption during the 30-year planning period. The results of this analysis are provided in Table 5-7 and Figure 5-4.

Table 5-7 Projected Water Consumption

	Total Water Consumption in the Study Area (Private and Public) (mgy)	**Total Water Consumption in the Town (Private and Public) (mgy)**
2005	63	282
2010	74	317
2015	86	353
2020	99	391
2025	112	432
2030	126	474
2035	140	519

Figure 5-4 Projected Water Consumption



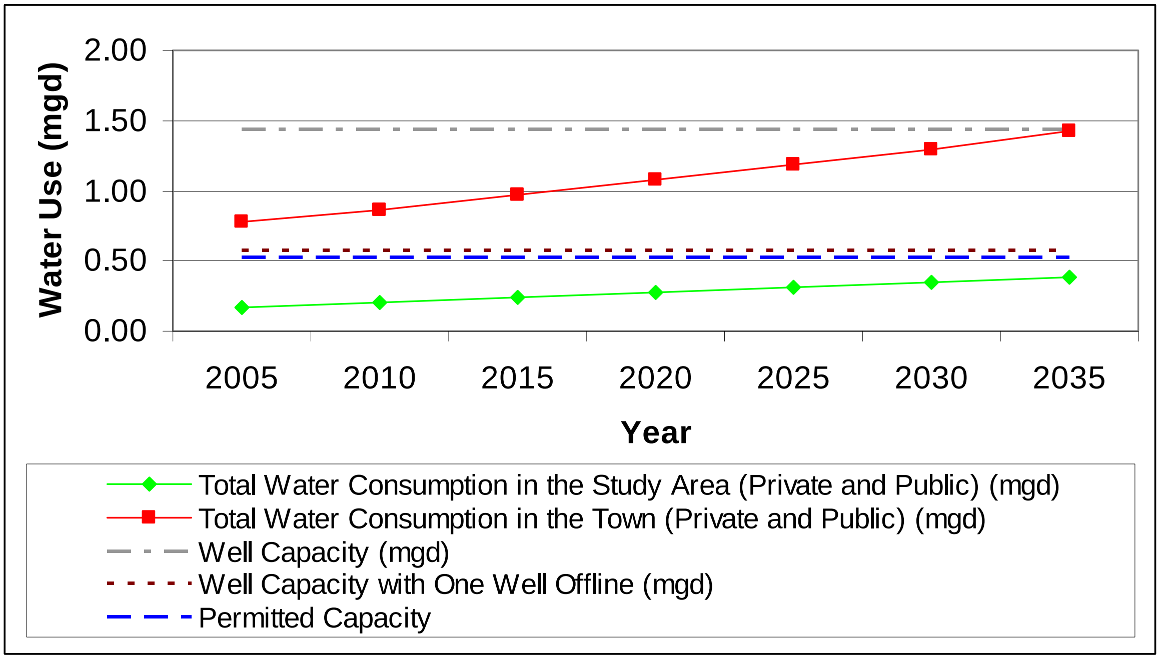
5.3 Water Needs

A comparison of the water use projections to the water supply capacity are included in Table 5-8 and shown in Figure 5-5.

Table 5-8 Comparison of Average Day Water Use Projections to Well Capacity

	Total Water Consumption in the Study Area (Private and Public) (mgd)	Total Water Consumption in the Town (Private and Public) (mgd)	Total Water Consumption in the Town at Buildout (mgd)	Well Capacity (mgd)	Well Capacity with One Well Offline (mgd)	Permitted Capacity
2005	0.17	0.77		1.44	0.57	0.53
2010	0.20	0.87		1.44	0.57	0.53
2015	0.24	0.97		1.44	0.57	0.53
2020	0.27	1.07		1.44	0.57	0.53
2025	0.31	1.18		1.44	0.57	0.53
2030	0.34	1.30		1.44	0.57	0.53
2035	0.38	1.42		1.44	0.57	0.53
Buildout			3.71	1.44	0.57	0.53

Figure 5-5 Comparison of Average Day Water Use Projections to Well Capacity



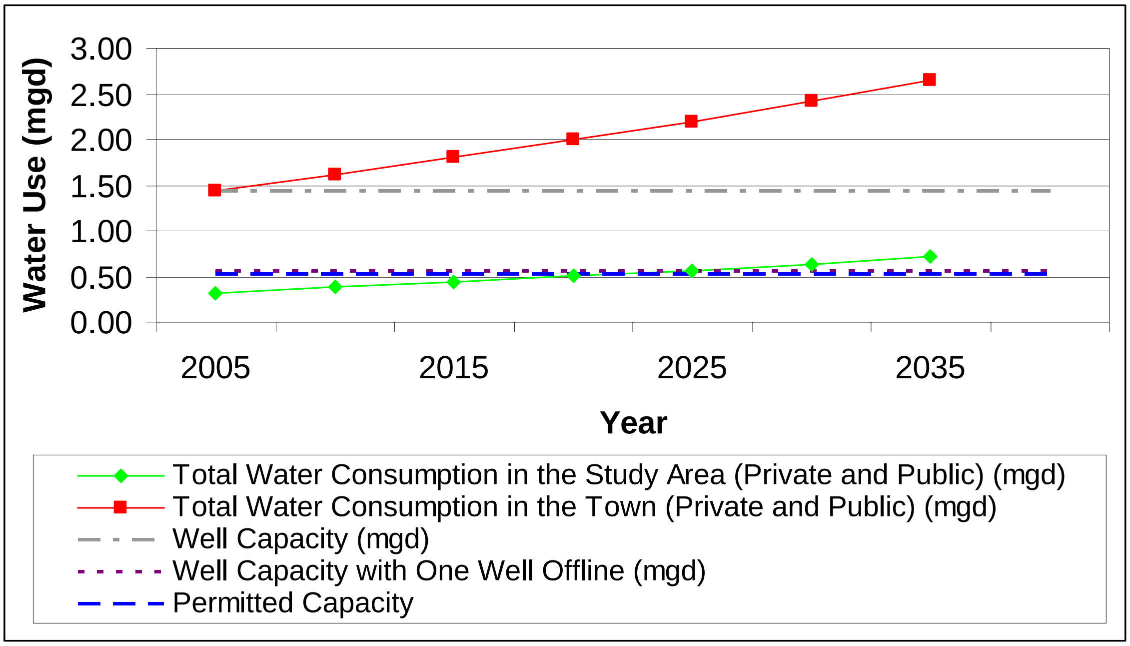
Currently, the water supply distribution system runs throughout the southern portion of Town, but there is very little within the study area. The water projections in Table 5-7 and Figure 5-4 include the total projected water use, whether on public or private water supply. Projections were performed this way to provide a more accurate water balance for the entire area. Therefore, the buildout figures do not match the EOEA estimated buildout water demand of 2.84 mgd, which is based on an existing use of 0.55 mgd (existing use is actually closer to 0.70 mgd) and additional use at buildout of 2.29 mgd. There are currently several residents and businesses not on the existing water supply, which account for this difference. CEI used EOEA assumptions to estimate both existing residential and business uses not on the public water supply. While this is fairly accurate for residential use, it only provides a gross estimate for business use, as assumptions were made as to the building size on each developed parcel using EOEA assumptions and then applying EOEA consumption figures. Existing building sizes and water uses may be lower. This was done for planning purposes for the overall water balance and is not reflective of accurate existing uses.

If we assumed that all future development was supplied with Town water supply and no existing sources were tied into the distribution system, then roughly 3 mgd could be expected to come from Town supplies at buildout. However, this would require substantial investment in the expansion of the water supply piping infrastructure, which may make such assumptions infeasible.

Projected town-wide demands, whether they are supplied by the Town or not, are compared to the existing water supply capacity to determine if there is enough supply to meet the 30 year projections. The data shows that there is enough supply to meet 2035 average day projections, however, it does not allow for any factor of safety (i.e., if one of the wells became unusable for any reason).

Additional supply would also be needed to meet maximum day demands as shown in Figure 5-6.

Figure 5-6 Comparison of Maximum Day Water Use Projections to Well Capacity



However, these figures assume that all new growth would be on public water supply, which is not likely to be the case. There are several residents already on private wells within the study area.

5.4 Potential Future Sources

Investigations in the mid 1980s identified a potential public water supply site off of North Main Street, on the southern side of the Nashua River near the Leominster town line. A well had been proposed at this location to provide water to a proposed large office campus proposed by the Digital Equipment Corporation in north Lancaster. The development fell through and the Town did not proceed with the acquisition of the site.

In 2005, the Department of Public Works initiated a groundwater exploration program and revisited the North Main Street site. The original test well was still in place. The well was pumped and the groundwater was tested. The water quality had degraded from the original test results in the 1980s. Specifically, sodium, magnesium and chlorides had increased significantly since the original test. These constituents are associated with highway deicing products and were the result of the construction and use of Interstate 190 to the west of the site in the 1980s.

Other areas were evaluated during the 2005 exploration and two sites showed promise as future water supply wells. The first, located off Pine Hill Road is located at the intersection of the Bolton, Lancaster and Harvard town lines along the Nashua River. The test well site was about three miles from the existing water distribution system.

The second site is located off Bolton Road near Forbush Mill Road and the intersection of the Nashua River and Still River. This site is close to the existing municipal water distribution system. This site was chosen for further investigation and permitting. The Board of Public Works is currently in the process of preparing a Site Examination Report and Pump Test Proposal for submittal to the Department of Environmental Protection. The site is anticipated to produce one million gallons per day of drinking water.

5.5 Outside Sources of Water

Outside sources of water supply were also evaluated to determine the potential for supplying future residents and businesses, particularly in the northern areas of Lancaster, where it could be expensive and difficult to expand the existing water supply infrastructure to bring supply to this area.

Town of Ayer

Nearly all Ayer's homes and businesses are connected to the municipal water system. Ayer's public water source is from two gravel-packed wells at Grove Pond (built in 1943 and 1952) and 2 wells at Spectacle Pond. The Spectacle Pond wells have a combined capacity of about 2.2 million gallons per day (mgd), and the Grove Pond wells yield 1.5-2.2 mgd, for a total capacity of about 4.3 mgd. In addition to the four wells, the DPW Water Division manages a distribution system that includes two water filtration plants and three storage tanks located at the Washington Street school complex with a combined capacity of 2.9 million gallons. The town is considering drilling a third well at Grove Pond between 2010 and 2015[1].

Town of Bolton

There is no public water system in Bolton. All properties are on private wells[2].

Town of Clinton

Water from the Wachusett reservoir, MWRA's water supply, is treated by the Town of Clinton. The Town uses about 700 MG of water annually. There is currently an interconnection with Lancaster through Sterling Street. Clinton provides a portion of Sterling Street with water. These customers are billed directly. Since the MWRA provides Clinton with its water, Lancaster would be required to pay MWRA and Clinton for additional water supply. However, Clinton would consider providing Lancaster with additional supply[3].

[1] Community Opportunities Group, Inc and BSC Group. Town of Ayer Comprehensive Plan Update. March 2005.
[2] Harold E. Brown, Public Works Director, Bolton DPW (personal communication, August 2, 2006)
[3] Christopher McGowen, Public Works Director, Clinton DPW (personal communication, January 4, 2007)

Devens

Devens currently supplies water to the Devens community and supplements the Shirley MCI supply. Total normal system demands are about 0.3 mgd. The source capacity is about 4.75 mgd. MCI Shirley has contracted for a reserve capacity of 400,000 gpd to meet their needs. At present, service to MCI-Shirley is for fire protection and back-up support; however, MCI Shirley has indicated that in the future this could include the entire daily demand but no final plans have been made on this transition.

Water supply pipes at Devens do not extend to Route 2. If the Devens community were to provide supplemental water supply to North Lancaster, the cost for extending the water main would need to be considered as well as any internal upgrades at Devens needed to accommodate the desired flow.[4].

Town of Harvard

The Town of Harvard is supplied by two wells, Well #2 and Well #5. The Town is currently permitted 43,000 gpd from Well #2 and 23,000 gpd from Well #5. The Town's current water use is approximately 20,000 gpd. They are currently working on new water supplies in the area. The Town's closest main to Lancaster is a 12" main approximately 6-7 miles away. The use of Harvard's water supply by Lancaster would be at the discretion of the Water Commission.[5]

City of Leominster

The City of Leominster is supplied by eight reservoirs and three groundwater wells. The eight reservoirs are located in three systems, the Fall Brook Reservoir, the Notown Reservoir System and the Distributing Reservoir System. The supply yields about 4 mgd, with an average daily use of 3 to 3.5 mgd. Leominster is currently working with DEP to discuss updating their permitted use. The City found two wells that could be used for a source of supply but the state turned it down due to lack of need. Lancaster currently has an interconnection with Leominster on Sterling Street. Leominster currently supplies a few customers on Sterling Street in Lancaster with water.[6] Leominster also serves the Johnny Appleseed Visitors Center on Route 2 and the Orchard Hills Athletic Club on Duval Road. The potential for additional supply from Leominster over the long-term is unknown, but current limits on their supply likely limit immediate increases in interconnections.

Town of Lunenburg

The Town of Lunenburg is supplied by 5 gravel-pack wells. This water supply system serves about half of the town. The WMA permit is 510,000 gpd and their typical demand is 460,000 gpd occasionally exceeding the permit limit. The Town was working on a conservation land easement but was voted down and is now in serious need of a new

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[4] D. Bevilacqua, Utilities Manager; M. Cohen; M. Mitchell; J. Moore, Utilities Division Supervisor; Devens Community of Mass Development (personal communication January 9, 2006)
[5] Richard Nota, Public Works Director, Harvard DPW (personal communication, January 23, 2006)
[6] Rick Cormier, John Roseburg, Leominster Water Dept.; Ray Racine, Town Engineer, Leominster DPW (personal communication, January 9, 25 & 30, 2007, respectively)

water supply source. Lunenburg would be willing to sell water to Lancaster if it was available. The nearest water main for possible interconnection ends approximately 9 miles away at Kilburn Street[7].

Shirley Water District

The Shirley Water District obtains its water supply from two gravel packed wells. They currently use an average of about 325,000 gallons per day, with a yield of between 500,000 and 600,000 gpd. The Shirley Water District provides water to a subdivision along Grant Way. This was requested by a developer and as a result, a 750,000 gallon tank was constructed off of Grant Way in Lancaster for that subdivision. Shirley Water District sells water directly to the individual homeowners. As a result of the development, Shirley Water District obtained authority to serve a small district in Lancaster, which is defined by the Shirley Town line, Shirley Road in Lancaster, Route 2 in Lancaster and Fort Pond in Lancaster. The approximate boundaries are shown on Figure 5-7. The Shirley Water District is open to serving more of Lancaster. They have had some discussions with Rockport to provide them water. Rockport is already located within the approved district.[8]

Town of Sterling

The Town of Sterling obtains its water supply through three gravel-packed wells in the western part of the town. They are currently in the process of installing three additional wells in southern Sterling that will replace an existing well. The Town uses an average of 0.58 mgd. Sterling has a registered withdrawal volume of 0.40 mgd and a permitted withdrawal volume of 0.20 mgd, for a combined approved withdrawal of 0.60 mgd. They have a master plan that includes projected use over the next 20-30 years which states that the need for new sources in that time is non-existent due to adequate supply. About 65% to 70% of the town is served by the public water supply system. In the past, the town has refused to sell water to developments in other municipalities and would most likely not be interested in selling water to Lancaster[9].

5.6 Distribution System

Infrastructure

Lancaster's water distribution system consists of 35 miles of water main pipes, ranging in diameter from two inches to 30 inches (interconnection piping). Some pipes in the system date back to 1890. Pipe material primarily consists of cast iron pipe, followed by ductile iron pipe. There is also some 2" copper L-type pipe throughout the distribution system.

The distribution system is fed from the two water supply wells located off of Bolton Road. There are two storage tanks located off of Windsor Road; a one million gallon tank

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[7] Frank McNamara, Lunenburg Water Dept. (personal communication January 3, 2007)
[8] Brian Goodman, Shirley Water District (personal communication November 1, 2006)
[9] Lou Manring, Public Works Superintendent; Mark Semenuk, Sterling DPW (personal communication January 18, 2007 and February 21, 2007, respectively).

and a two million gallon tank, referred to as the George Hill Tanks. Combined, the two storage tanks can store up to 3 million gallons of drinking water. The tanks are each 40 feet tall and the operating range is between 35 and 40 feet of water in the tanks. The overflow is at elevation 556 feet. The extent of Lancaster's water supply system is shown in Figure 5-8.

Haley and Ward developed a computer based hydraulic model of the distribution system as part of its 2002 update to the original 1989 Water System Master Plan. The model was used to evaluate improvements to the distribution system to improve fire flows and system pressures.

Lead Service Lines

There are between 900 and 1000 lead goosenecks located throughout town.

Cross Connection Control Program

The Town of Lancaster has a Cross Connection Ordinance that requires all commercial, industrial and institutional users of the public water supply to install and maintain an approved backflow prevention device for "building containment". It also allows the Water Commission to survey premises and require approved backflow prevention devices where needed. The Commission reserves the right to discontinue water service to the premises until such device has been installed.

The Lancaster Water Department contracts with Water Service Associates to perform the cross connection control program. All cross connection devices are tested three times a year, once by the owner and twice by the Water Department, all at the owner's expense.

Meter Testing

The town has 1700 metered accounts. Some meters are 30 years old. Customer meters are only tested if there is a complaint by the customer. The Town supplies all meters up to 1" in size. Larger meters are supplied by the owner.

Meters are read quarterly with a handheld device and the readings are downloaded into the system. A new billing system was put into place in September 2004. There are 28 meter reading routes. The town is in the process of changing to radio read. A few hundred meters were replaced and adapted for radio read within the last year.

Master meters use venturi flow tubes to measure flows pumped from the wells. These are calibrated annually by comparing metered flows at the well to flows through a nearby hydrant.

Historic Leak Detection

Lancaster hires a contractor to perform leak detection every few years or when an increase in usage is noted. Leak detection surveys were completed in 2000 and 2003.

5.7 Emergency Procedures

Emergency Response Plan

The Department of Public Works has a Water System Emergency Response Plan dated December 23, 2004. The plan differentiates emergency situations into five levels based on the level of disruption to the water system. These include:

Level I – Routine Problems
Level II – Alert/Minor Emergencies
Level III – Major Emergencies
Level IV – Natural Disasters
Level V – Nuclear Disasters/Terrorist Acts

The procedure for notifying the public of emergency declarations or boil orders is to use the local/regional media. Lancaster would keep the public informed about new developments through "special reports and public service news".

Interconnections

There are two interconnections with surrounding communities: 1) a 30 inch main on Sterling Street serves as an interconnection with the City of Leominster; and 2) a 16" main on Sterling Street serves as an interconnection with the town of Clinton. These interconnections are controlled by valves located at the intersection of Sterling Street and Redstone Hill Road, which would allow supply from these other Towns into the Lancaster distribution system. Currently, Sterling Street from the Clinton town line to the Redstone Hill Road intersection is supplied by Clinton. Sterling Street from the Sterling town line to the Redstone Hill Road is supplied by Leominster (3 customers).

5.8 Water Conservation

Water conservation is one method to help manage water withdrawals. There are many water conservation techniques a water supplier can implement. Following are some of the techniques Lancaster uses.

1. <u>Outdoor Water Use Bylaw</u> – To help manage water withdrawals, the Town of Lancaster recently adopted an Outdoor Water Use Bylaw to restrict or prohibit water use as necessary to protect the Town's water supply. Restrictions include limiting outdoor watering to daily periods and particular days of the weeks, while prohibited water uses include filling swimming pools and use of automatic irrigation sprinklers.

2. <u>Increasing Block Rate Structure</u> **–** Lancaster uses an increasing block rate structure to bill water customers. Water consumption is broken into four quarterly usage blocks including 0-1,000 cubic feet, 1,100-3,500 cubic feet, 3,600-10,000 cubic feet and over 10,000 cubic feet.

5.9 Summary of Needs

Based on the above assessment, CEI recommends the following actions by Lancaster:

1. **Develop a Conservation Plan –** Per capita water use within the Town has fluctuated between 66 and 91 gpcd. Although Lancaster currently implements some water conservation techniques, there are many more that can be used to help manage withdrawals. Upon issuing a permit for increased withdrawals in the existing supply, DEP will require that Lancaster meet a per capita use of 65 gpcd through the development and implementation of a compliance plan. The compliance plan will focus on conservation measures to reduce the per capita consumption, such as:

   - A program that provides water saving devices such as faucet aerators and low flow shower heads at cost;
   - A program that provides rebates or other incentives for the purchase of low water use appliances;
   - The adoption and enforcement of an ordinance, bylaw or regulation to require moisture sensors or similar climate related control technology on all automatic irrigation systems;
   - The adoption and enforcement of an ordinance, bylaw or regulation to require that all new construction include water saving devices and low water use appliances;
   - The adoption and enforcement of an ordinance, bylaw or regulation to require that sites for new construction minimize lawn area and/or irrigated lawn area, maximize the use of drought resistant landscaping, and maximize the use of top soil with a high water retention rate;
   - The implementation of a program to encourage the use of cisterns or rain barrels for outside watering; and

   CEI recommends that Lancaster develop a conservation plan that considers these items. The plan should be written to meet DEP's requirements for a Compliance Plan.

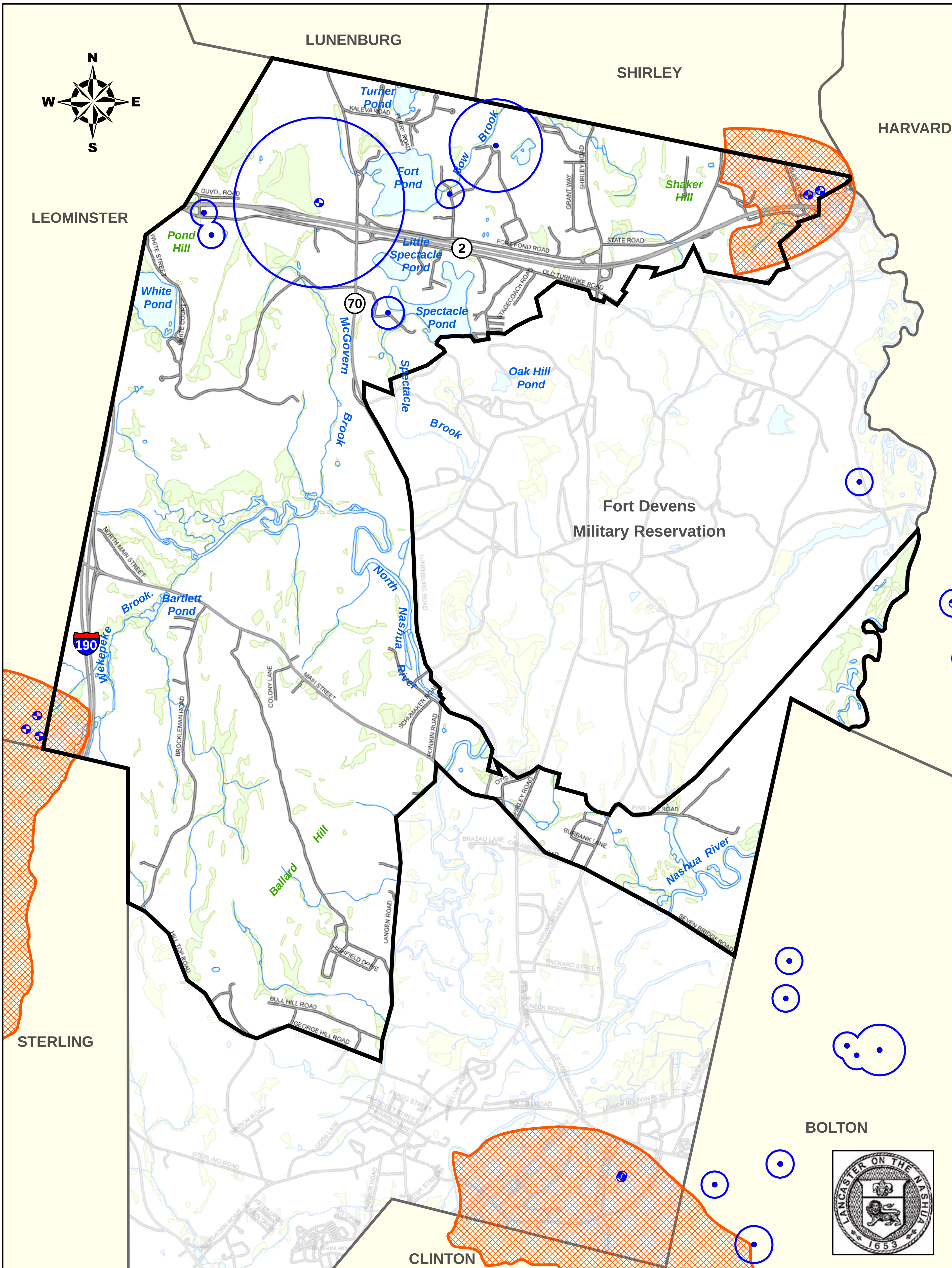
2. **Perform a Comprehensive Water Audit –** Although Lancaster has reduced its unaccounted for water down to 17% over the last few years, further reductions are necessary. DEP will be requiring Lancaster to develop and implement a plan to reach 10% unaccounted for water. This should begin with the development of a comprehensive water audit to evaluate how unaccounted for water is calculated and to make any necessary adjustments. For example, using actual calendar consumption, rather than billed water uses per calendar year, adjusting for master meter calibration and accounting for unmetered uses. This will provide the Town with a good baseline on which to direct future efforts such as meter testing and leak detection.

3. **Provide System Redundancy –** Currently, the Town relies on two wells with a combined capacity of 1.44 mgd to supply residents and businesses within Lancaster. These wells are typically pumped on an alternating cycle except for emergency situations. If the larger of the two well pumps were out of service, the other well would still have the capacity to supply 1.37 mgd[10]. Thus, there would be little impact on system capacity. However, the wells are located next to each other within the same aquifer, leaving the system susceptible to complete loss of supply in the event of contamination. Additional supplies should be sought in other areas of Town to provide redundancy to the system.

4. **Acquire Land for Future Tank Siting –** The Water Distribution System Master Plan Update and Capital Improvement Plan prepared by Haley and Ward in 2002 discussed storage requirements based on existing conditions to be 1.6 million gallons, which is adequately met by the two storage tanks with a combined capacity of 3 million gallons. Although the existing tanks are adequate for existing water needs, there was no evaluation of future storage needs based on projected growth. Obviously, the best location to site tanks is on a hill to obtain the necessary elevations to maintain an adequate pressure in the system at minimal expense. Lancaster should acquire high elevation land for future tank siting.

5. **Add Customer Types to Billing System –** Water consumption by user class within Lancaster is currently estimated. The current billing system does not differentiate the type of customer served (i.e., residential, commercial, institutional, municipal), which makes it difficult to assess the per capita consumption rate. There have been significant discrepancies in this data in the past, but there is no easy way to check since the billing system does not classify users. User codes should be added to the billing system to allow for easy access and accounting of water use by user class.

[10] Haley and Ward, Inc. Letter to the Lancaster Board of Public Works dated June 22, 2005 regarding New Service Capacity.



LEGEND

Public Water Supply

- Community Source
- Non-Community Source
- ZONE II - Recharge Area
- Interim Wellhead Protection Area (IWPA)

- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

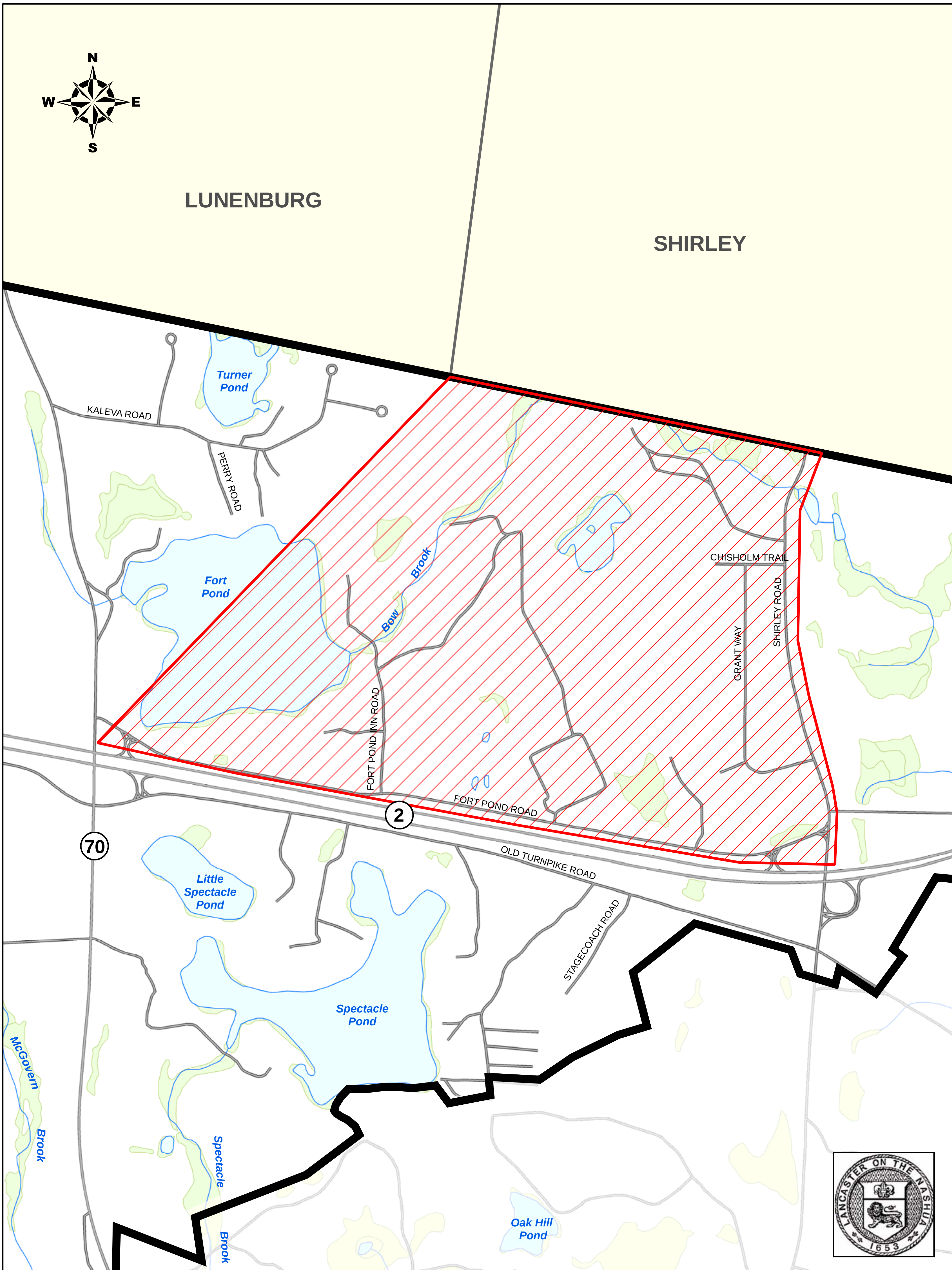
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 5-1

Water Supply Zone II

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Shirley Water District

IWRM Study Area

Hydrography

Lake, Pond

DEP wetlands

Stream, Brook

Data Sources: Town of Lancaster, Town of Shirley, MassGIS, MADEP

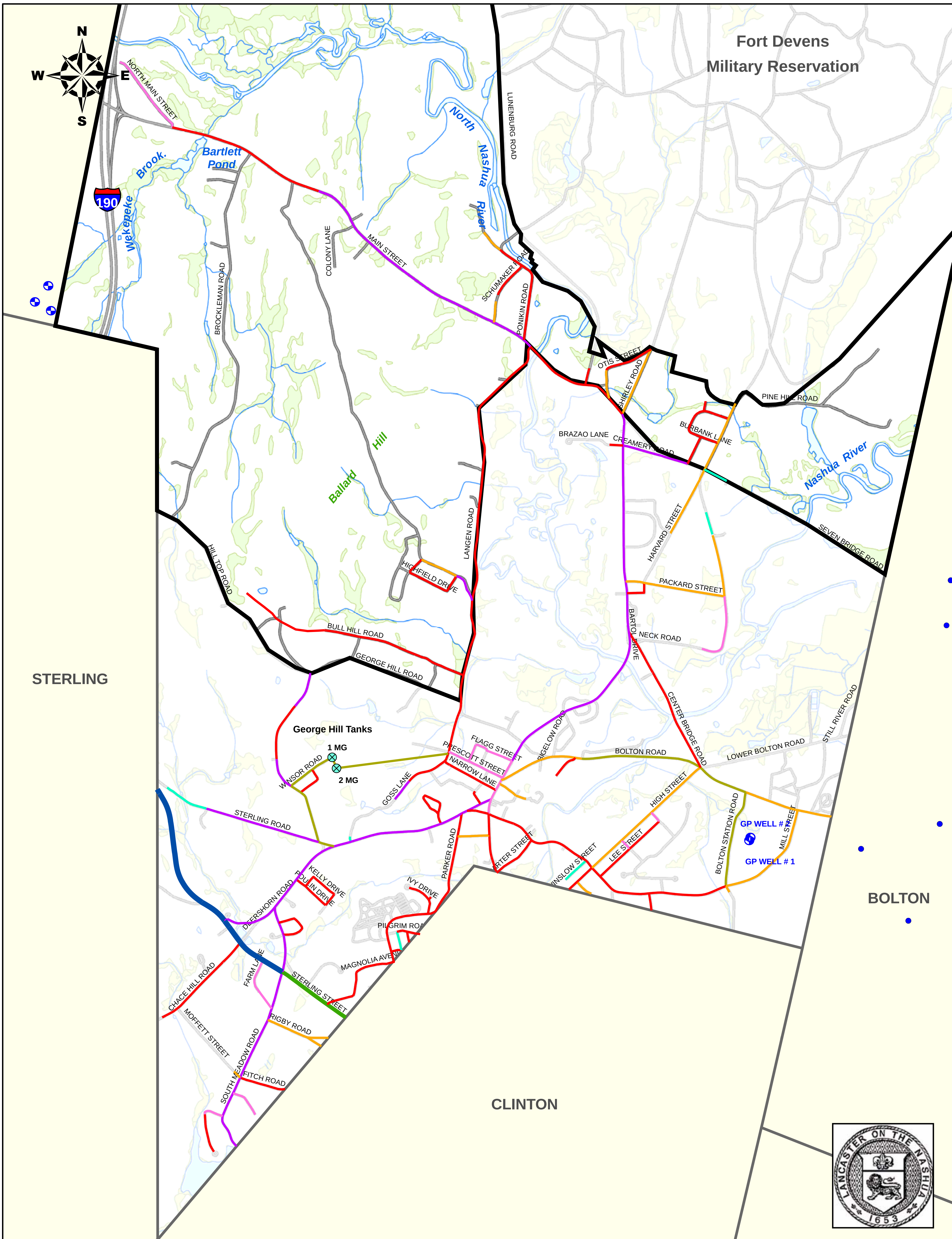
0 1,000 2,000 3,000 Feet

Figure 5-7

Shirley Water District within Lancaster

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Water Supply Tank

Public Water Supply

- Community Source
- Non-Community Source
- IWRM Study Area

Water Supply Pipes

- 2"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16" (Town of Clinton)
- 30" (City of Leominster)

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 5-8

Water Supply System

Lancaster, MA

Comprehensive Environmental Inc.

6.0 Stormwater Needs Assessment

Water is quickly becoming scarcer in the Northeast, largely due to the interruption of the hydrologic cycle caused by new development. As asphalt and other impervious surfaces increase, and other soils are compacted by human activity, our generous 40+ inches of rainfall no longer seems able to provide us with all the water we need for human use, irrigation and water resources such as fishable/swimmable water bodies and clear running streams. The increased imperviousness, even from lawns, creates more runoff and interferes with recharge. In addition, many of the land uses are not vegetated, so the large evapotranspiration component of natural woods is replaced by a large amount of "new" runoff.

For each acre of land, the natural rainfall is roughly 1 million gallons per year. Of this 1 mg, about half is evapotranspiration and about half (in an A or B soil) is recharge. So the same acre developed still receives 1 mg of rainfall, but it may ALL be runoff even where none existed before. This new runoff causes flooding damage to infrastructure, private property and natural habitats. The increased stormwater runoff also contributes high concentrations of pollutants and higher temperature water from its passage over hot asphalt and other surfaces. These pollutants, including increased temperature, can dramatically affect aquatic life. Channel erosion and sedimentation is another common problem, with increased runoff velocities and volumes occurring on a more frequent basis. All of these factors have detrimental effects on aquatic habitat.

Due to the detrimental effects increased runoff from development incur, it is important to consider stormwater runoff implications in any planning scenario that looks at population and development growth. The NPDES Phase II Stormwater Permit Requirements address this to some extent, however, they only apply to some communities and even so, technically only to urbanized areas. The Town of Lancaster is subject to the NPDES Phase II requirements and is currently in the process of implementing their Phase II Stormwater Management Plan. This section discusses the status of their Phase II compliance, along with known stormwater issues within town and outlines additional actions that need to be taken to improve the handling and control of stormwater.

6.1 Existing Stormwater Management System

Description of System

The existing Town municipal storm sewer system (MS4) lies primarily outside of this project's study area to the South. There is some stormwater infrastructure located in the study area near Route 117 and further north near Route 2, but for the most part the stormwater runs off as sheet flow into adjacent undeveloped land. The Town is working on documenting the stormwater outfalls, which will include incorporation of the outfall locations into GIS.

Flooding Issues

There are several wetlands and waterways within Lancaster as discussed under Section 2. Flooding within Lancaster is associated with the Nashua River, which often floods its banks. Flooding of the Nashua and North Nashua River has caused problems on Lunenberg Road, Route 70, Route 117, Center Bridge Road, Bolton Road and in some fields near Bolton. The flooding has been noted to come up about 1000 feet from its banks and is most prominent in the Spring. The Town experiences flooding in these areas every couple of years.[1]

Typical Developments BMPs

Currently, Lancaster only requires the control of peak stormwater flows as a condition of its subdivision regulations. There are no requirements for control of water quality or to recharge. As such, existing stormwater controls within the Town consist primarily of detention basins. There are also some vegetated swales throughout Town. The Town takes ownership of structures on Town owned roads. Private entities maintain ownership of their structures.

Water Quality Issues

Some water quality issues have been reported at Spectacle Pond. Milky water laden with sediment was reported to enter the pond during rain events. Both DEP and the Lancaster Conservation Commission investigated the reports and were unable to find a problem.

MassDEP also has a list of impaired waters, the 303d list, throughout the state. Those waters listed as impaired in Lancaster, along with the type of impairment are included in Table 6-1.

Existing or Planned Total Maximum Daily Loads (TMDLs)

A draft TMDL has been prepared for the Nashua River Watershed to address pathogens. TMDLs are anticipated for each of the pollutants listed for the Category 5 waters.

[1] Jack Sonia, Lancaster DPW Director (personal communication September 19, 2006)

Table 6-1 Lancaster 303d List				
Name	**Segment ID**	**Size**	**Category***	**Pollutant**
Nashua River (8143575)	MA81-09_2004	1.7 miles	5	-Cause Unknown -Nutrients -Pathogens -(Objectionable deposits**)
North Nashua River (8144650)	MA81-04_2004	10.4 miles	5	-Cause Unknown -Pathogens -Taste, odor and color -Turbidity
Fort Pond (81046)	MA81046_2004	76.1 acres	5	-Nutrients
Nashua River (8143500)	MA81-05_2004	14.2 miles	5	-Cause Unknown -Unknown Toxicity -Metals -Nutrients -Pathogens -Taste, odor and color -Turbidity
Spectacle Pond (81132)	MA81132_2004	61.0 acres	2	Uses Attained: -Secondary Contact -Aesthetics
Still River (8144625)	MA81-15_2004	3.2 miles	3	-N/A
White Pond (81155)	MA81155_2004	47.2 acres	4c	Impairment Cause: -(Exotic species**)

*Category Descriptions: Category 5 “Waters requiring a TMDL”; Category 2 “Attaining Some Uses; other Uses Not Assessed”; Category 3 “No Uses Assessed”; Category 4c “Impairment not Caused by a Pollutant”
**Non-Pollutant Impairment

Phase II Compliance

Summary of Phase II Requirements

Phase II compliance focuses around meeting six minimum measures outlined by EPA. These include:

1. *Public Education & Outreach* – The first of six Phase II control measures requires regulated operators of MS4s to implement a public education program to distribute educational materials or otherwise communicate to the community about the impacts of stormwater discharges on local water bodies and steps the community can take to reduce stormwater pollution.

2. *Public Participation/Involvement* – Phase II requires regulated towns to obtain public participation throughout the stormwater management program, beginning before submittal of the NOI and engaging all economic and ethnic groups.

3. *Illicit Discharge Detection & Elimination* – Under Phase II, Phase II towns must develop and implement an illicit discharge detection and elimination program to find and eliminate inappropriate discharges to the storm drain system. This requires the Town to map existing stormwater outfalls and receiving waters, to evaluate the outfalls for illicit discharges, and to address identified illicit

discharges. The Town must also develop a regulation to prohibit illicit discharges to the storm drain system and educate the public about illicit discharges.

4. *Construction Site Stormwater Runoff Control* – Phase II towns are required to implement and enforce a program to reduce pollutants in stormwater runoff to the MS4 from construction activities that disturb one or more acres. This requires the development of a local regulation related to the implementation of proper erosion and sediment controls, and controls for other wastes, on regulated construction sites. Towns are also responsible for inspecting and enforcing the controls required by the regulation.

5. *Post-Construction Stormwater Management in New Development/Redevelopment* – Similar to the "Construction Site Stormwater Runoff Control" measure of Phase II, towns are required to develop and enforce a regulation that requires the implementation of post-construction runoff controls at sites where construction activities disturb one or more acres. The controls to be implemented must be designed to treat stormwater runoff from sites after they are developed.

   Another large component of this requirement is that municipalities are now required to ensure the long-term operation and maintenance of stormwater runoff controls on all municipal properties. This also requires that they address poor water quality entering their system from private properties.

6. *Pollution Prevention/Good Housekeeping* – Municipal operations have the potential to contribute pollutants to stormwater runoff if staff are not properly educated and trained in pollution prevention and good housekeeping practices. Under Phase II, towns must take a thorough look at their existing municipal operations and train staff to incorporate pollution prevention/ good housekeeping practices into operations. This involves a review of operations at specific facilities (i.e., highway garages, parks), as well as operations that may occur throughout town (i.e., catch basin cleaning and street sweeping).

In addition to the six minimum measures identified above, Phase II Towns need to implement BMPs to meet TMDLs for waters within the Town. In many cases, many of the measures outlined to meet the six minimum measures also meet recommendations provided in TMDL plans. However, some additional measures beyond the six minimum measures may be required.

Phase II Compliance

Lancaster filed form BRP WM 08A NPDES Stormwater General Permit Notice of Intent for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) to outline their plan for complying with the Phase II requirements. Lancaster began aggressively implementing their plan in 2007. Table 6-2 summarizes what the Town has completed and what remains to be completed under the Phase II program.

Table 6-2 Phase II Activities		
	Completed	**To Be Completed**
General Permit Review		Prepare letters to the Natural Heritage and Endangered Species Program and MA Historical Commission to determine if stormwater in Lancaster is impacting endangered species and historic sites.
Public Education & Outreach	1. BMP 1PE – The annual report states a customized brochure was developed for residents and will be mailed in May 2007. Brochures for developers and other applicable businesses were selected for distribution at Town Facilities. 2. BMP 2PE – Educational resources were developed. 3. BMP 3PE – Storm drains in regulated areas have been stenciled. 4. Street sweeping frequency was increased in selected areas. Letters were drafted for residents and businesses identifying a phone number for citizen concerns.	1. BMP 2PE – Distribute education resources through school programs and community events in 2007. Keep documentation of meetings with schools and Town officials, and stormwater related information disseminated to the public through these sources. 2. Incorporate information on illicit discharges into public education materials.
Public Participation & Involvement	1. BMP 1PP – A meeting was held with Nashua River Water Association and their research and monitoring data on the Nashua River was obtained 2. BMP 2PP – SWMP progress and needs information was presented at a public meeting held by the Planning Board and Conservation Commission. *Document minutes, materials presented and list of attendees.* 3. BMP 3PP – A clean up event was conducted in town. 4. BMP 4PP – Identified a call in number for concerns related to Stormwater.	1. BMP 2PP – Issue a press release and hold another public meeting. 2. BMP 3PP – Coordinate annual cleanup day with community groups and schools. This is scheduled for May 2007. Document who is involved (i.e., 30 residents) and what is accomplished (i.e., removed 3 tons of trash from open space areas) for past and future efforts. 3. BMP 4PP – Log calls from residents.
Discharge Detection & Elimination	1. BMP 1ID – Developed a map of stormwater outfalls and drains. 2. BMP 2ID – Performed inspection of selected lines during regulation operations. Researched methods on identifying and elimination illicit discharges. 3. BMP 4ID – Collected oil for recycling. Held a Household Hazardous Waste collection event.	1. BMP 2ID – Continue to perform inspections until all outfalls are evaluated. Evaluate flows for the potential presence of illicit discharges, which is usually accomplished by sampling. All inspections should be documented on log sheets. 2. BMP 3ID – Prepare and adopt an illicit discharge bylaw. 3. BMP 4ID –Advertise Household Hazardous Waste Collection events. Track participation and materials collected. 4. Tie illicit discharge information into public education BMPs.

Construction Site Runoff Control	1. BMP 1CO – Researched guidance on water quality benchmarks. Used existing data from NWRA, rather than sampling. Began looking into an action plan for construction site runoff control. 2. BMP 2CO – Researched guidance on inspection criteria. 3. BMP 5CO – Gathered by-law information from neighboring communities. Drafted bylaws.	1. BMP 2CO – Develop an inspection form for use by Town departments for construction projects and erosion controls. 2. BMP 3CO – Train staff on conducting construction inspections and using the inspection form. 3. BMP 4CO – This BMP call for the collection of water samples and building a program for full compliance. Consider eliminating this BMP and focusing on the inspection forms and ensuring developers are complying with the new bylaw. 4. BMP 5CO – Submit bylaw for town election.
Post Construction Runoff Control	1. BMP 5PC – Drafted bylaws.	1. BMP 1PC/2PC/3PC – Develop performance criteria and/or a BMP manual for new and re-development. Performance criteria could be outlined in the regulations that accompany the new bylaw. The MA Stormwater Management Policy could be referred to for BMPs until a specific manual is developed. Incorporate LID techniques that focus on the reduction of imperviousness. 2. BMP 4PC – This BMP calls for sample collection to determine effectiveness of run-off controls. CEI suggests eliminating this BMP. Rather, the Town should incorporate requirements for the developer to evaluate the effectiveness of the BMP, which may or may not involve sampling. 3. BMP 5PC – Prepare and adopt stormwater management bylaw and accompanying regulations.
Pollution Prevention & Good Housekeeping	1. BMP 2GH/3GH – Developed stormwater management training materials. DPW staff attended awareness level training. *Documentation on the content of the training and who attended should be provided.* 2. BMP 4GH – Performed street sweeping and catch basin cleaning in the Spring of 2005. *Provide documentation on the areas maintained and the amount of sediment collected.*	1. BMP 1GH – Evaluate municipal facilities and operations for stormwater impacts and develop and implement recommendations for pollution prevention. Develop standard operating procedures for decreasing the stormwater impact from operations. 2. BMP 2GH/3GH – Train all staff involved with stormwater management. This can be completed in house or through a consultant. Document the materials presented and the staff that attended. 3. BMP 4GH – This could be combined with BMP 1GH to develop standard operating procedures for practices to reduce pollutant loadings. These may include street sweeping and catch basin cleaning. Develop an inspection and maintenance program for town-owned stormwater BMPs. 4. Develop a program for the management of stormwater residuals.

BMPs for Meeting TMDLs	1. BMP 1TM – Met with town boards and committees to gather input to establish evaluation methods.	1. BMP 1TM – Obtain and evaluate existing TMDL reports for water bodies within Lancaster. 2. BMP 2TM – Identify BMPs to meet TMDLs. Many of the Phase II stormwater BMPs often meet the TMDL recommendations. Other BMPs should be assessed after all Phase II BMPs to meet the six minimum measures have been implemented. 3. BMP 3TM – Implement BMPs in identified areas, consistent with established TMDLs in Lancaster. 4. BMP 4TM – Determine effectiveness of efforts to meet TMDLs.

Design Standards
As previously discussed, Lancaster only requires the control of peak stormwater flows as a condition of its subdivision regulations. While this can help with flooding due to very large storms, it does not protect surface waters from increased pollutant loads, channel erosion or increased temperatures. No control of runoff volumes are required, which means more runoff and less recharge. To better control the impacts of development in the study area, Lancaster, with funds provided by the Commonwealth of Massachusetts Riverways Program, undertook a project to develop an environmental overlay district (EOD) that would address water quality and quantity impacts associated with development. The EODs focused on performance standards for both stormwater and wastewater. A summary of the overlays and standards is provided below:

Stormwater Performance Standards (Stormwater Overlay District)

A. Recharge is required for groundwater depths greater than four feet at the following quantities:

Soil Type	Recharge Over Impervious Surface (in)
A	1.25
B	1.00
C	0.65
D	0.10

B. A water quality volume of 1" over the impervious surface must be treated to remove pollutants before being discharged to surface waters. Treatment must occur through either infiltration or an underdrain system that allows the water to cool before being discharged.

C. Post-development peak flows cannot exceed pre-development peak flows for the 1-, 10-, and 25-year storms.

D. 24-hour extended detention of the 1-year, 24-hour storm in most locations.

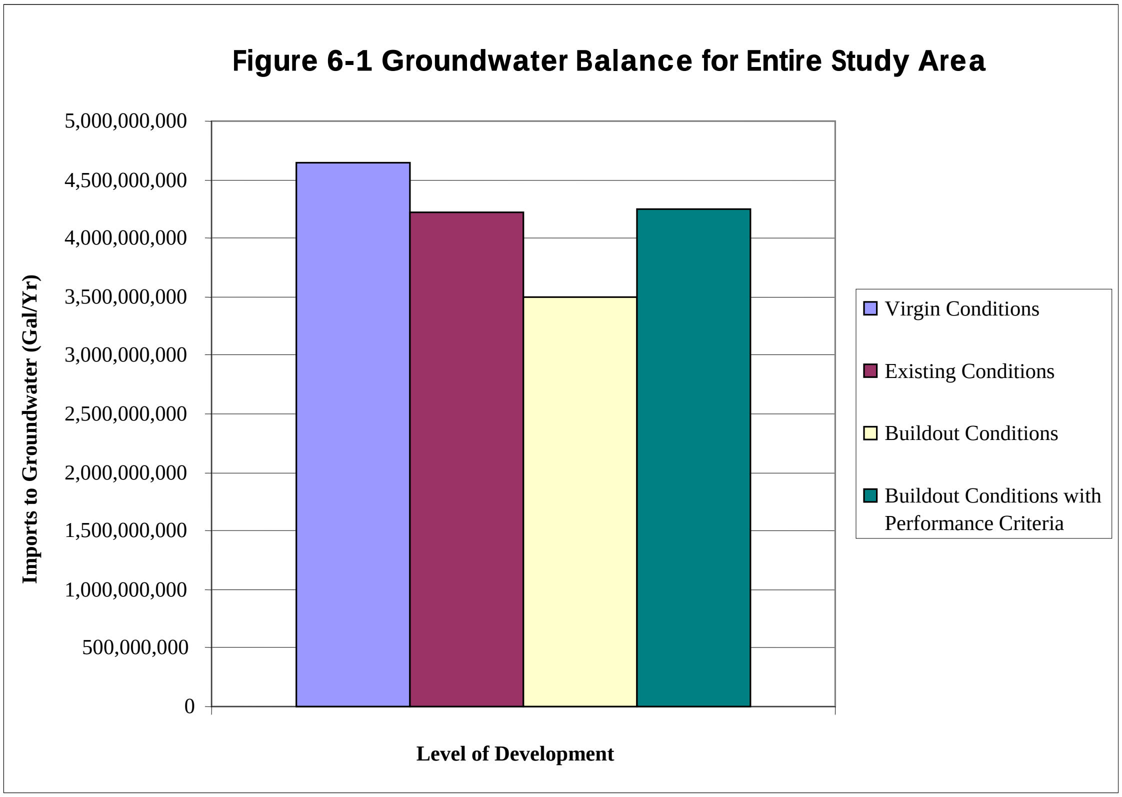
Wastewater Standards
Two overlay districts were proposed:

A. *Fisheries and aquatic habitat overlay district* – defined by any lot containing bordering vegetated wetlands or their 100-foot buffer. Large flow wastewater treatment systems (>1,000 gpd) must meet 10 mg/L nitrate at the property boundary or limit of sensitive resource.

B. *Expanded water resources protection district* – defined by high and medium yield aquifer areas and their zone of contribution. Large flow wastewater treatment systems (>1,000 gpd) must meet 10 mg/L nitrate at the property boundary or limit of sensitive resource and include pathogen treatment.

Medical offices, veterinary hospitals and nursing homes must also include pathogen controls.

The implementation of these design standards provides a significant benefit to the water balance presented in Section 3, since it keeps more water on the site. The results of these applied standards are illustrated in Figure 6-1. As shown in the figure, the use of the design standards maintains the water balance that exists under existing conditions. Lancaster plans on incorporating these standards into its new stormwater management bylaw developed to meet the Phase II requirements.



Summary of Needs

Based on the above assessment, CEI recommends the following actions by Lancaster:

1. Implement the recommendations of the EOD study. This will help prevent additional flooding and water quality problems in the study area.
2. Complete the "To Be Completed" items in Table 6-2 to comply with Phase II regulations. This work will also help with existing water quality problems and help prevent future water quality and quantity problems.
3. Evaluate the cause and develop solutions to address existing flooding areas within Town.
4. Look into redevelopment BMPs that will help increase recharge from existing development, which will help with existing water quality and flooding issues.

5. Look into the implementation of a stormwater utility to collect the necessary funds to adequately maintain existing and future stormwater infrastructure and to implement the Phase II program.

7.0 Wastewater Management Systems

7.1 Regional Wastewater Management

This section evaluates regional wastewater management options for use in the alternatives analysis in Section 8. Figure 7-1 shows the location of adjacent wastewater treatment plants (WWTP) in relation to the project area. Table 7-1 summarizes wastewater treatment and disposal in and around the project area. Important considerations for this project include:

- The southern portion of Lancaster is already sewered, with wastewater sent to the Clinton wastewater treatment facility for treatment since Lancaster has no centralized treatment system of its own.
- As described in this section, the Clinton facility has limited capacity to accept more sewage from Lancaster.
- The North Lancaster project area is relatively rural and town officials do not wish to encourage higher population densities or suburban sprawl by providing sewer throughout the northern portion of the town.
- There is a desire to provide limited sewer for commercial/industrial areas in North Lancaster to encourage economic growth and jobs creation.

As part of a cooperative effort between the City of Leominster, the Town of Lancaster, Mass Highway and the Massachusetts Department of Environmental Protection, there are currently plans for an inter-municipal agreement that will provide for a sewer main to connect the three parcels of the Rte 2 commercial/industrial corridor experiencing septic disposal issues. These properties are Orchard Hills, Roll-On America and the Johnny Appleseed Route 2 Rest Area. The inter-municipal agreement will provide 50,000 gallons per day of flow capacity which can be used by these three properties as well as priority existing residential properties.

Table 7-1 Lancaster and Adjacent Town Wastewater Management Summary

Town	Wastewater Treatment
Town of Ayer	Ayer WWTP and Devens WWTP
Town of Bolton	septic
Town of Clinton	Clinton WWTP
City of Leominster	Leominster WWTP
Town of Lunenburg	Leominster WWTP and Fitchburg WWTP
Town of Shirley	Devens WWTP
Town of Sterling	septic
Town of Lancaster	Clinton WWTP
Lancaster Study Area	septic

Town of Clinton

The Clinton WWTP is located about ¼ mile from Lancaster's southern border at Rte 110 shown in Figure 7-1. The plant was built in 1992 and is operated by the MWRA. The plant provides secondary treatment using an activated sludge process in combination with nutrient removal, chlorination, and dechlorination. The major facilities include headworks, primary settling tanks, trickling filters, aeration tanks, secondary settling tanks, sludge digesters, a sludge press and an off-site dedicated sludge-only landfill.[1] There are changes currently planned for the facility including hypochlorite tanks, a secondary generator, and replacement of the soda ash generator. The plant discharges to the South Branch of the Nashua River.[2]

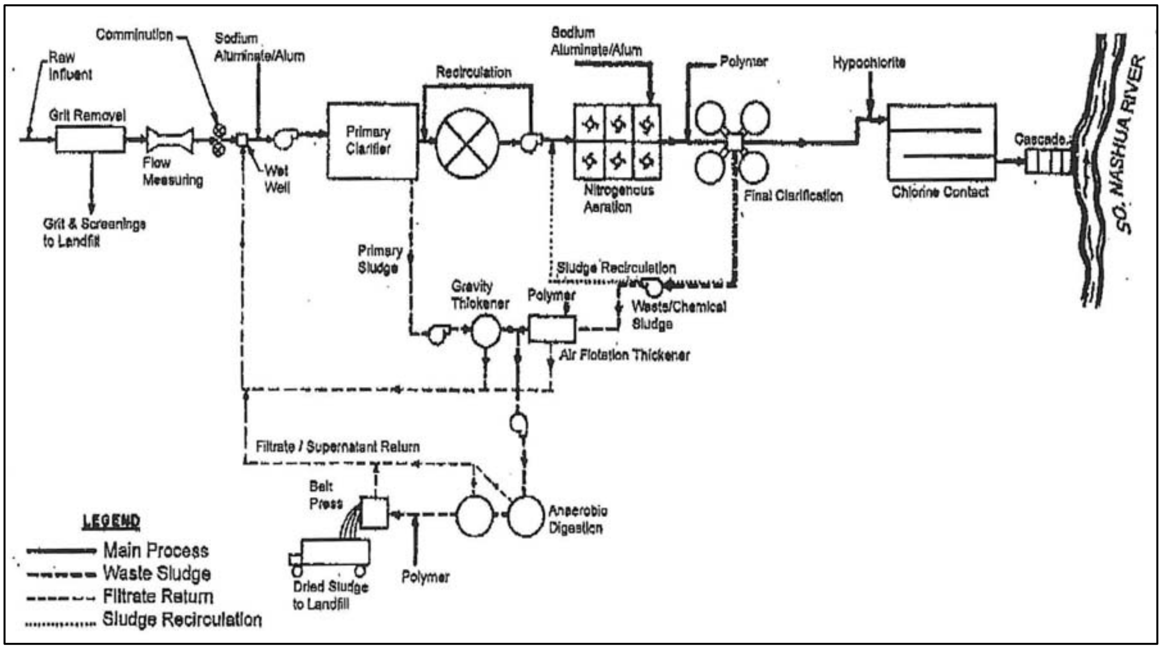


Figure 7-2 Clinton WWTP Treatment Process Diagram
(Adapted from MA DEP WWTP Fact Sheet)

The plant is currently permitted to discharge 3.01 mgd based on a running average of the previous 12 months. Figure 7-2 shows the treatment plant process. Lancaster is allowed to discharge an average of 0.37 mgd. Average wastewater flows from Clinton and Lancaster are about 2.7 mgd and 0.27 mgd respectively. The permitted discharge limit was exceeded for several months in 2005, although high rains in October 2005 contributed to this.

The plant currently has an average day design capacity to handle 4 mgd, which is based on the primary sedimentation tanks, however, it can process higher peak flows. The peak

[1] Massachusetts Water Resources Authority Chlorination System Report: Clinton Treatment Plant (NPDES Permit No. MA0100404, February 26, 2001. Environmental Quality Department Report ENQUAD ms 068.
[2] John Riccio, Clinton WWTP (personal communication, May 5, 2006)

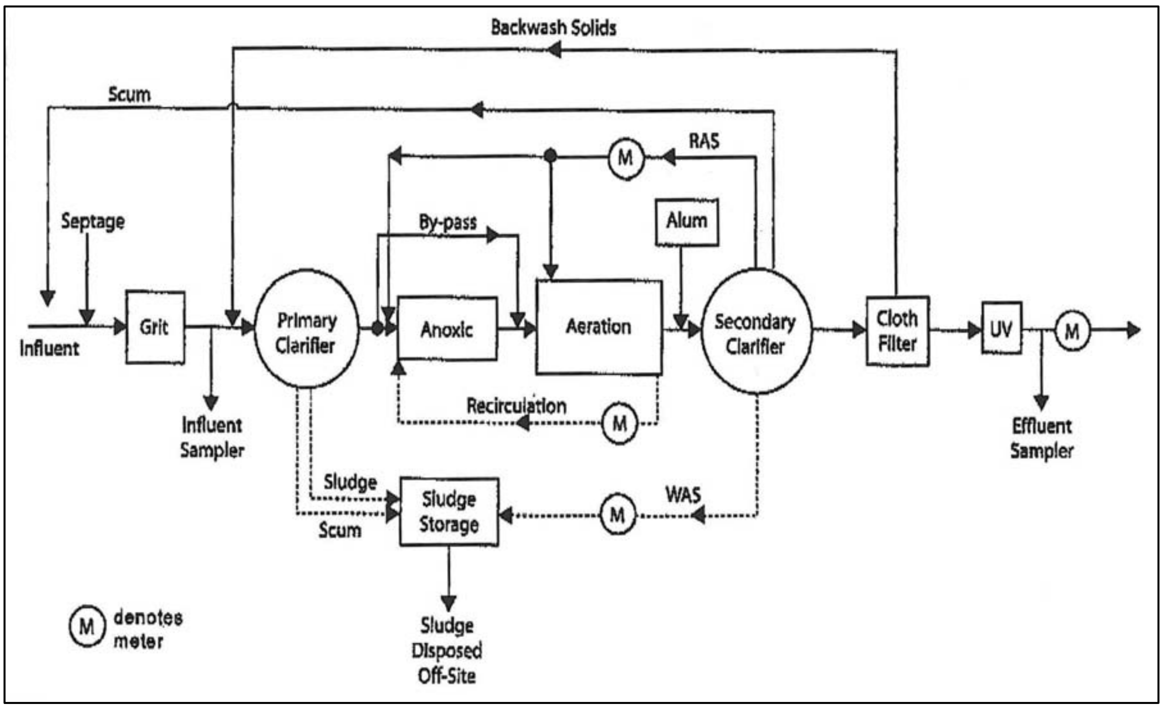
hydraulic flow is 12 mgd. Both Lancaster and Clinton are under an Administrative Consent Order to provide a 2:1 infiltration and inflow (I&I) reduction for new developments to tie into the sewer system.[2] However, houses with failing Title 5 systems can tie in at any time[2].

The southern portion of Lancaster located within the Sewer District has an extensive sewer network that discharges to the Clinton/MWRA treatment plant. Upgrades and extension of this sewer network would be required to serve the study area. Depending on the size of the new area served, an upgrade to the WWTP may also be required.

Town of Ayer

The Ayer WWTP is located 3 miles from the northeast corner of Lancaster at 25 Brook Street in Ayer, Massachusetts (Figure 7-1). The plant uses an activated sludge treatment process with advanced treatment and discharges tertiary treated flows to the Nashua River. Figure 7-3 shows the Ayer WWTP treatment plant process. Approximately 98% of the Town is sewered. The regulatory discharge limit for the Ayer WWTP is 1.79 mgd and it is currently at capacity. When the capacity of the plant is exceeded, excess sewer flows are pumped through a 16-inch force main connecting to the gravity sewer main discharging to the Devens facility. A new transmission main would be necessary for Lancaster to connect to the 42-inch trunk line in Ayer which then discharges to Devens.

Figure 7-3 Ayer WWTP Treatment Process Diagram
(Adapted from MA DEP WWTP Fact Sheet)



Town of Bolton

There are no large scale wastewater treatment plants in Bolton. The majority of the town is on private septic systems. A few properties along the Hudson line are tied into the Hudson sewer system.[3]

City of Leominster

The Leominster WWTP is located at 436 Mechanic Street in Leominster, Massachusetts. The design flow of the plant is 9.3 mgd with secondary treatment. The discharge is to the North Nashua River (see Figure 7-4). There is currently capacity available at this plant.[4]

In order for the project area to connect to the Leominster facility, a new force main would need to be installed along Route 2 to Leominster. The Leominster WWTP is located 1.3 miles from Lancaster's western town line at Rte 2, however, the existing Leominster collection system is significantly closer. This new sewer line would need to cross the railroad to tie into the Leominster collection system.

Town of Lunenburg

The Town of Lunenburg has approximately 12 miles of sewer lines with 9 lift stations. Approximately 90% of the sewered area is discharged to the Leominster WWTP. The remaining 10% flows by gravity to the Fitchburg WWTP.[5]

Town of Shirley

The wastewater collection system in Shirley is managed by the Shirley Sewer Commission. Wastewater flows in Shirley discharge to the Devens WWTP.

The Devens WWTP was constructed in 2000 and 2001. Devens' current Phase I wastewater treatment plant has a capacity of 3.0 mgd; however it only processes approximately 1.0 mgd. Figure 7-5 illustrates Devens WWTP treatment process. Of the 3.0 mgd, 2.2 mgd has been reserved and is under contract with existing customers. The plant receives flows from Devens, MCI-Shirley, Shirley, and a portion of Ayer. Inflow and Infiltration only account for roughly 0.15 mgd of flows on an average basis, so there may be few savings from upstream communities trying to reduce I/I. Since Shirley MCI has modified operations at a portion of its facility and may not require the maximum treatment volume currently contracted with the Devens' Utilities Department, they may be able to "sell back" a portion of the contracted capacity, which could become available for new clients.[6]

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[3] Harold E. Brown, Public Works Director, Bolton DPW (personal communication, August 2, 2006)
[4] Roger Brooks, Business Manager, Leominster DPW (personal communication, July 11, 2006)
[5] Jim Breault, Lunenburg DPW (personal communication August 17, 2006)
[6] D. Bevilacqua, Utilities Manager; M. Cohen; M. Mitchell; J. Moore, Utility Division Supervisor; Devens Community of Mass Development (personal communication January 9 ,2006)

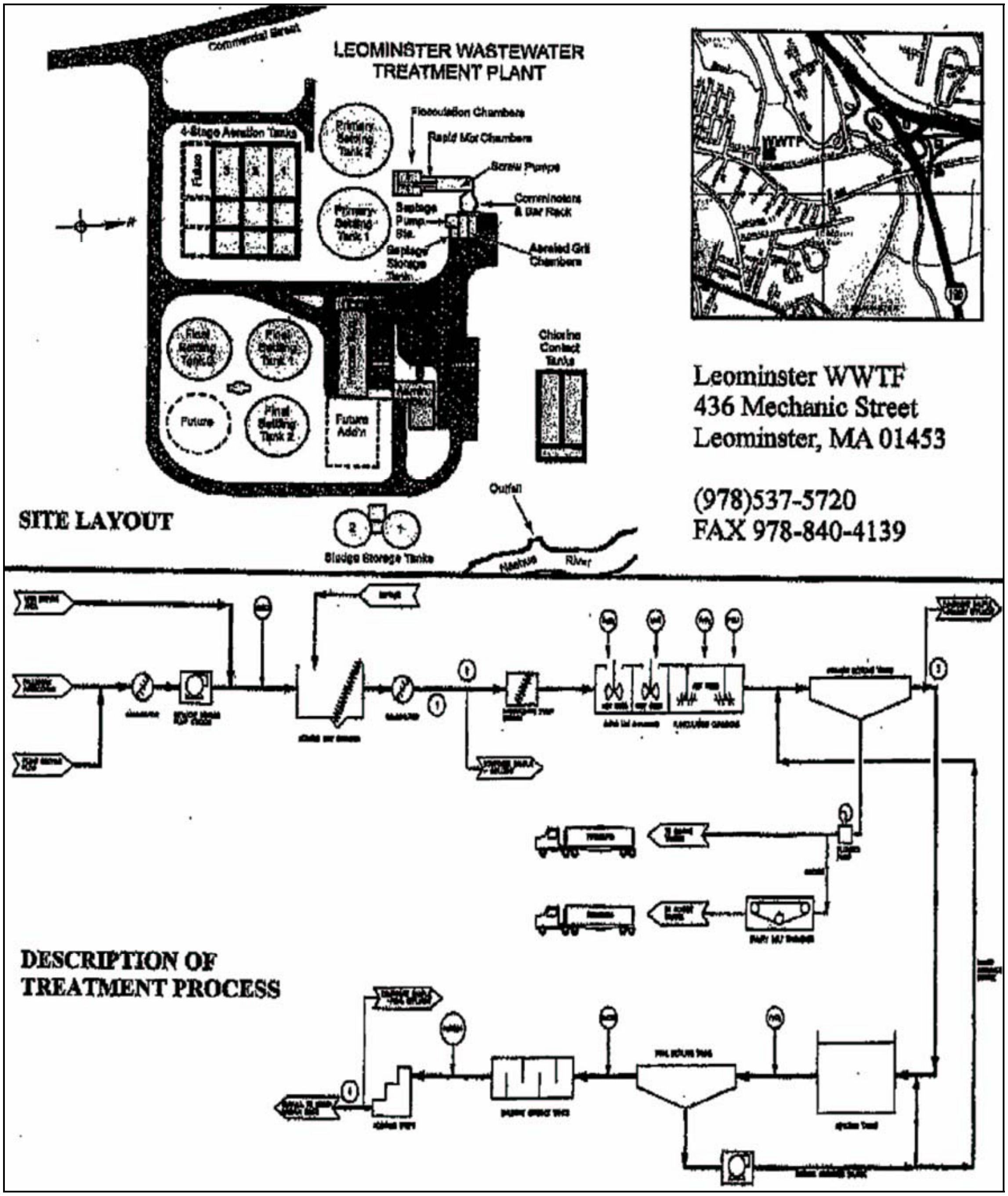


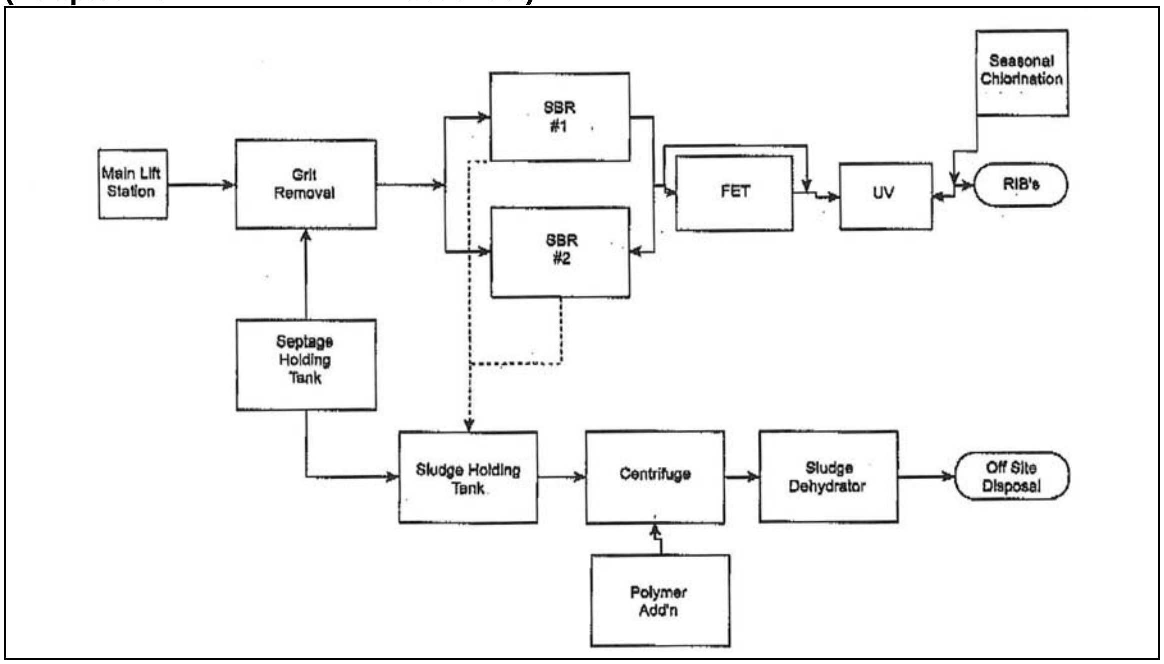
Figure 7-4 Leominster WWTP Treatment Process Diagram

(Adapted from MA DEP WWTP Fact Sheet)

Once the daily treatment demand begins to approach the plant's current 3.0 mgd capacity, the approved Phase II funding appropriation and construction will begin with a 1.5 mgd expansion for additional process capacity, totaling 4.5 mgd.

Wastewater flows are treated through sequencing batch reactors with UV treatment for the effluent (Figure 7-5). Treated flows are discharged to groundwater through rapid infiltration sand filter beds. Cake or heat-dried sludge is disposed at a landfill or the Marlboro compost facility.

Figure 7-5 Devens WWTP Treatment Process Diagram
(Adapted from MA DEP WWTP Fact Sheet)



The Devens plant is located 3.2 miles from the northeastern corner of Lancaster. MCI-Shirley discharges sewer flows through a new 6-inch force main, 15-inch gravity sewer, a 24-inch gravity sewer, and the 42-inch intercepter running along the east side of the Nashua River in the Town of Ayer. Excess flow from Ayer is pumped into this line just before it reaches the main lift station which pumps the sewage via two 16-inch force mains to the Devens WWTP. Lancaster sewer flows could be discharged to the Devens WWTP but the existing force mains and gravity sewers would need to be upgraded. Alternatively, a new sewer could be installed to accommodate the additional flow.

Town of Sterling

The Town of Sterling is not sewered. It is entirely served by private septic systems.

7.2 Study Area Wastewater Management

Existing Onsite Systems

Wastewater treatment systems within the IWRM study area currently rely on individual on-site systems. There is no sewer network in the study area. Of the 1,237 parcels in the study area, 790 are developed with on-site systems.

Types of Systems in Lancaster

On-site septic systems in Lancaster consist of either cesspools or conventional systems that may or may not meet Title 5 regulations. These are defined further below:

Cesspools – A cesspool consists of discharging wastewater from a building to an underground leaching structure. Wastewater enters the leaching chamber where the solids settle to the bottom or are naturally decomposed. The liquid portion flows out of the sidewalls of the tank and receives final treatment as it passes through the soils. This type of system is very prone to failure. It is very important to have these systems pumped periodically to prevent solids buildup causing failure. Cesspools are no longer allowed to be installed for onsite wastewater treatment.

Conventional Title 5 Systems – The State Environmental Code, 310 CMR 15.000 (Title 5), regulates existing, new, and upgraded septic systems. A new Title 5 system consists of a pipe line from the building, a septic tank, a distribution box, the soil absorption system (SAS or leach field) and a reserve area (Figure 7-6). Wastewater from the building travels through the pipe to the septic tank. Here it receives primary treatment by settling particles. Due to the lack of oxygen within the tank, some anaerobic decomposition does occur within the septic tank.

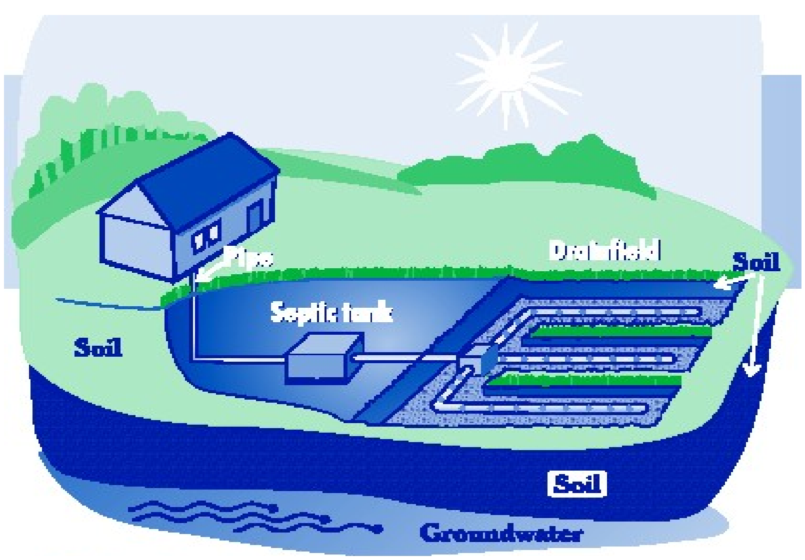


Figure 7-6 Typical Conventional System

Maintenance of the septic tank is important and consists of having it pumped periodically. This prevents solids from entering the distribution box and the SAS which would cause clogging and ultimately failure of the system. The distribution box uniformly distributes flows to the SAS to prevent overloading of specific areas. Piping within the SAS disperses flows throughout the treatment area. Here the flow percolates through the soil and encounters microorganisms which break down organic components.

For compliance with Title 5 of the State Environmental Code, 310 CMR 15.00, onsite septic systems must meet several design criteria to provide protection of public health, safety, welfare and the environment. The following summarizes some of the key criteria on-site systems must meet to comply with Title 5:

- Onsite sewage disposal systems must consist of a septic tank which discharges liquid effluent through gravity distribution, dosing or a pressure distribution network to a soil absorption system.
- Every system must be designed by a Massachusetts Registered Professional Engineer or a Massachusetts Registered Sanitarian.
- A minimum four foot separation must be provided between the bottom of the underlying soil absorption system and high groundwater elevation for soils with percolation rates greater than two minutes per inch, or five feet for soils with percolation rates two minutes or less per inch. At least four feet of soil beneath the soil absorption system must be a naturally occurring pervious soil.
- No new systems in Nitrogen Sensitive Areas or areas with drinking water supply wells shall be designed to receive or shall receive more than 440 gallons of design flow per acre per day except as allowed for aggregate flows and enhanced nitrogen removal.
- Septic tanks for single family dwelling units with a design flow of less than 1,000 gpd must have a minimum effective liquid capacity of 200% of the design flow or a minimum hydraulic detention flow of 48 hours, whichever is greater.
- A two compartment septic tank or two tanks in series are required for design flows greater than 1,000 gpd. The total combined effective liquid capacity of the tanks shall not be less than 1,500 gallons.
- Septic tanks must be constructed of sound and durable watertight materials not subject to excessive corrosion, decay, frost damage, or cracking or buckling due to settlement or backfilling. Metal septic tanks are prohibited.
- Soil absorption systems must be designed to serve a minimum of three bedrooms unless a deed restriction limiting the use to two bedrooms is granted to the local Approving Authority.
- The soil absorption system shall be sized in accordance with effluent loading rates provided under 310 CMR 15.242. New systems shall not be sited in areas with percolation rates slower than 60 minutes per inch.

- New construction sites shall include a reserve area sufficient to replace the primary soil absorption system.

The regulations of the Lancaster Board of Health require the following criteria (among others) for a Conventional Title 5 system[7]:

- At least two deep test holes shall be located within the proposed primary leaching area and at least two deep test holes shall be within the proposed reserve leaching area.
- Each leaching area shall have at least one maximum groundwater-level determination and the separation between groundwater or mottling and the bottom of the leaching system shall be at least five feet.
- Disposal systems shall not be constructed in fill which is to be placed directly on or near ledge, hardpan, or other impervious materials or in any area where peat is present or when the groundwater level is two feet or less below natural surface grade. At least four feet of pervious material shall be below the bottom of the proposed leaching and expansion areas.
- At least one percolation test shall be located within the primary leaching area and at least one test shall be in the reserve leaching area. A leaching facility shall not be closer than twenty five feet from a failing percolation test without having a passing test between the two locations.
- Decayed ledge or decayed shale topsoil and subsoil will not be considered pervious material. Depth of pervious material above ledge shall be at least five feet. A horizontal offset to ledge of twenty five feet must be maintained as well.
- Sewage disposal for office and industrial buildings must be designed based on square footage of building rather than the number of employees.
- The maximum amount of effluent that may be discharged is 440 gallons per acre per day. The minimum distance between septic systems servicing separate facilities shall be 100 feet.
- An individual sewage disposal system and all connecting sewer lines shall be installed on the same lot as the facility(ies) discharging sewage into said system.
- Prior to the approval of an alternative system for new construction the applicant must demonstrate that the lot can support a subsurface sewage disposal system meeting Title 5 and Lancaster Board of Health regulations without a variance.

Inventory of Systems

Figure 7-7 shows the current locations of parcels in the study area using on-site systems for wastewater disposal. From January 2000 to May 2006, 21 septic system permits were issued for upgrading existing systems or installing new systems. Table 7-2 shows parcel

[7] Regulations of the Lancaster Board of Health. Approved November 4, 1999.

status and the proportion developed and undeveloped[8] including their total respective areas by subwatershed.

Table 7-2: Summary of Development in Project Area by Subwatershed

Subwatershed	Parcels[a]	Total Parcel Area (acres)[b]	Number of Developed Parcels[c]	Developed Parcels Area (acres)	Estimated Number of Undeveloped Parcels	Undeveloped Parcels Area (acres)	Estimated Number of Undeveloped Parcels
Ballard Hill	207	1,152	137	549	70	603	52%
Fort Pond	212	942	164	329	48	613	65%
McGovern Brook	40	715	7	122	33	593	83%
Nashua River	154	828	98	97	56	731	88%
North Nashua River	177	1,611	99	493	78	1,118	69%
Shaker Hill	35	484	23	284	12	200	41%
Spectacle Pond	208	322	148	261	60	61	19%
Wekepeke Brook	131	1,276	68	484	63	792	62%
White Pond	77	325	41	149	36	176	54%
Total	**1,241**	**7,655**	**785**	**2,768**	**456**	**4,887**	**64%**

[a] The number of parcels is based on Lancaster assessor's data.
[b] The Total Parcel Area represents the parcel area and does not account for roadways and waterbodies that make up the balance of the subwatershed area as provided in Table 3-1.
[c] The number of developed and undeveloped parcels were determined based on existing assessor's data and whether it showed a structure value.

Current and Potential On-site System Problems

Table 7-3 summarizes data collected from the local Board of Health (BOH) regarding the status of on-site septic systems in the study area, including failing and passing systems. Figure 7-8 identifies the locations and result of the inspections for each of the systems included in Table 7-3.

As seen in Table 7-3, Lancaster is currently experiencing problems with on-site wastewater disposal systems in several of the nine IWRM subwatersheds. On-site system failures experienced in these subwatersheds are primarily due to poor soil conditions or small lots with old systems. Areas experiencing problems include pond communities adjacent to Fort Pond, Spectacle Pond and White Pond, commercial properties along Duval Road and residential properties along Old County Road and Main Street.[9] Figure 7-8 highlights the areas of concern currently experiencing on-site disposal system problems.

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[8] Parcels are listed as "developed" if the assessor's database indicated a building or if buildings were shown on the 2005 orthophotos used for the project (the most recent orthophotos at the time of the project).
[9] William Brookings, District Sanitarian, Nashoba Associated Board of Health (personal communication, July 31, 2006)

Table 7-3 Title 5 Inspection Results in Study Area by Subwatershed									
Subwatershed	Number of Developed Parcels	Developed Parcels Area (acres)	Identified Failures	Not Inspected	Conditional Pass	Septic Permit Issued	Pass	Title 5 Compliant	Built Before 1978[1]
Ballard Hill	137	38	28%	14	37%	2	5%	22	58%
Fort Pond	164	50	30%	6	12%	2	4%	42	84%
McGovern Brook	7	0	0%	0	0%	0	0%	0	0%
Nashua River	98	17	17%	3	18%	1	6%	13	76%
North Nashua River	99	22	23%	7	32%	2	9%	13	59%
Shaker Hill	23	2	10%	0	0%	0	0%	2	100%
Spectacle Pond	148	29	19%	10	34%	2	7%	17	59%
Wekepeke Brook	68	9	14%	3	33%	1	11%	5	56%
White Pond	41	9	19%	6	67%	0	0%	3	33%
Total	**785**	**176**	**22%**	**49**	**28%**	**10**	**6%**	**117**	**66%**

a Failures as a percentage of only those systems inspected.
b Disposal system passed Title 5 inspection, but it may not have been constructed to Title 5 standards.
c Disposal system was built to the Title 5 standards.
d Developed parcels not identified as having septic systems installed on or after 1978. This includes developed parcels with no dates available.

***Pond Communities* –** The residential housing around the ponds is densely populated. These areas are among the earliest areas that were developed in the Town. Lots surrounding the ponds were initially developed as summer camps but many have recently been renovated as year round residences without upgrading the original wastewater disposal systems. It is difficult to determine the extent of failing systems in these pond communities since only a few had inspections. Of those that have had inspections, the majority did not pass and can not meet Title 5 requirements.

***Duval Road Commercial Properties* –** According to the Nashoba Associated Boards of Health, the commercial area experiencing system failures along Duval Road includes three properties, Roll-On America, Orchard Hills Athletic Club, and the Rte 2 Rest Area. On-site system failures at these three properties are due to local soils characteristics. Although the surrounding soils in this area are classified as Group A (high infiltration rates), the soils at these properties are not providing adequate absorption and are causing system failures. Orchard Hills has reported breakout failures from their disposal system.

***Old County Road and Main Street* –** According to the 1986 Master Sewer Plan Update (SEA Consultants Inc.) there have been more than 20 septic system failures along the Old County Road and Main Street corridors. These areas are primarily comprised of hydrologic Group C and D soils which have marginal to low infiltration rates. Insufficient depths to groundwater also plague this area. A questionnaire sent out to residents in 1985 regarding their septic systems returned over 30 responses from residents along North

Main Street indicating that they were having some type of septic system problem (Figure 3.3 in Appendix B - Master Sewer Plan Update, 1986).

Septage Disposal

Nearly 20 companies service septic tanks in Lancaster. Available records of pumping between January 1, 2003 and June 14, 2006 are included in Appendix C. Septage pumped from these properties is disposed of at the facilities listed in Table 7-4.

Table 7-4 Septage Disposal Facilities

Facility Name	Facility Address
Clinton WWTP	677 High Street: Clinton, MA 01510
Concord WWTP	509 Bedford Street; Concord, MA 01742
Devens WWTP	31 McPherson Road; Devens, MA 01432
East Fitchburgh WWTP	Lanides Lane: Fitchburg, MA 01420
Leominster WWTP	436 Mechanic Street; Leominster, MA 01453

There is currently only one wastewater NPDES permit within the project area. This site is the River Terrace Healthcare (NPDES ID MA0025763) located at 1675 Main Street adjacent to Ballard Hill Road. The facility houses approximately 82 Residents.[10] Wastewater flows are ultimately discharged to the North Nashua River.

Adequacy Evaluation

Many septic systems are located on ample size lots with medium to high permeability rates. These on-site systems appear to provide sufficient treatment under these conditions. For the systems not passing inspection, there appear to be two underlying themes: 1) poorly drained or very highly permeable soils and/or 2) small parcels in high density housing areas. These areas have the greatest need for improvements. These sites may require an extension of sewer or package treatment plants to prevent future failures.

Potential or Previously Identified Treatment and Disposal Sites

As part of the proposed North Lancaster Development District along Route 2 in the northwestern part of Lancaster, a community wastewater treatment plant is being proposed on the lands of Stephen Harper and Steve Boucher. The community system would provide sewage disposal for both the proposed commercial area and properties with failing onsite systems in the densely developed areas along the ponds. The soils are highly variable in the general area indicating that there are locations available to place the treatment and disposal facilities following on-site soils testing. This proposal is included in Appendix D in two documents prepared by S.J. Mullaney Engineering, Inc. dated in 2005.

[10] River Terrace Healthcare Webpage http://www.riverterracehc.com/BuildPage.asp?Pageid=26

7.3 Treatment, Collection and Disposal Options

There are a variety of options for treating wastewater discharges from residential and commercial/industrial properties. In general, wastewater alternatives can be broken down into several categories:

Onsite Disposal Systems

Onsite disposal system design issues include soil percolation rates and distances to groundwater and/or bedrock. In Massachusetts, soils with percolation rates of more than 30 minutes per inch are generally not acceptable, although existing systems may be allowed variances that can go as high as 60 minutes per inch. If soils have a percolation rate greater than 2 minutes per inch, a minimum separation of 4 feet from the leachfield bottom to groundwater or bedrock is required, with 5 feet required for soils with a percolation rate of less than 2 minutes per inch. In general, however, given the right type of soils and/or sufficient lot size of 2-acres or more, most properties should be able to achieve Title 5 compliance.

High density and predominantly poor soil characteristics are the two main factors leading to high incidence of system failures and problems with upgrading the existing systems to meet Title 5 criteria. Failures can also be attributed to other factors, such as change in the original system's designated use. For example, many of the seasonal properties around the ponds have been progressively changed over to full time residences where both the time the existing systems are used and the overall hydraulic loadings have increased significantly.

Recognizing that conventional Title 5 systems depend on soil type, it may require a doubling of the bed size to provide adequate infiltration rates plus the requirement to designate an area for a redundant or backup leachfield location. When these requirements (e.g., soils, lot size, house size, setbacks) are looked at cumulatively, the difficulties in upgrading the existing systems on lots of less than a half acre to Title 5 compliance are compounded. In these cases, Innovative/Alternative systems may be required.

Innovative & Alternative Treatment Systems

Over the past 20 years the onsite wastewater treatment system industry has developed many new treatment technologies that can achieve high performance levels on sites with size, soil, ground water, and landscape limitations that might preclude installing conventional systems. New technologies and improvements to existing technologies are based on defining the performance requirements of the system, characterizing wastewater flow and pollutant loads, evaluating site conditions, defining performance and design boundaries, and selecting a system design that addresses these factors.

Most of the alternative treatment technologies applied today treat wastes after they exit the septic tank; the tank retains settleable solids, grease, and oils and provides an environment for partial digestion of settled organic wastes. Post-tank treatment can include aerobic (with oxygen) or anaerobic (with no or low oxygen) biological treatment in suspended or fixed-film reactors, physical/chemical treatment, soil infiltration, fixedmedia filtration, and/or disinfection. The application and sizing of treatment units based on these technologies are defined by performance requirements, wastewater characteristics, and site conditions.

Innovative and alternative (I/A) systems as defined by the MassDEP are on-site disposal systems that are not constructed according to Title 5 standards. I/A systems may even function better than a typical Title 5 system for both residential and commercial uses, but can also be more costly. Appendix E displays the currently approved systems for general use in Massachusetts, as well as systems that are only approved for piloting or remedial use. For new construction, I/A systems can only be installed on lots where the existing Title 5 requirements can be met for percolation rate and separation to impervious soils and groundwater.

Conventional septic tank and field systems only provide for basic solids removal with liquid treatment and disposal occurring in the leaching field. The goal of these innovative alternative technologies is to provide for significant increase in treatment before the wastewater is discharged to the leaching field. Based on soils, this higher level of treatment and effluent quality going to a leachfield may provide as much as a 50% reduction in both the primary and reserve field areas required to meet Title 5.

According to Wastewater Engineering Treatment Disposal and Reuse (Metcalf & Eddy, 1991) a median strength influent to a wastewater treatment plant has a biochemical oxygen demand (BOD) of 220 mg/ℓ, total suspended solids (TSS) of 220 mg/ℓ and a total nitrogen (TN) concentration of 40 mg/ℓ. Typical wastewater influent concentrations to individual septic systems may be higher (BOD of 300 mg/ℓ, TSS of 300 mg/ℓ and TN of 45 mg/ℓ) due to less dilution. Thus, individual septic systems may need to remove a greater amount of pollutants to achieve the same effluent concentration as a wastewater treatment plant.

Since the conventional onsite systems do not actively remove nutrients from wastewater flow before entering the leaching field, it can be concluded that properly installed and operated septic systems, particularly on small lots, may still result in significant loading of pollutants to groundwater and subsequent receiving streams depending on the local conditions, especially the density of the development and the system’s hydraulic loading. The goal of the onsite innovative alternative technologies is to provide for a significant increase in the level of treatment prior to discharge. Systems such as the recirculating sand filter, the Amphidrome, Bioclear system and the single home Fast system, all approved by MassDEP, provide for a significant improvement achieving secondary treatment standards with an 85% removal of BOD and TSS to 30 mg/ℓ each, with a 60% removal of TN down to approximately 15 mg/ℓ. These systems, due to their expense and complexity, are likely mostly suitable for clustered homes or businesses. If the system is over 10,000 gallons per day, then a MA DEP groundwater discharge permit is required.

Systems Larger than 10,000 Gallons per Day

MassDEP requires groundwater discharges permitted pursuant to 314 CMR 5.00 to meet effluent limits of 10 mg/l of nitrogen at the point of discharge. MassDEP developed a Nutrient Loading Approach to Wastewater Permitting and Disposal, Policy No. BRP/DWM/PeP-P99-7, dated August 20, 1999 that allows permittees the option of demonstrating the compliance of their discharge with 314 CMR 5.00 through an alternative nutrient loading approach that establishes an ambient nitrogen concentration for the overall site that cannot be exceeded at any downgradient wells located at the property boundaries. The approach estimates the nutrient loadings associated with a land use and estimates a groundwater concentration in the area for comparison to standards. A groundwater concentration of 5 mg/l of nitrogen must be met at the property line in nutrient sensitive areas and a groundwater concentration of 10 mg/l of nitrogen must be met at the property line in all other areas. It offers some flexibility in the use of wastewater treatment technologies to meet these limits in the groundwater, rather than just at the discharge.

Innovative Collection Systems

In addition to innovative treatment systems, there are also a number of innovative collection and transport systems. For example, a cluster system may be as simple as a group of households served by one larger common leaching area. Since the conveyance portion of the wastewater system is often well over half of the total capital cost, it is an important factor in the design. In addition to conventional gravity collection systems, which may or may not include pump stations, there are also vacuum systems; grinder pump/low pressure systems; and initial Septic Tank Effluent *Pressure* Systems (STEP) and Septic Tank Effluent Gravity Systems (STEG).

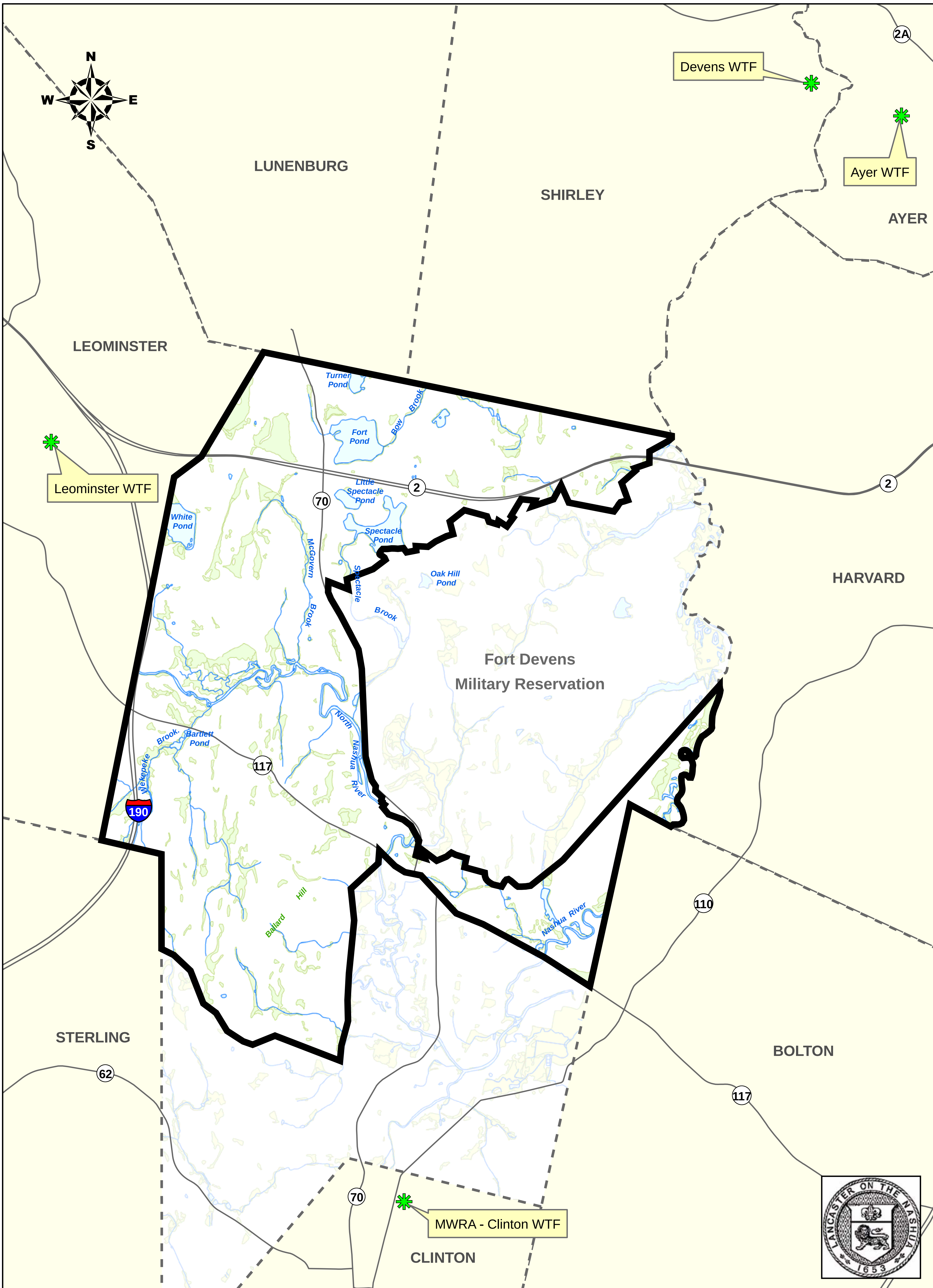
These systems combine onsite septic tanks with small diameter sewers (minimum 4 inch diameter) which transports effluent to a treatment disposal site. In the Septic Tank Effluent Gravity System (STEG), there are no pumping costs except in hilly areas, but generally flow is by gravity. In Septic Tank Effluent Pressure Systems (STEP), flow goes from a septic tank with effluent pumped through small diameter pressure lines to a treatment site. In both cases, the small diameter pipe allows considerable cost reduction and flexibility in areas with shallow depth to bedrock or other factors that drive up the cost of collection systems.

Another collection alternative is a vacuum sewer system, which places a vacuum source on small diameter collection pipes via vacuum units at each home. Sewage is then drawn from the home unit into the line via the vacuum unit. Sewage is then drawn to a central location for treatment. Similarly, individual pumps with grinders can be placed at each home where discharges to a pressure sewer system with conveyance to a treatment facility as a slurry.

Conventional Treatment Systems

New centralized treatment systems within the project area have not been considered as an alternate. Existing systems were described in Section 7.1 under Regional Wastewater

Management. Based on that discussion, it appears that the most viable options for centralized treatment include the Clinton/MWRA Treatment Plant for the southern portion of the project area and the City of Leominster's Treatment Plant from the northern portion of the North Lancaster project area. These have very limited capacity for Lancaster's sewage, but innovative options such as STEG/STEP to reduce the volume are discussed further in Section 8. The only larger plant available for conventional treatment of large volumes would be the Devens plant, discussed further in Section 8.0.



LEGEND

Wastewater Treatment Facility

IWRM Study Area

Hydrography

Lake, Pond

DEP wetlands

Stream, Brook

Data Sources: MassGIS

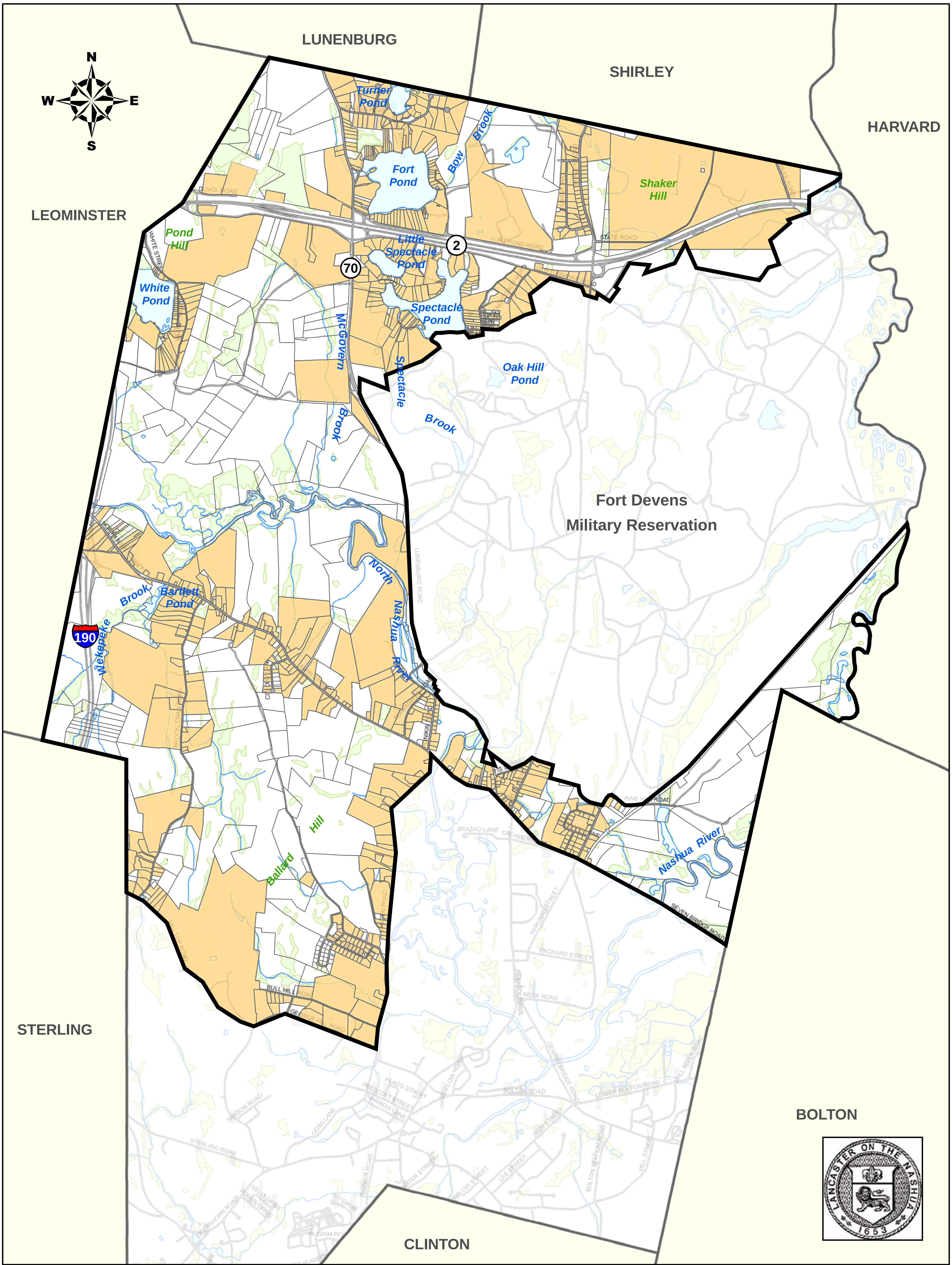
0 2,500 5,000 7,500 10,000 Feet

Figure 7-1

Regional Wastewater Treatment Facilities

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

- Parcels with On-Site Systems
- Parcel Boundary
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, NABH, MassGIS, MADEP

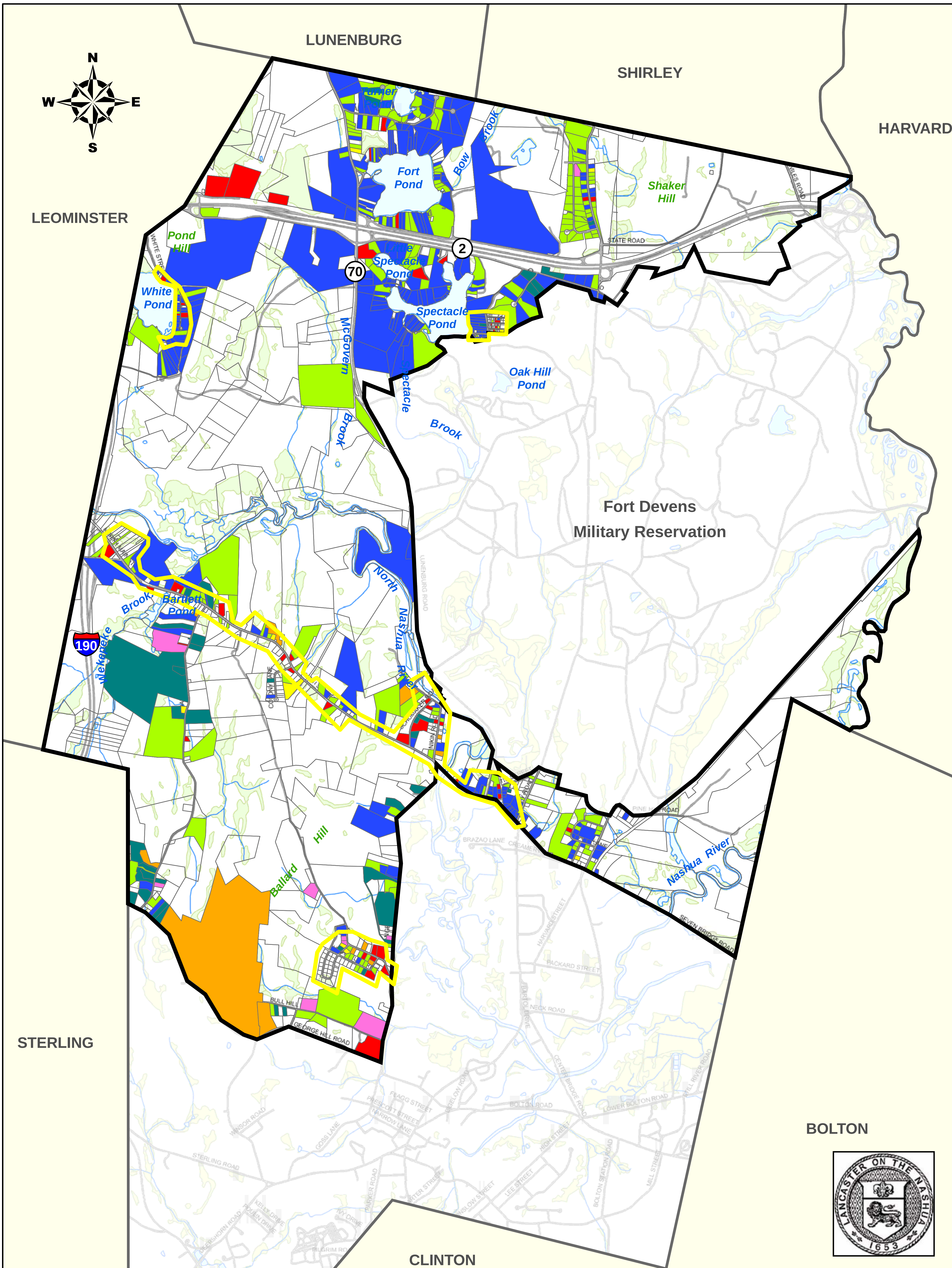
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 7-7

Developed Parcels with On-Site Disposal Systems

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Title 5 Inspection Results
- Pass
- Conditional Pass
- Failure
- Area of Concern

Title 5 Inspection Perc Rates min/in
- 2-10
- 11-20
- 21-29
- 30+

- Parcel Boundary
- IWRM Study Area

Hydrography
- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, NABH, MassGIS, MADEP

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 7-8

Title 5 Inspection Locations and Areas of Concern

Lancaster, MA

Comprehensive Environmental Inc.

8.0 Wastewater Needs Definitions/Alternative Potential Treatment and Disposal Locations

8.1 Identify Wastewater Needs

Section 7.0 outlined current and potential onsite system problems. A multi-phase ranking system was then used to identify and prioritize areas of concern within the study area. The first phase of the ranking focused on the developed parcels (existing systems) and the likelihood that they could be brought up to standards, as obtained from the Nashoba Regional Board of Health and presented in Table 8-1.

Table 8-1: Phase 1 Ranking Based on Extrapolation of Actual Failures to All Existing Systems

	Number of Developed Parcels	Number of Parcels Inspected[a]	Failures in Number and as a Percentage of Inspected Systems		Extrapolated Number of Potential System Failures	Phase 1 Ranking refers to the Total Number of Extrapolated system Failures[b]
Ballard Hill	137	38	14	37%	50	2
Fort Pond	164	50	6	12%	20	6
McGovern Brook	7	0	0	0%	0	9
Nashua River	98	17	3	18%	17	7
North Nashua River	99	22	7	32%	32	3
Shaker Hill	23	2	0	0%	0	8
Spectacle Pond	148	29	10	34%	51	1
Wekepeke Brook	68	9	3	33%	23	5
White Pond	41	9	6	67%	27	4
Total	**785**	**176**	**49**	**28%**	**219**	

a Note that some subwatersheds, particularly McGovern Brook, have so few parcels and inspections that this ranking is not significant.
b Lower rank subwatersheds indicate a greater degree of problem. Each ranking, including Phase 1-4 will be added together in the summary table (Table 8-5) to indicate the overall rankings.

Phase 2 of the ranking considers only parcel size, under the assumption that most parcels this small will be unable to upgrade the septic system to today's standards. The results of this phase are shown on Table 8-2.

In Phase 3, environmental features were first considered for developed parcels (Table 8-3). Those developed parcels with one or more of certain features were considered likely to be failed, including parcels that:

a) lie within 100' of a surface water or in a 100-year flood plain
b) have severe groundwater limitations
c) have severe limitations from shallow depth to bedrock

Table 8-2: Phase 2 Ranking Based on Developed Parcel Size				
Subwatershed	Number of Developed Parcels	Parcels that are less than 1/2 acre	Percentage of Developed Parcels that are Less Than 1/2 acre	Phase 2 Ranking[a]
Ballard Hill	137	24	18%	3
Fort Pond	164	18	11%	5
McGovern Brook	7	0	0%	8
Nashua River	98	47	47%	2
North Nashua River	99	15	16%	7
Shaker Hill	23	0	0%	8
Spectacle Pond	148	71	47%	1
Wekepeke Brook	68	16	24%	6
White Pond	41	24	51%	3
Total	**785**	**215**	**27%**	

a This ranking of developed parcels considers that any parcel that contains less than 1/2 acre based on the assessors maps, whether inspected or not, is likely to have trouble upgrading to a Title 5 compliant system due to lack of space.

Table 8-3: Phase 3 Ranking of Developed Parcels Based on Environmental Features								
Subwatershed	Number of Developed Parcels	Parcels with Severe Groundwater Limitations		Parcels with Severe Limitations due to Shallow Depth to Bedrock		Parcels Within 100' of Surface Water or in 100 Year Flood Plain		Ranking[a]
Ballard Hill	137	120	88%	1	1%	34	25%	3
Fort Pond	164	48	29%	11	7%	90	54%	5
McGovern Brook	7	3	33%	0	0%	3	33%	6
Nashua River	98	22	22%	0	0%	2	2%	9
North Nashua River	99	74	78%	1	1%	22	23%	4
Shaker Hill	23	16	80%	0	0%	1	5%	8
Spectacle Pond	148	28	19%	16	11%	82	54%	7
Wekepeke Brook	68	48	73%	17	26%	28	42%	1
White Pond	41	12	26%	8	17%	35	74%	2
Total	**785**	**371**	**47%**	**54**	**7%**	**297**	**38%**	

[a] The Environmental Features Ranking of each subwatershed is determined as follows:

- Compute the percentage of lots having severe limitations for each feature based on the surficial geology maps
- Add the percentages for each of the three categories to obtain a total ranking score (this may exceed 100% because some lots may have severe limitations in more than one category)
- Subwatersheds that have the highest aggregate score have the lowest (worst) ranking for environmental features

Finally, Phase 4 (Table 8-4) considered undeveloped parcels based on the same environmental features. Note for this phase that landowners might be more easily able to use mounded or innovative/alternative systems since they would be building new systems instead of upgrading failed systems, so this screening simply indicates which subwatersheds are more likely to have development constraints without sewers. As a result, the Phase 4 screening was not used in prioritizing sewering of existing homes (Table 8-5).

Table 8-4: Phase 4 Screening of Undeveloped Parcels Based on Environmental Features

Subwatershed	Number of Undeveloped Parcels	Undeveloped Parcels Area (acres)	Severe Groundwater Limitations	Severe Limitations from Shallow Depth to Bedrock	Within 100' of Surface Water or in 100 Year Flood Plain	Ranking
Ballard Hill	70	603	61	2	21	4
Fort Pond	48	613	15	2	26	7
McGovern Brook	33	593	16	2	23	2
Nashua River	56	731	27	5	33	5
North Nashua River	78	1,118	47	5	44	3
Shaker Hill	12	200	3	0	3	8
Spectacle Pond	60	61	7	2	12	9
Wekepeke Brook	63	792	40	13	31	1
White Pond	36	176	7	3	23	6
Total	456	4,887	223	34	216	

Ranking calculated by taking the sum of the percentages of undeveloped parcels with environmental constraints.

Table 8-5: Ranking Summary Table					
Subwatershed	Failures Ranking (Table 8-1)	Developed Ranking (Table 8-2)	Developed Ranking (Table 8-3)	Sum of Ranking Points[a]	Priority
Spectacle Pond	1	1	7	7	**1**
Ballard Hill	2	3	3	9	**2**
White Pond	4	3	2	12	**3**
North Nashua River	3	7	4	15	**4**
Wekepeke Brook	5	6	1	17	**5**
Fort Pond	6	5	5	20	**6**
Nashua River	7	2	9	21	**7**
Shaker Hill	8	8	8	28	**8**
McGovern Brook	9	8	6	29	**9**

[a] The formula is 200% of the failures ranking plus 100% of the parcel size ranking plus 50% of the developed ranking (environmental features).

A summary of the characteristics of the highest priority subwatersheds, along with associated areas of concern, is provided in Table 8-6.

<table>
<tr><th colspan="6">Table 8-6: Development of Alternatives</th></tr>
<tr><th>Subwatershed</th><th>Priority</th><th>Major Roads</th><th>Characteristics</th><th>Areas of Concern</th><th>Area Name</th></tr>
<tr><td>Spectacle Pond & White Pond</td><td>1 & 3</td><td>Spectacle Pond Ave
Holiday Lane
White Pond Road</td><td>High Density
Many Pre-Title 5 Systems
Close Proximity to Surface Water
Steep Slopes</td><td>Spectacle Pond Ave
Holiday Lane
White Pond Road</td><td>Spectacle Pond & White Pond</td></tr>
<tr><td>White Pond/Fort Pond - Rte 2 Commercial / Industrial Area</td><td>3 & 6</td><td>Rte 2 / Duval Road</td><td>Commercial Area
Existing High Flow Failures
Poor Soils</td><td>Orchard Hills
Roll-On America
Johnny Apple Seed/ Rte 2 Rest Area</td><td>Rte 2 Area</td></tr>
<tr><td rowspan="2">Ballard Hill</td><td rowspan="2">2</td><td>North Main Street</td><td>Poor Soils
High Density
Many Pre-Title 5 Systems</td><td>North Main Street</td><td rowspan="7">North Main Street</td></tr>
<tr><td>Langen Road</td><td>Poor Soils
Low Density</td><td></td></tr>
<tr><td>North Nashua River</td><td>4</td><td>North Main Street</td><td>Poor Soils
High Density
Many Pre-Title 5 Systems</td><td>North Main Street</td></tr>
<tr><td rowspan="2">Wekepeke Brook</td><td rowspan="2">5</td><td>North Main Street</td><td>Poor Soils
High Density
Many Pre-Title 5 Systems</td><td>North Main Street</td></tr>
<tr><td>Brockleman Road</td><td>Poor Soils
Low Density</td><td></td></tr>
<tr><td>Nashua River</td><td>7</td><td>North Main Street</td><td>Poor Soils
High Density
Many Pre-Title 5 Systems</td><td>North Main Street</td></tr>
</table>

8.2 Areas of Concern

There are several apparent problem areas in the high priority subwatersheds. These are described below.

White Pond and Spectacle Pond – White Pond and Spectacle Pond each have a heavily populated area adjacent to the pond. Each of these areas contains a high density of failures within the subwatershed causing them to be selected as areas of concern. An analysis of nutrient loadings from septic systems in these areas was performed using MassDEP's Bureau of Resource Protection Interim Policy – Nutrient Loading Approach to Wastewater Permitting and Disposal. The purpose of this analysis is to estimate nitrate-nitrogen concentrations in groundwater from the developments for comparison to standards. The standard for non-nutrient sensitive areas is 10 mg/l. The results of the analysis revealed a nitrate-nitrogen concentration of about 16 mg/l in the White Pond area and of about 13 mg/l in the Spectacle Pond area. Both of these exceed the standard of 10 mg/l indicating that more treatment is needed, especially considering that the homes in these areas rely on private wells for water supply, drawing from the same groundwater in which the wastewater is discharged. The assumptions used in the calculations are provided in Appendix F.

<u>Rte. 2 Commercial/Industrial Area</u> – The Rte 2 commercial/industrial area consisting of Orchard Hills, Roll-On America and the Johnny Appleseed/Rte 2 Rest Area is another area of concern located in the White Pond subwatershed. Mass Highway and the MassDEP are involved in a wastewater disposal solution for this area which is described in further detail below.

<u>North Main Street Corridor</u> – Located in the Ballard Hill, North Nashua, and Wekepeke Brook subwatersheds is the North Main Street Corridor. This is the area where the majority of failures from these three subwatersheds lie. This was confirmed through review of available Board of Health records and discussions with the Board of Health Agent.

8.3 Development of Wastewater Alternatives

Based on the information developed previously, there are numerous options available for addressing the wastewater issues of the study area in the Town of Lancaster. Because a large component of the area is still undeveloped, a strong correlation can be made between areas that are currently having problems with onsite systems and those that do not, and what would happen in the future if those development trends continue. The following options exist to handle, treat and dispose of wastewater from residences and commercial sites:

1. Continue to use existing onsite wastewater disposal systems, typically septic tanks and leachfields, which would lead to more failures in the future;

2. Based on site specific conditions, upgrade systems to meet Title 5 criteria;

3. Replace existing onsite system with a new, innovative alternative option, in many cases requiring the installation of a proprietary system;

4. Replace existing systems with a cluster or community type option where the wastewater is collected and conveyed by a sewer main to a small package plant for treatment and discharge/disposal, as feasible;

5. Collect and convey wastewater by a sewer main to a more regional wastewater treatment plant which may handle flows from various communities.

6. Some combination of all the aforementioned options based on site specific conditions.

Considering the site specific data and availability for disposing of wastewater at existing wastewater treatment plants, these options have been further refined into specific alternatives for evaluation, as follows:

- **Wastewater Alternative No. 1. –** Continues reliance on individual onsite wastewater treatment systems in total. Some of these systems may require innovative/alternative (I/A) systems due to site or soils constraints.
- **Wastewater Alternative No. 2** - Represents the full conventional sewering option that provides for the collection of wastewater from all properties with off-site disposal to a regional wastewater treatment facility.
- **Wastewater Alternative No. 3 –** Assumes that traditional individual onsite systems are used in most areas and for most residential sewer needs, but also includes a package wastewater treatment plant to treat and locally dispose of wastewater from commercial/industrial areas in the northern area of Town plus some off-site disposal to a regional wastewater treatment facility for other areas of Town.
- **Wastewater Alternative No. 4 –** Assumes that traditional individual onsite systems are used for most homes, but also includes selective sewering of specific problem areas around White and Spectacle Pond and around North Main Street using innovative collection systems that minimize volume so that existing treatment plant capacity can be used more effectively.

Detailed Evaluation of Alternatives

Each of the four alternatives introduced above has advantages and disadvantages related to costs and the overall impact on the culture of the Town, depending on how they are implemented. An evaluation of each of these alternatives in terms of scope, impact and cost is presented below.

Wastewater Alternative #1: Existing Conditions

Much of the Town of Lancaster has traditional individual onsite systems for residential development. The study area includes a generally even distribution of soil types mostly in the A and C classifications which are acceptable for use for onsite treatment and disposal. As highlighted in Section 8.2, Areas of Concern, there are localized pockets where the soils are essentially incompatible for onsite disposal. This existing conditions alternative or ‘No Action’ option represents the baseline condition upon which all other alternatives will be compared.

The previous watershed screening effort identified three specific areas of concern: 1) Spectacle and White Pond areas in the north; 2) the commercial/industrial area around Route 2; and 3) the North Main Street corridor. Concerns at the first two areas primarily result from density issues. The Route 2 commercial/industrial area represents three facilities consisting of Orchard Hills, Roll-On America and the Johnny Appleseed Route 2 Rest Area that have been unable to develop Title 5 compliant systems due primarily to soils issues. Therefore, as part of a cooperative effort between the City of Leominster, the Town of Lancaster, Mass Highway and the Massachusetts Department of

Environmental Protection, there are currently plans that will provide for a sewer main to connect the three parcels of this commercial/industrial corridor. For the purposes of this evaluation, that localized sewering activity, which is also limited in scope to primarily serve that area, has been included as a part of the existing/baseline conditions.

Other than this localized sewering effort, Wastewater Alternative #1 provides for no additional sewering to take place. It relies on continued traditional individual onsite systems for residential properties. Subsequent development will require implementation of a Title 5 or innovative technology to handle all generated wastewater on each 2-acre+ site. Similar Title 5 compliant individual package plant systems are also available in support of commercial/industrially zoned areas.

This alternative focuses specifically on onsite treatment and disposal, but would not preclude development options for localized clustered developments to provide for small community treatment and disposal systems, along with water supply. This alternative would result in a relatively neutral net wastewater recharge and water withdrawal water balance.

Advantages
The principal advantage associated with this option is that it provides for a continuation of traditional individual onsite systems, leaving the scope, size and cost of wastewater handling disposal options up to the specific development. Another advantage is that the water balance would benefit from no transport of wastewater to other basins or towns.

Disadvantages
This option may lead to suburban sprawl in residential areas, and is generally not conducive to close-knit community neighborhoods with open space. The lack of water and sewer in this area may detract businesses from developing in the industrial/commercial zones of Lancaster. It also results in likely higher costs to landowners in some areas where soils or other constraints are significant.

Wastewater Alternative #2: Full Sewering (Gravity Main) to Devens and Clinton WWTP

This alternative is designed specifically to provide for a maximum conventional sewering option. The purpose of this alternative is to outline the basic scope and costs for opening the study area to a full sewering option with less emphasis on the impacts of development as a general method of highlighting the overall capital costs for such an endeavor. Consistent with Alternative #1, the Route 2 commercial/industrial corridor would still be implemented. However, in this alternative the northern half of the study area would be tied to the Devens Wastewater Treatment facility which currently has sufficient capacity to handle the flows designated from these northern sub-basins. Devens, along with its other commitments, has the ability to expand its existing facility to accommodate current and future demands. Figure 8-1 shows trunk line corridors that would be part of the overall sewering approach. Individual developments would be responsible for the expenses to tie into the trunk line corridors.

The southern portion of the study would be handled consistent with Alternative #3, with gravity sewer lines provided to collect and send flows to the Clinton WWTP.

Advantages
The primary advantage of full sewering would be the Town's ability to attract more intensive business growth if water supply were also provided. Greater residential densities could be achieved without risks to public health.

Disadvantages
There are several disadvantages to this alternative, primarily led by costs and long-term Operations & Maintenance expenses for sewage disposal. Another concern is that significant quantities of water would be exported, possibly leading to eventual declines in streamflows over the long-term. It is noted that high density development would likely occur over a much wider area if both water and sewer were available, so the overall buildout population of Lancaster would likely be much higher than today's buildout estimates.

Wastewater Alternative #3: Full Sewering with Package Wastewater Treatment Plants and Clinton WWTP

This alternative assumes that a package plant is built in North Lancaster to serve commercial/industrial customers along with residential growth within the vicinity. One possibility is the package plant that was previously proposed by S.J. Mullaney Engineering, Inc. as part of a North Lancaster Development District (NLDD). This alternative involves collecting and sending the wastewater from the northern portion of the Town to a package plant located in the McGovern Brook subwatershed.

The southern watersheds would be sewered via traditional gravity sewers to the Clinton treatment plant. This approach would require an upgrade of the existing trunk line that services the existing Lancaster Sewer District to the Clinton Plant. This approach would ultimately result in a separate sewering district and would in all likelihood not fall under the same Administrative Consent Order applied to the existing Lancaster Sewer District. Because the sewer system would be newer, issues of infiltration/inflow would be eliminated from the beginning. While the Clinton facility currently has permit restrictions in terms of both quantity and quality of its effluent standards, existing information indicates that the plant, independent of some of the I/I issues that it experiences, has the hydraulic capacity to handle additional flows. The limiting factor in this facility would be the potential to improve the effluent quality as a part of discharge. Since the facility is operated by MWRA, this would require that the Town enter into a long-term contract in support of MWRA's requirement to upgrade the existing facility to provide for a higher level of treatment. No specific capital cost value has been tied into such an upgrade option as this would require a separate feasibility study of the Clinton plant.

Figure 8-2 graphically presents Alternative #3.

Advantages
This alternative opens the option for larger segments of the study area to become sewered and tied into one or more package plant systems. As such, the scope and costs for the implementation, operation and control of the package plant systems would be borne by the development community.

Disadvantages
The Town may not wish to take on the burden that ultimate ownership and operation of the package plant(s) would present. It is also noted that the annual costs to homeowners may be significant. This option may also need increased population densities in these areas in order to be cost-effective.

Wastewater Alternative #4: Selective Sewering

This alternative also relies extensively on the use of onsite wastewater handling and disposal systems; however, as outlined previously, some portions of the study area have had a higher level of system failures. Some of the principal causes of these failures are associated with both soil limitations and lot size. In these areas, Title 5 compliance without some sewering is not realistic, as the systems servicing small lots in dense areas cannot be upgraded to meet these requirements.

In this alternative, Septic Tank Effluent Pump (STEP) systems would be installed along with small diameter sewer mains to either a small package plant(s) or to an existing regional wastewater treatment facility. Septic Tank Effluent Gravity (STEG) systems would be used where possible in concert with STEP systems. Solids would be collected at the existing septic tanks (some of which might need replacement), with more frequent collection and delivery to septage facilities.

Areas with these systems installed would need to be set up on a permit system to make sure that the Operations and Maintenance is completed each year. In some areas, STEP systems could be used to a controlled diurnal pattern of wastewater flows such that upgrades to receiving plants such as Clinton would not be needed. However, this would require further analysis and negotiation with MWRA and Clinton to evaluate the feasibility and cost comparison with a separate offsite disposal area. The diurnal flow control would allow wastewater to be transferred to existing systems at times of low flow to prevent additional peak flows. Some additional storage may be required. Two main areas would be served: Spectacle and White Pond to the Leominster treatment plant and North Main Street to the Clinton plant.

Figure 8-3 graphically presents Alternative #4 with a more detailed description provided below.

Advantages
This alternative is the least costly to provide basic service to the areas most in need of sewer service. Growth impacts would be non-existent as only those homes needing the

service most would be addressed. While this alternative handles specific problem areas within the study area, future development would still take on a rural nature along the lines of bedroom community. The lack of water and sewer in this area for future tie-ins may detract businesses from developing in Lancaster, as with Alternative #1.

Disadvantages
The total net flow contributed to the Clinton plant is subject to the facility's permit restrictions, along with MWRA and MassDEP review and approval. The discharge limit would control the size of the conveyance line and would limit future tie-ins. Further study would be needed to develop detailed cost estimates and evaluate whether Clinton or Leominster would be willing to take the effluent.

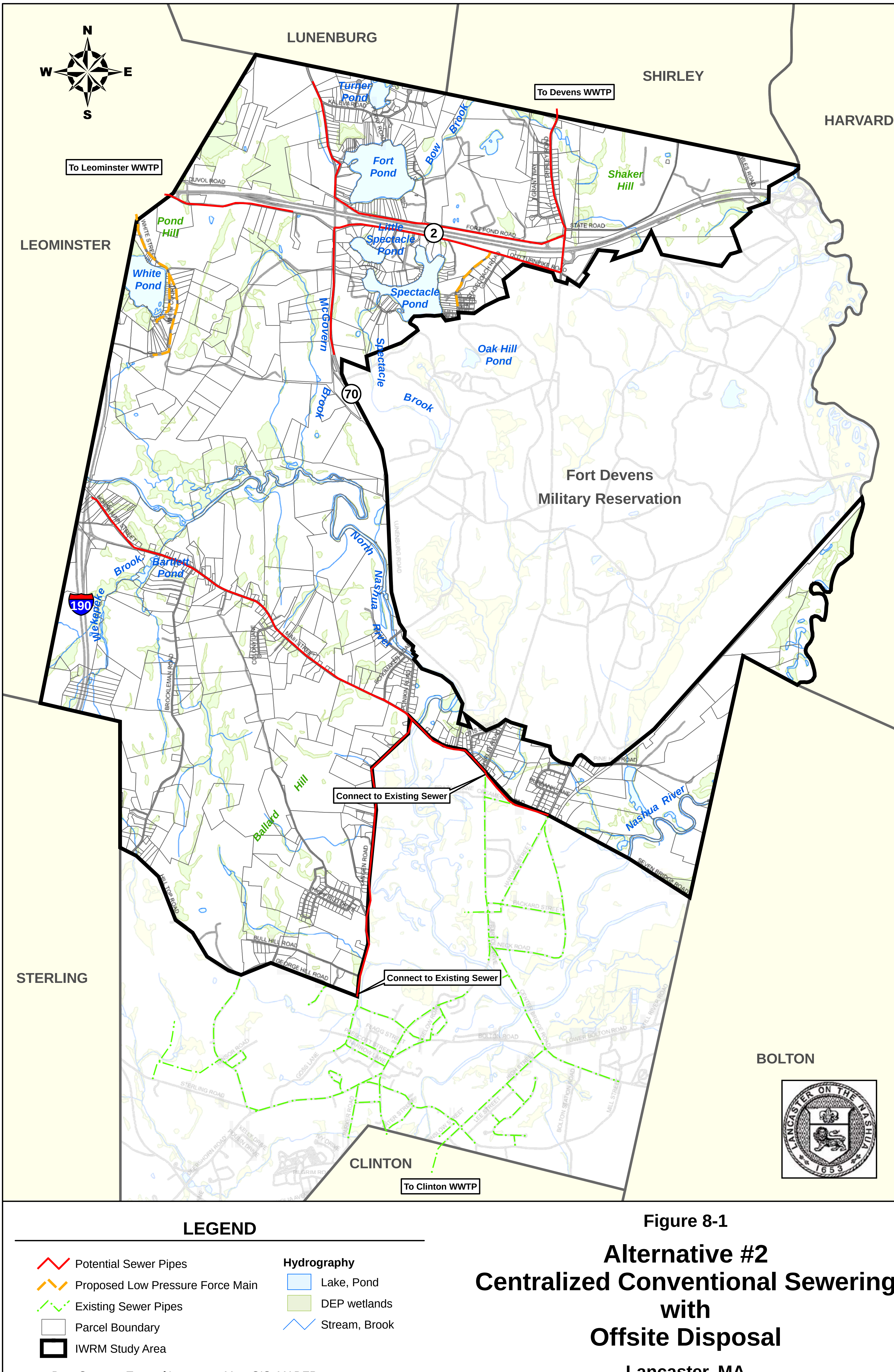
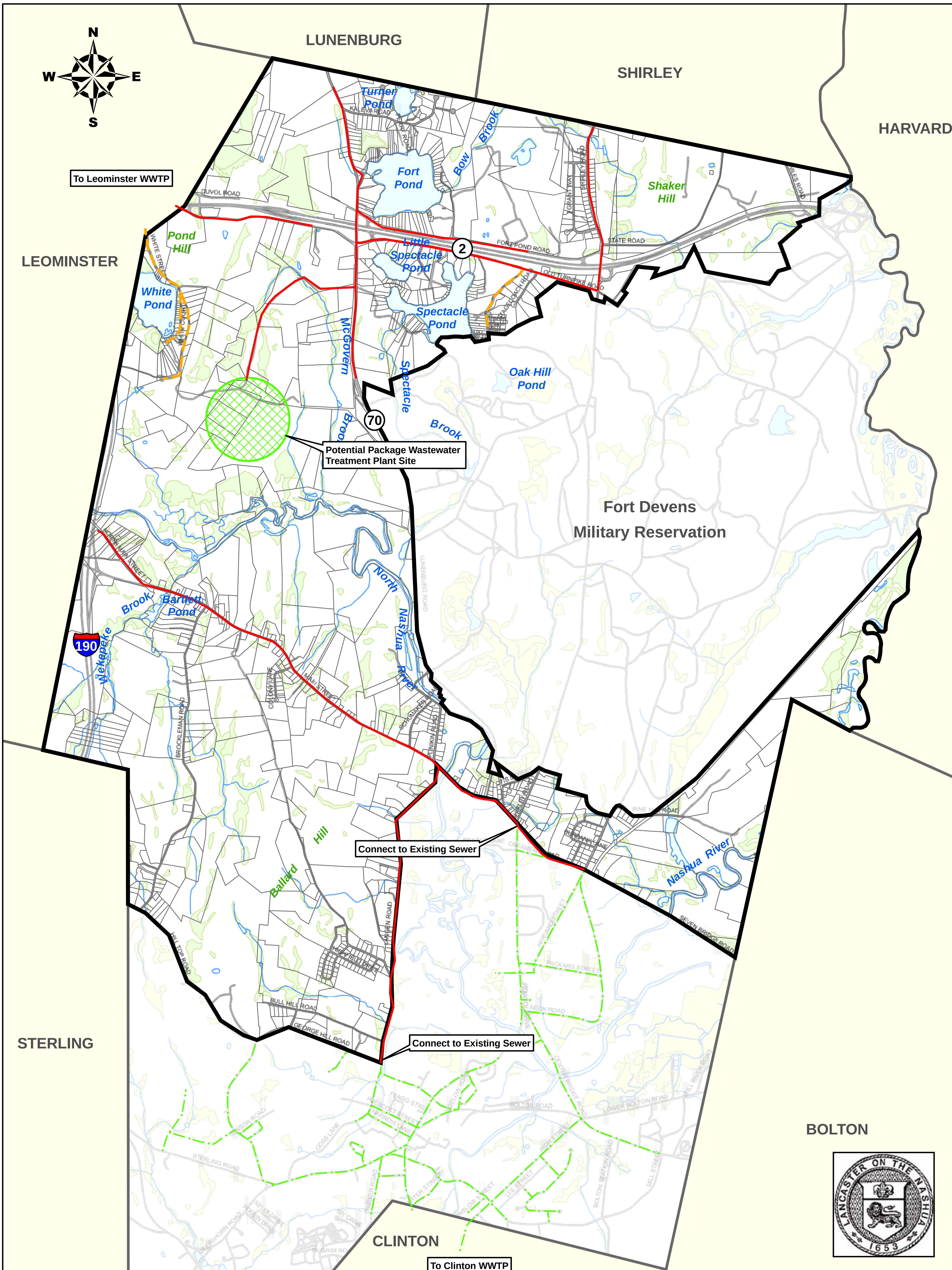


Figure 8-1

Alternative #2
Centralized Conventional Sewering with Offsite Disposal

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

- Potential Sewer Pipes
- Proposed Low Pressure Force Main
- Existing Sewer Pipes
- Package Wastewater Treatment Plant
- Parcel Boundary
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

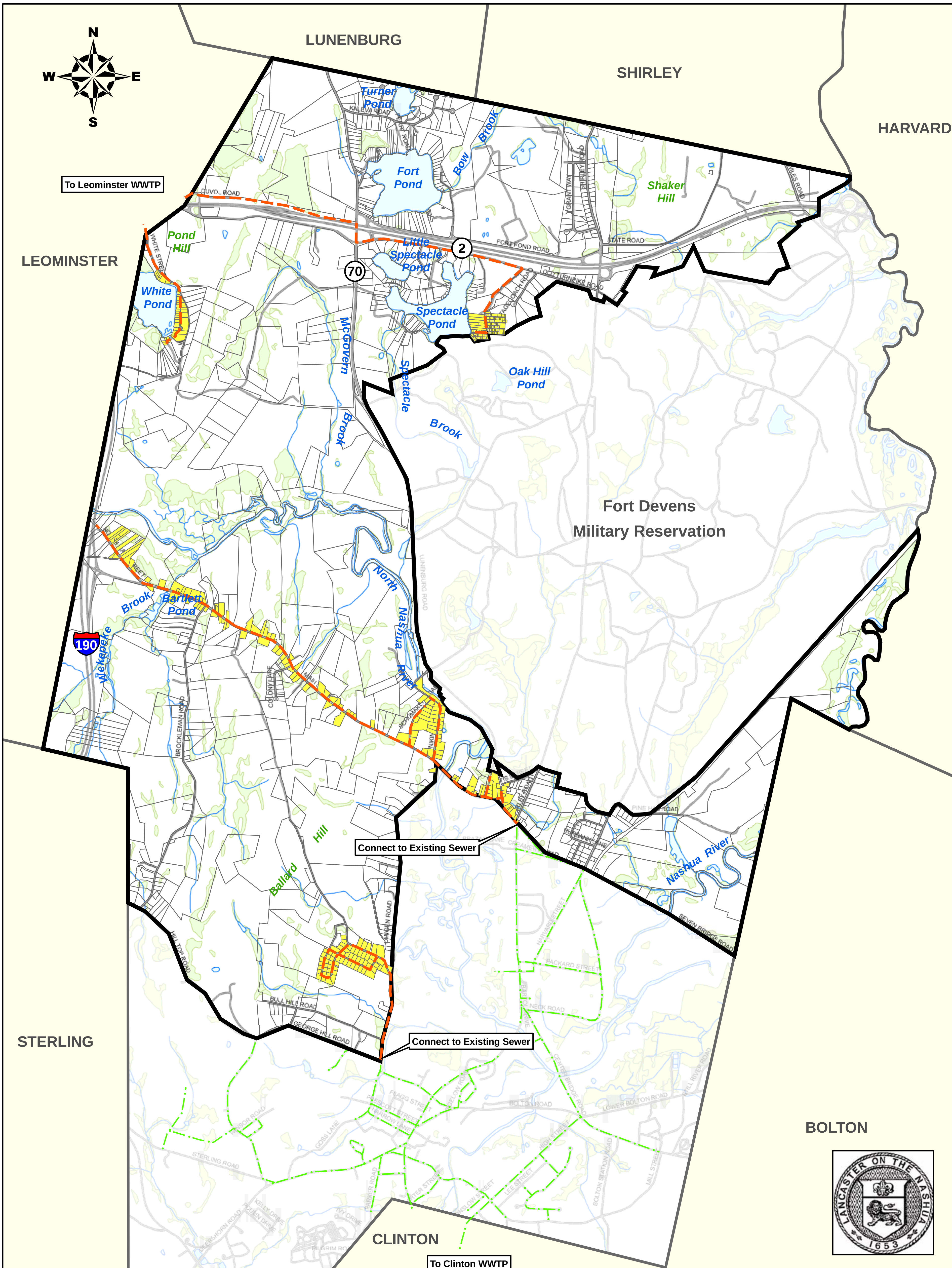
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 8-2

Alternative #3
Decentralized Package System and Limited Offsite Disposal

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

- Proposed Low Pressure Force Main
- Existing Sewer Pipes
- Proposed Sewered Parcels
- Parcel Boundary
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 8-3

Alternative #4 Selective Sewer with Limited Offsite Disposal

Lancaster, MA

Comprehensive Environmental Inc.

9.0 Costs

This section pulls together the costs for each of the alternatives described in Section 8.0. It is important to note that the Town could choose to mix and match components to some degree, for example, the minimal sewers proposed in Alternative 4 could be combined with a package plant for commercial industrial land in North Lancaster to encourage new businesses to locate there. The costs of each alternative, broken down by major component, are described below. This summary is followed by an assessment of the impacts of each alternative on the water balance of the study area. Finally, recommendations are presented for further work in all areas: water supply, wastewater and stormwater.

Wastewater Alternative # 1: Existing Conditions

This 'No Action' alternative assumes that all properties will use onsite treatment systems. The total wastewater produced at buildout is 3 mgd. There are no planned costs associated with this option because existing and future landowners would continue to provide their own wastewater. Some landowners may see extraordinary expenses to upgrade their systems.

Wastewater Alternative # 2: Full Sewering (Gravity Main) to Devens & Clinton WWTP

The full sewer costs were based on the collection systems for both the North and South Sewering Alternative Areas which includes the major trunk lines constructed as gravity or pressure mains. The use of low pressure STEP systems for the White and Spectacle Pond Subwatersheds was used as a cost component for this alternative. The collected flows would then be sent to the respective wastewater treatment plant at Devens or Clinton via a gravity main.

Topography was evaluated to determine if these areas would be served by pressure or gravity sewers. Flows were estimated, assuming two people per acre at 100 gallons per capita per day with a peaking factor. Pipe sizes were determined based on the corresponding flows and type of line (pressure or gravity) using Manning's equation or Bernoulli's Equation. A 36" diameter pipe was sized to handle the flows for the cross country gravity main to Devens. The average flow to Devens for this option is 2.1 mgd. The total flow to the Clinton WWTP is 0.9 mgd.

From these assumptions the pipe type, size and lengths were determined for each area and totaled to determine costs shown in Table 9-1. The same assumptions and components for costing analysis were used in conjunction with Means Cost data to establish total sewering costs. These cost components for each different pipe size were totaled and a linear footage cost was calculated applied to all proposed sewering. The same cost assumptions were also used for the gravity flow to Devens option, Means Cost data was used to estimate the cost to install a large diameter (36") reinforced concrete pipe interceptor using deeper depths and larger excavations. Means Cost data was also used to estimate installation of manholes based on an assumption of 300 foot spacing.

Means Cost data was also used to estimate installation of the "spaghetti lines" and cleanouts for the STEP systems for White and Spectacle Ponds. The number of cleanouts was determined based on the total linear footage of low pressure main divided by an average 1000 foot spacing, but this number can vary for individual roads and developments based on the necessity for cleanouts at bends, dead ends and tie-ins in the system.

Costs for upgrading existing sewer lines were not included in this analysis and it was assumed that these upgrades would be done on a case by case basis during full scale design. It is noted that costs for the receiving plant upgrades are not included even though these may be significant especially at Clinton.

Table 9-1 Alternative 2: Full Sewering with Offsite Regional Treatment at Devens and Clinton

Item	Estimated Quantity	Unit	Cost
Gravity Mains	61,500	LF	$10,332,000
Pressure Mains	6,500	LF	$709,800
Sewer Manholes	205	EA	$1,205,400
Pump Station (Package)	4	EA	$700,000 (est.)
36" Gravity Main	21,400	LS	$5,392,800
Sewer Manholes	71	EA	$417,480
4" Pressure Spaghetti Lines	10,000	LF	$705,600
Sewer Cleanouts	20	EA	$120,000
Grinder Pumps & Tanks	133	EA	$2,480,000
		Grand Total	**$22,063,080**

Wastewater Alternative # 3: Full Sewering with Package Wastewater Treatment Plants and Clinton WWTP

Alternative #3 costs are based on the collection systems for both the North and South Sewering Alternative Areas which includes the major trunk lines constructed as gravity or pressure mains. The use of low pressure STEP systems for the White and Spectacle Pond Subwatersheds was used as a cost component for this alternative. The North section would be directed to a package wastewater treatment plant with an onsite recharge system. The southern area flows would be sent to the Clinton WWTP.

Flows were estimated for each area and topography was evaluated to determine if the area would be pressure or gravity. The flows were estimated based on the assumption of 100 gallons per capita per day. This accounts for infiltration and inflow that is not a factor in the existing conditions alternative. The total flow to the package plants is 2.1 mgd. Pipe sizes were determined based on the corresponding flows and type of line (pressure or gravity) using Manning's equation or Bernoulli's Equation. A similar worst case flow scenario was used for sizing the STEP system for White and Spectacle Pond Subwatersheds that was used in other alternatives.

From these assumptions the pipe type, size and lengths were determined for each area and totaled to determine costs shown in Table 8-8. The pipe costs were determined using Means Cost data with the assumption that all pressure main would be PVC and all gravity main would be reinforced concrete pipe. The pressure main assumed a uniform depth and width for excavation, installation, backfill, pavement and cleanup costs. Gravity main costs used similar cost components, including excavation, installation, backfill, paving and clean up costs but these components were adjusted for each increase in pipe size for depth and width of gravity main. Cost components for each different pipe size were totaled and a linear footage cost was calculated and used to apply to the total linear footage for all of the proposed sewering.

Means Cost data was also used to estimate installation of the low pressure mains and cleanouts for the White and Spectacle Pond STEP systems using several different cost components for excavation, installation, backfill and cleanup. The number of cleanouts was determined based on the total linear footage of low pressure main divided by an average 1000 foot spacing, but this number can vary for individual roads and developments based on the necessity for cleanouts at bends, dead ends and tie-ins in the system. Means Cost data and manufacturer’s information was used to estimate construction costs for grinder pumps and precast concrete storage tanks. Costs for several construction components including individual service lines, excavation, installation of components, backfilling and cleanup were used for the grinder pumps and tanks installed on each individual lot.

Means Cost data was also used to estimate installation of manholes using several cost components and the number of manholes was determined based on the total linear footage of sewer pipe divided by an average of 300 foot spacing. Means Cost data was also used to estimate construction costs for pump stations and a package treatment plant.

Fifty percent of the wastewater for the northern area is assumed to remain onsite at existing systems. Costs for upgrading existing sewer lines were not included in this analysis and it was assumed that these upgrades would be done on a case by case basis during full scale design. Although this alternative appears to be the costliest, it is anticipated to be less than Alternative 2 once upgrade to other facilities such as the Clinton plant are considered. Further, the costs that would be charged by Clinton and/or Devens have also not been considered, and these costs could be significant.

Table 9-2 Alternative 3: Full Sewering with Package Wastewater Treatment Plant Costs			
Item	Estimated Quantity	Unit	Cost
Gravity Lines	68,500	LF	$11,508,000
Pressure Mains	11,000	LF	$1,189,000
Sewer Manholes	230	EA	$1,352,400
Pump Station (Package)	4	EA	$700,000 (est.)
1.0 MGD Treatment Plant	1	LS	$5,000,000 (est.)
4" Pressure Spaghetti Lines	10,000	LF	$705,600
Sewer Cleanouts	20	EA	$120,000
Grinder Pumps & Tanks	133	EA	$2,480,000
		Grand Total	**$23,055,000**

Wastewater Alternative # 4: Selective Sewering

As described in the previous section, STEP system operation in a diurnal pattern will be used to provide the southern area flows to the Clinton WWTP. The northern area wastewater flows will be pumped on an as-needed basis.

The flows were estimated based on assuming 2.8 people per parcel at 70 gallons per capita per day with no peaking factor applied. Instead of applying a peaking factor, it was assumed that the flows would be managed under a diurnal pattern with a more controlled flow pattern. System component capacities were determined based on a scenario in which a power loss occurred for three days and during this time wastewater effluent was stored in additional onsite effluent storage tanks. With restoration of power, all the pumps would turn on based on the full level in the storage tanks and a surge of effluent flows would pass through the system creating a peak flow. This peak flow was subsided based on the grinder pump's controller being programmed to turn on and off based on pressures and flows in the system's lines. As operating pumps in the system relieve the pressure and drain their tanks additional pumps can come on line. Pipe sizes were determined based on these worse case scenario assumptions and the corresponding total flows.

The pipe costs and cleanouts were determined using Means Cost data with the assumption that all pressure main would be PVC and typical sizes for STEP systems utilize smaller diameter pipes or "spaghetti lines" which can range from 1-1/2" to 4" diameter along the entire length of a force main. The pressure main assumed a uniform depth and width for excavation, installation, backfill, pavement and cleanup costs. Cost components for each different pipe size were totaled and a linear footage cost was calculated and used to apply to the total linear footage for all of the proposed sewering. Means Cost data was also used to estimate installation of cleanouts using several cost components and the number of cleanouts was determined based on the total linear footage of force main divided by an average 1000 foot spacing, but this number can vary for individual roads and developments based on the necessity for cleanouts at bends, dead ends and tie-ins in the system. Means Cost data and manufacturer's information was used to estimate construction costs for grinder pumps and precast concrete storage tanks.

Costs for several construction components including individual service lines, excavation, installation of components, backfilling and cleanup were used for the grinder pumps and tanks installed on each individual lot. The costs for grinder pumps and tanks was included as one cost component because the associated costs could be funded by each individual landowner or by the town as an up front capital cost recovered through betterment fees. Additional costs required for upgrading the Clinton plant or existing system upgrades were not included because it was assumed the upgrades would not be required with the controlled diurnal flow patterns associated with the STEP systems. Table 9-3 details the costing component for each of the problematic areas being addressed by this partial sewering option. The total cost for this option is roughly $10.0 million.

Table 9-3 Alternative 4: Selective Sewering Costs

Item	Estimated Quantity	Unit	Cost
Spectacle and White Pond Option			
4" Pressure Spaghetti Lines	18,500	LF	$1,305,000
Sewer Cleanouts	20	EA	$120,000
Grinder Pumps & Tanks	133	EA	$2,480,000
		Sub-total	**$3,905,000**
North Main Street Option			
4" Pressure Spaghetti Lines	29,900	LF	$2,110,000
Sewer Cleanouts	30	EA	$180,000
Grinder Pumps & Tanks	203	EA	$3,785,000
		Sub-total	**$6,075,000**
		Grand Total	**$9,980,000**

Appendix A

Environmental Overlay District Pilot Project

Environmental Overlay District Pilot Project

Final Report

Lancaster, MA

JUNE 30, 2006

Prepared for:

Town of
Lancaster
695 Main Street
Lancaster, MA 01523

Prepared by:

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Town of Lancaster, Massachusetts
Environmental Overlay District Pilot Project

Table of Contents

List of Appendices

List of Tables

List of Figures

Executive Summary

Water is quickly becoming scarcer in the Northeast, largely due the interruption of the hydrologic cycle caused by new development. As asphalt and other impervious surfaces spread, and other soils are compacted by human activity, our generous 40+ inches of rainfall no longer seems able to provide us with all the water we need for human use, irrigation and water resources such as fishable/swimmable water bodies and clear running streams. The increased imperviousness, even from lawns, creates more runoff and interferes with recharge. In addition, many of the land uses are not vegetated, so the large evapotranspiration component of natural woods is replaced by a large amount of "new" runoff.

For each acre of land, the natural rainfall is roughly 1 million gallons per year. Of this 1 mg, about half is evapotranspiration and about half (in an A or B soil) is recharge. So the same acre developed still receives 1 mg of rainfall, but it may ALL be runoff even where none existed before. This new runoff causes flooding damage to infrastructure, private property and natural habitats.

The Town of Lancaster, through funding provided by the Commonwealth of Massachusetts Riverways Program, underwent a study to develop an Environmental Overlay District (EOD) to better protect water resources from development impacts. An EOD is a single or series of overlays that can be applied to specific portions of a Town and requires that certain performance standards be met in these areas. In Lancaster, the focus of the EOD was on providing a better hydrologic balance in developing areas, focusing on the central and northern portions of Lancaster. Emphasis was on keeping more water in the basin to offset water supply withdrawals and wastewater discharges associated with development, while simultaneously improving water quality.

Implementation of the EOD and performance criteria in Lancaster will result in a water savings of almost 750 million gallons, or a 21% improvement from the conditions expected without the EOD and performance criteria.

In addition to water quantity benefits, the EOD also provides water quality benefits including:

- cooling of stormwater discharges to help preserve instream temperatures and dissolved oxygen levels in receiving water bodies – a factor critical to fisheries;
- removal of large quantities of stormwater pollutants that can pollute water bodies;
- slow and more natural discharge of runoff during smaller storms, protecting the hydrologic cycle and allowing for recharge to occur;
- reduced erosion of streambanks caused by the increased velocities found in developing areas due to imperviousness;
- better protection of water bodies from nutrient pollution due to large septic systems in areas that are not sewered but may receive commercial development;

- greater public health controls in certain aquifer areas to reduce the likelihood of pollutants such as pharmaceuticals; and
- minimized flooding due to high intensity runoff peaks and imperviousness.

The environmental benefits described above equal financial savings to the Town of Lancaster, including:

- Less money spent on future stormwater infrastructure due to the reduced runoff, which will reduce future flooding problems;
- Less money spent on stormwater best management practices (BMPs) and the clean up of surface waters due to the treatment controls required during development, which will help preserve existing water bodies;
- Less money spent on future water supplies since the increased recharge provides more sustainable aquifers available for water supply withdrawal and the proposed controls help to prevent the contamination of aquifers used for supply.

Development of the EODs and performance standards involved five major components, including:

1. Delineation of subwatersheds in the study area – the study area was broken into nine subwatersheds. The subwatersheds were used to evaluate development impacts and the water budget for smaller, more manageable areas.

2. Buildout assessment – a buildout assessment was performed to determine the total number of new lots at buildout including some fill-in of existing properties. This was then used to determine water use and wastewater generation under buildout conditions for comparison to undeveloped (virgin) and existing conditions.

3. Environmental Overlay Districts – EODs were developed with performance standards for both stormwater and wastewater. A summary of the overlays and standards is provided below:

   <u>Stormwater Performance Standards (Stormwater Overlay District)</u>

   A. Recharge is required for groundwater depths greater than four feet at the following quantities:

Soil Type	Recharge Over Impervious Surface (in)
A	1.25
B	1.00
C	0.65
D	0.10

B. A water quality volume of 1" over the impervious surface must be treated to remove pollutants before being discharged to surface waters. Treatment must occur through either infiltration or an underdrain system that allows the water to cool before being discharged.

C. Post-development peak flows cannot exceed pre-development peak flows for the 1-, 10-, and 25-year storms.

D. 24-hour extended detention of the 1-year, 24-hour storm in most locations.

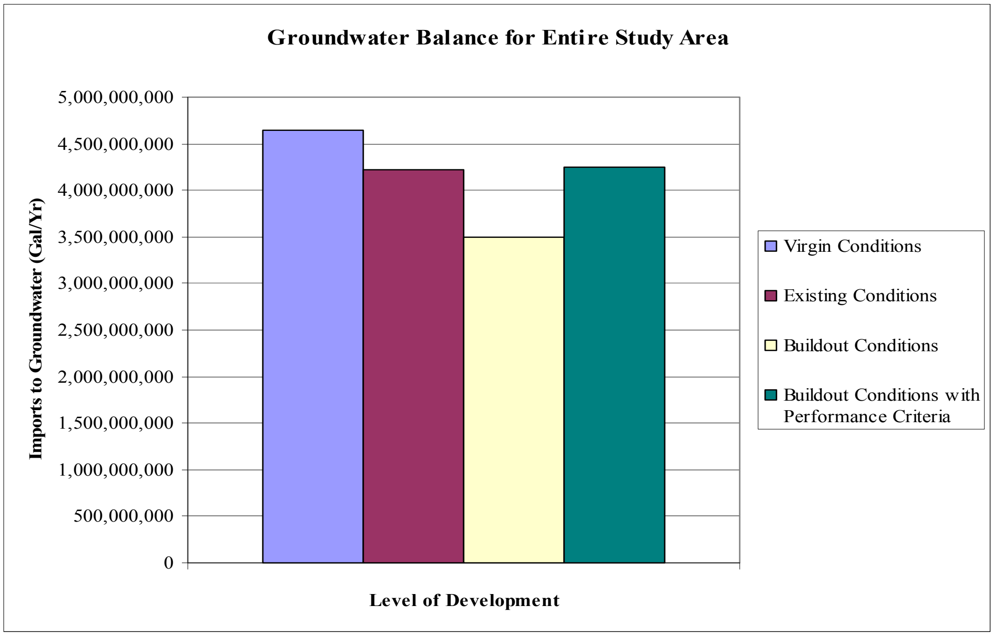
<u>Wastewater Standards</u>

Two overlay districts were proposed:

A. Fisheries and aquatic habitat overlay district – defined by any lot containing bordering vegetated wetlands or their 100-foot buffer. Large flow wastewater treatment systems (>1,000 gpd) must meet 10 mg/L nitrate at the property boundary or limit of sensitive resource.

B. Expanded water resources protection district – defined by high and medium yield aquifer areas and their zone of contribution. Large flow wastewater treatment systems (>1,000 gpd) must meet 10 mg/L nitrate at the property boundary or limit of sensitive resource and include pathogen treatment. Medical offices, veterinary hospitals and nursing homes must also include pathogen controls.

4. Water balance – a water balance was performed to compare virgin, existing and buildout conditions with and without the EODs. The focus was water that would infiltrate through the ground to replenish groundwater. The results are summarized on the following page and showed that the use of the proposed performance criteria significantly increased the amount of water retained within the study area compared with no performance criteria applied.



5. Stormwater BMP Restoration and Offset Locations – offsets to water supply withdrawals and wastewater discharges were identified. These are used to keep water within the study area by reducing or replacing what is taken from surface and groundwaters.

Based on the results of these components, it was recommended that Lancaster incorporate the EODs and performance standards into their regulations and develop a Developer's Guide to the overlays. It was also recommended that DEP, in conjunction with Riverways, develop the water balance model created for this project into a more user-friendly version that could be used state-wide.

1.0 Overview

The purpose of this pilot project is to demonstrate one way to use regulation in a Massachusetts community to better protect water resources from the significant hydrologic changes that are occurring throughout the state related to development. Two main aspects include 1) the development of performance based Environmental Overlay Districts to provide a better 'water balance' in developing areas, and 2) the development of a list of possible 'offsets' to increased water supply withdrawals and wastewater discharges.

The project was funded by the Commonwealth of Massachusetts Riverways Program, with additional funding from the Town of Lancaster via a related ongoing demonstration program called the Integrated Water Resources Management Program or IWRM. That larger project was funded largely by the Department of Housing and Community Development. The Riverways Grant is a *Keeping Water Local Demonstration Project*, and may also serve as a statewide example of the type of project that could be done as a preliminary step to or as part of a Comprehensive Wastewater Management Plan (CWMP) or an IWRM.

The Town of Lancaster is a small but rapidly growing community located in a historic, significant environmentally sensitive area. The Town is experiencing rapid growth as a suburban bedroom community for its larger and more populous neighbors like Leominster and Worcester, but it is also well within commuting reach of Boston. The Town lies in the Nashua River Basin, at the headwaters and confluence of the North and South branches of the river. Much of Lancaster thus drains to the 10,000 acre Central Nashua River Valley Area of Critical Environmental Concern, home to a number of endangered species as well as the Fort Devens military reserve.

There are many problems facing Lancaster, including a lack of economic development in spite of its proximity to Route 2, largely due to the unavailability of water and sewer service in this North Lancaster area. This has resulted in a relatively high tax rate. In addition, growth patterns in Lancaster demonstrate a distinct tendency towards sprawl, with commercial development beginning to occur on Route 70 near Route 2, however, the types of development are not necessarily able to provide as much in terms of local jobs and tax base as desired due to the lack of sewer and water. Much, but not all of the existing development in Lancaster lies on areas with relatively poor soil conditions.

A Comprehensive Wastewater Management Plan (CWMP), or wastewater facilities plan, is ongoing for sewering of South Lancaster with likely discharge to the Clinton Wastewater Treatment Plant to the south. Although this CWMP is nearing completion, it only addresses the southern portion of the Town. Additionally, CWMPs focus on sewering needs with little consideration of how the new sewers might impact population density, drinking water, stormwater, waterways, recharge and wetland resources. The result can be unintended increases in development, which may in turn increase runoff, water supply withdrawals and potentially the export of wastewater from the Town or basin. These combined impacts can have detrimental effects on local rivers, streams and groundwater aquifers, by decreasing recharge and the replenishment of aquifers and baseflows, while withdrawing more and in some cases exporting it away as wastewater.

This problem is becoming more common in Massachusetts and other urbanizing areas, as evidenced by increased flooding and declining streamflows in summer. Streams and rivers receive reduced sustainable base flows due to less recharge, and the increased stormwater runoff contributes high concentrations of pollutants and higher temperature water from its passage over hot asphalt and other surfaces. These pollutants, including increased temperature, can dramatically affect aquatic life. Channel erosion and sedimentation is another common problem, with increased runoff velocities and volumes occurring on a more frequent basis. All of these factors have detrimental effects on aquatic habitat.

> ***The goal of the EOD is to minimize the impacts of development by better planning for growth.***

To prevent these problems from occurring in the central and northern portions of town, Lancaster is in the process of piloting an Integrated Water Resources Management Plan (IWRM) approach (instead of a CWMP) as a Smart Growth technique in these areas. The Fort Devens military reserve is not included in the study area since Lancaster does not have any jurisdiction over the military reserve. The IWRM Plan[1] is a multi-discipline approach that will integrate planning for wastewater with water supply and stormwater by considering all of these aspects of infrastructure to better conserve water resources by maintaining a more natural hydrologic cycle, whereas CWMPs traditionally focus only on wastewater.

Although the IWRM will help to maintain the water balance by sustaining base flows, it does not address the other detrimental effects of increased runoff, particularly increased pollution, warming of streams and channel erosion. To combat these issues, Lancaster is developing an environmental overlay district (EOD) that addresses both water quantity and quality issues. The EOD is a regulatory control that guides development within the Town to help maintain the water balance while addressing water quality. The intent is that the program developed with this pilot could be used in other communities as a preliminary step done before a CWMP or IWRM, one that would lay the groundwork to prevent unintended consequences of sewering by putting a better regulatory framework in place prior to beginning wastewater facilities planning. It also provides a significant tool in that the EOD model can be used to evaluate future sewering and other scenarios in terms of their impacts on the hydrologic cycle.

An EOD consists of one or more designated areas where specific requirements for development are put in place up front so that the hydrologic cycle, fisheries, and water

[1] Massachusetts DEP's IWRM scope has not yet been released but is expected to consider many of the same issues as are being considered in Lancaster's Pilot IWRM.

supplies are better protected before development intensifies, as it often does once water and sewer services become available. The goal of the EOD is to minimize the impacts of development by better planning for growth. EOD areas are selected where a greater level of protection is needed. Lancaster is developing EODs to provide better:

- Pollutant removal
- Temperature control
- Groundwater recharge
- Flood control
- Aquatic habitat protection
- Aquifer sustainability

Each EOD will be accompanied with performance criteria that set the foundation for new development projects to meet the objectives outlined above.

2.0 Summary of Methodology

The project, completed in early 2006, focused on certain common impacts that affect both community expenditures and aquatic life and streamflow. These factors are described below in Section 2.1. In Section 2.3, the study area is further described.

2.1 Targeted Development Impacts

Interference with the Natural Hydrologic Cycle. In a natural hydrologic cycle, a portion of the precipitation goes back into the atmosphere through evaporation and transpiration (evapotranspiration); a portion infiltrates into the ground, where it is able to recharge groundwater flows and provide baseflows for streams, and lastly a portion runs off over the surface of the land and is discharged into nearby surface waters. Figure 2-1 shows a simplified diagram of the hydrologic cycle.

Traditional development interferes with the natural hydrologic cycle. In urbanized areas, the three components (evapotranspiration, infiltration and runoff) still occur but in different proportions and with other factors coming into play. Increased imperviousness significantly increases runoff at the expense of infiltration. Water that once infiltrated through soils to recharge groundwater and replenish baseflows is converted into stormwater runoff. This runoff reaches streams in a matter of hours, as opposed to the several months it would take to reach the streams as recharge.

Infrastructure such as roads, bridges and pipelines may also be damaged as the bank erodes, setting the scene for potentially devastating damage during major floods.

Runoff is further increased as evapotranspiration is also converted to runoff when the original forested cover is removed. In addition, groundwater and surface water are withdrawn for human consumption. In some cases, much of this water consumption is returned to the ground as wastewater, but in other cases it is transferred from the area and discharged in other locations. Groundwater tables are lowered by the lack of infiltration/ recharge and in some cases the additional withdrawals to support the development, so that groundwater discharge to streams (baseflow) may eventually suffer during dry periods. Figure 2-2 shows a simplified diagram of the hydrologic cycle under developed conditions.

Reduced Recharge.
Reduced recharge to groundwater is one of the greatest impacts of development. Recharge is essential to replenish groundwater aquifers, rivers and streams. Without adequate recharge, water supply wells can dry up and/or their yield can be significantly reduced. Rivers and streams can also dry up as groundwater tables are lowered, reducing groundwater baseflows. This is particularly true in the summer when there is less rainfall to supply rivers and streams. The reduced groundwater baseflows also mean higher stream temperatures and greater pollutant concentrations, as more of the streamflow

comes from surface runoff that has heated and picked up pollutants as it traveled over dark, impervious surfaces such as pavement and rooftops.

Flooding. Increased runoff equals increased flooding, which can lead to erosion of natural streambanks and widening of the stream channel to handle the larger flow volumes during frequent storm events. This increases sediment loadings to the streams and exposes plant roots along the banks. Although flood controls such as detention basins have been used for many years to reduce peak flows, they only address the larger infrequent storms, typically those above the 2-year, 24-hour storm. Meanwhile, stream channels are exposed to more frequent erosive flows associated with the smaller storms, resulting in loss of bottom dwelling and other aquatic organisms that rely on relatively stable, sediment-free habitat. Infrastructure such as roads, bridges and pipelines may also be damaged as the bank erodes, setting up the scene for potentially devastating damage during major floods.

Increased Water Temperature. Impervious surfaces also increase stream temperatures. Stormwater runoff is warmed as it travels over hot surfaces such as black pavement and rooftops. This heated surface runoff replaces much of the cool baseflow that reached the stream under natural, undeveloped conditions. This effect is then exacerbated by clearing of trees along streams, eliminating shade needed to keep streams cool. The increased temperatures can reduce dissolved oxygen levels, necessary for fish and other aquatic life to survive. This may lead to the replacement of sensitive fish species and other life forms with organisms that are better adapted to poorer conditions.

Higher Pollutant Loads. Pollutant concentrations also increase with increased runoff. As human land use intensifies, pollutants build up (i.e., pesticides, fertilizers, animal wastes, oil, grease, heavy metals, suspended solids, phosphorus, pathogenic bacteria and road salt). These materials are then washed off by rain and runoff, increasing the pollutant load to receiving waters. Not only does this impact rivers and streams by reducing sensitive species and increasing more tolerant species, but it also impacts receiving lakes and ponds. Increased phosphorus loads to lakes and ponds can cause eutrophication, which increases aquatic vegetation and filling in of the water body. Pathogenic bacteria can lead to beach closures, more costly treatment requirements for surface water supplies and closure of shellfish beds.

Each of these impacts must be controlled to sustain a healthy water balance and environment, and were considered in the development of an EOD for Lancaster. The term ‘water balance’ as used in this report refers to the inflows (i.e., recharge, wastewater inputs) and outflows (i.e., water supply withdrawals, off-site wastewater transfers) to the study area to determine the total net effect on groundwater and baseflow contributions. The purpose of the EOD is to maintain the existing water balance as much as possible, by properly planning for growth.

2.2 Study Area Subwatersheds

In a natural hydrologic cycle, groundwater generally flows towards rivers and streams, since, like surface water, it is subject to gravity and flows downhill. Once reaching a stream or river, the groundwater discharges (as long as it is at a higher elevation than the river), and thus provides baseflow that keeps streams flowing during the dry summer months. As water tables decline due to reduced recharge and increased withdrawals, streams may instead begin discharging to groundwater, losing even more flow. The intensity of this problem is dependent on local conditions such as geology, drainage area and level of development. Larger streams will have a less visible impact than smaller, headwater streams due to their large contributing area.

Considering this factor along with varied land uses within the study area, the evaluation used subwatershed scale evaluations of the hydrologic balance rather than focusing on the largest downstream water body. This allows for evaluations and impacts to headwater streams, as well as the larger receiving streams and provides a more manageable scale to evaluate the study area. This provides more localized information on which to base decisions

Lancaster was divided into 9 subwatersheds to evaluate development impacts and the local water budget for each area. The subwatershed boundaries are natural boundaries dictated by the local topography. These boundaries generally follow ridgelines or high points and represent the area that drains to the furthest downgradient point, which was typically chosen where a stream intersected another stream. Since Lancaster does not have jurisdiction in other towns or the Fort Devens military reserve, these boundaries were also used to delineate subwatersheds, even though the natural topographic boundary may extend into adjacent towns and Fort Devens. Since the water balance is focusing on keeping the water that falls within Lancaster in the Town, rather than on actual streamflows, this method of delineation was appropriate.

Most water bodies within Lancaster drain to the North Nashua and Nashua Rivers. The subwatershed divisions were chosen to represent each of the major tributaries draining to the North Nashua and Nashua Rivers, as well as those water bodies that drain out of town. Figure 2-3 shows the subwatershed divisions. The names and sizes of each subwatershed are listed below:

Subwatershed Name	Area (acres)
Shaker Hill	575
Fort Pond	1089
Spectacle Pond	460
McGovern Brook	767
White Pond	399
North Nashua River	1674
Wekepeke Brook	1315
Ballard Hill	1190
Nashua River	877

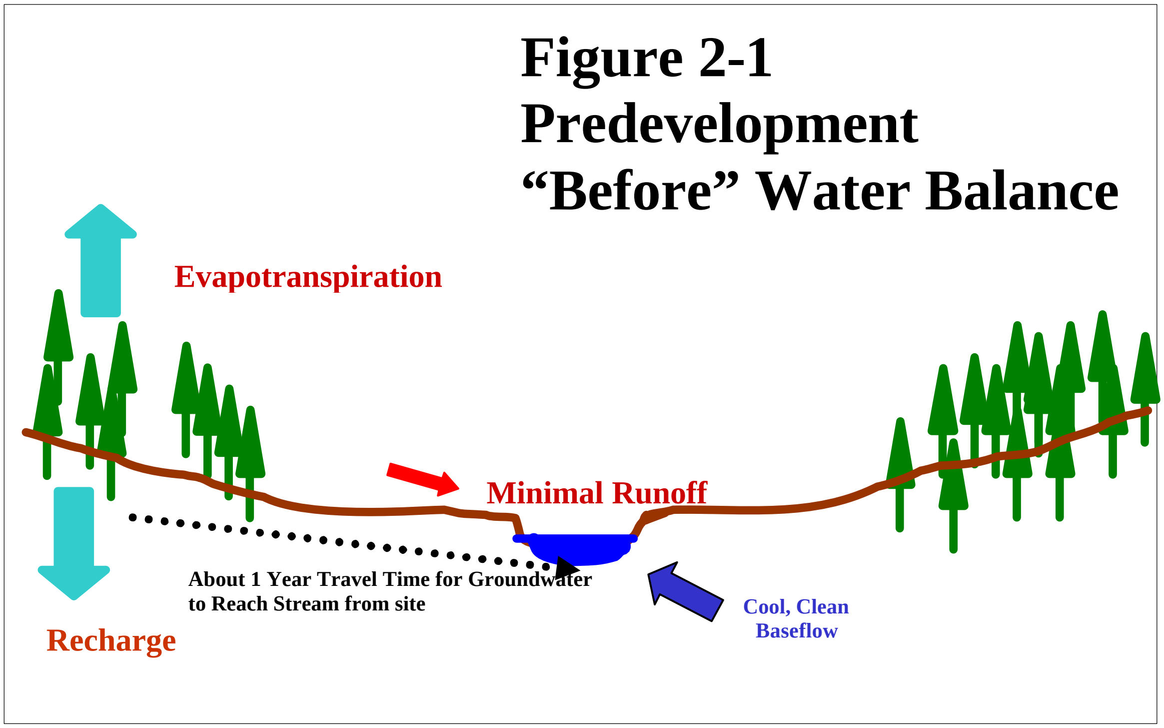


Figure 2-1 Predevelopment "Before" Water Balance

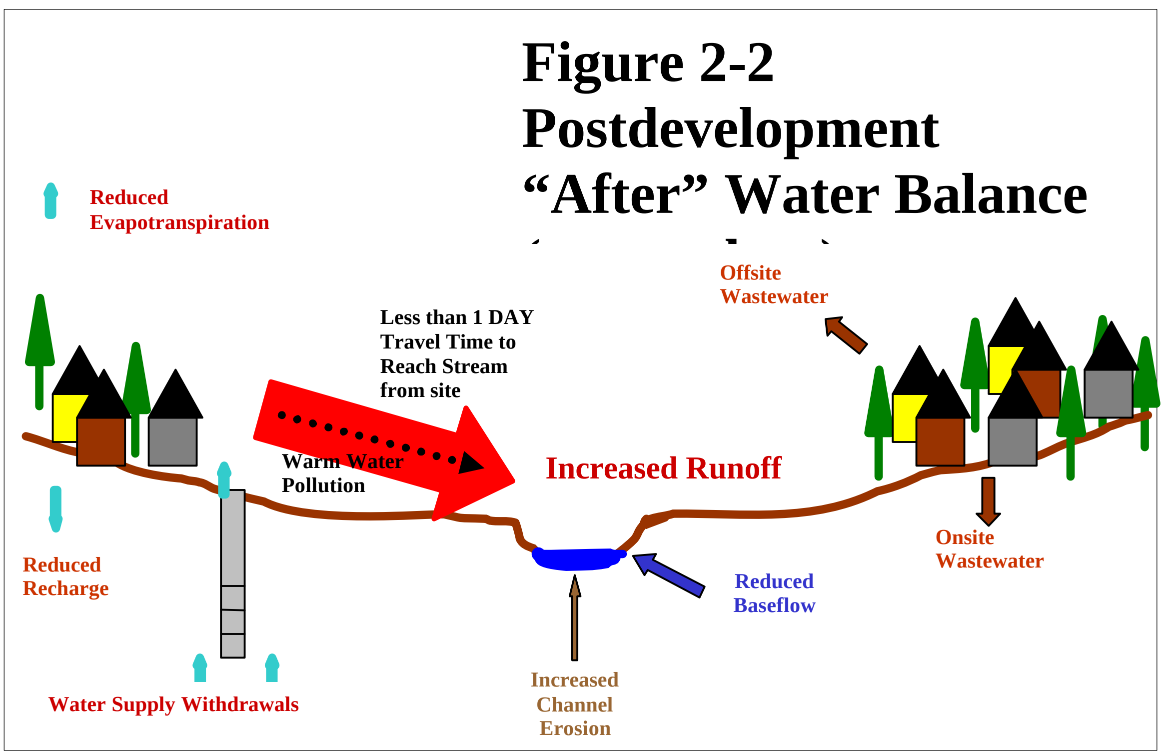
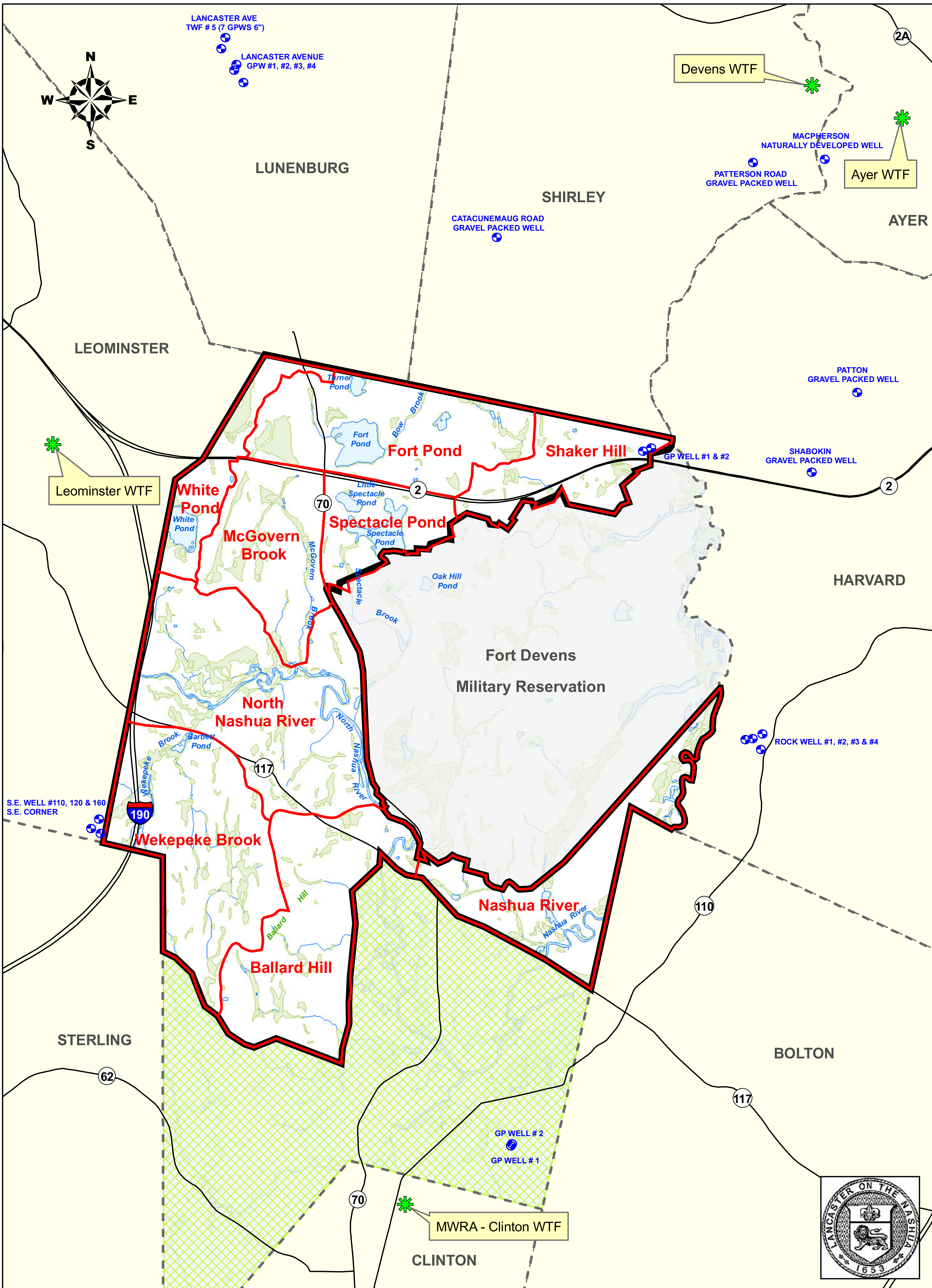


Figure 2-2 Postdevelopment "After" Water Balance



LEGEND

- IWRM Study Area
- Subwatershed Boundaries
- Sewer District
- Public Water Supply
- Wastewater Treatment Facility

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, CEI

0 2,500 5,000 7,500 10,000 Feet

Figure 2-3

Study Area Locus

Lancaster, MA

Comprehensive Environmental Inc.

3.0 Existing Conditions

3.1 Town Characteristics

Existing town characteristics provide a baseline from which to evaluate future development. Lancaster is a bedroom community serving Clinton, Leominster and Worcester. The Town's current land use primarily includes residential and commercial uses with little industry and a few working farms. Community information and land use are presented below.

Entire Town:
- Total Town Area = 28.2 square miles (*source: MA Department of Housing and Community Development*)
- Total Housing Units = 2,141 (*source: US Census Bureau, Census 2000*)
- Average Household Size = 2.8 (*source: US Census Bureau, Census 2000*)
- Total Population = 7,380 (*source: US Census Bureau, Census 2000*)

Study Area:
- Land within Study Area = 13.0 square miles
- Housing Units within Study Area = 859
- Estimated Residential Population within Study Area = 2,405

The land use categories for the Town of Lancaster were obtained from MassGIS with attributes last updated in 2002. Figure 3-1 identifies the types of land use in the study area. General land use categories provide a quick look at land characteristics that influence stormwater quantity and quality. The drainage subwatershed boundaries are shown on the map to illustrate the types of land uses found within particular drainage areas. The majority of Lancaster's land is comprised of undeveloped forested land, followed by residential uses. Most of the commercial and industrial land uses occur outside of the study area, in the southern end of town. The following table indicates the approximate acres and percentage of the major land use categories within the nine study areas.

Lancaster Land Use		
Landuse	**Acres**	**Percent**
Forest	5730.0	68.7%
Open Land	585.3	7.0%
Low Density Residential	544.8	6.5%
Crop Land	450.6	5.4%
Transportation	311.7	3.7%
Water	290.7	3.5%
Pasture	151.0	1.8%
Institution	78.1	0.9%
Non-Forested Wetland	64.4	0.8%
Commercial	56.9	0.7%
Waste Disposal (includes auto salvage yards)	48.3	0.6%
Urban Open	33.2	0.4%
Industrial	0.0	0.0%

* Open Space land use includes mining, and recreation land.
Source: MassGIS Land Use data layer

3.2 Zoning

The zoning for North Lancaster includes a large area of Light Industry just south of Route 2 and two moderate areas of Limited Office north of Route 2. The remainder of the underlying zoning in North Lancaster is Residential. Figure 3-2 shows existing zoning within the town. In addition, there are two existing overlay districts, one for Floodplains and one is the Water Resources District. Each of these is defined below:

Light Industry: General business district with allowance for recreational facilities

Limited Office: Offices, banks, warehousing, limited manufacturing

Residential: Two acre zoning for single family residences

Floodplains: Floodplain district overlay, prohibits residential developments

Water Resources: Overlay district for aquifers prohibits certain uses such as landfills and sewage disposal of more than 440 gallons of sewage/acre. Also requires a special permit for many activities and for any use that results in imperviousness of greater than 15% or 2,500 square feet of any lot. Recharge is encouraged but with limited pretreatment requirements.

The following table summarizes the size of each zoning district within the study area, as well as other land that doesn't fit into one of the zoning classifications. This other land includes the Route 2 corridor, owned by MA DOT, which is called out separately.

Lancaster Zoning		
Zoning District	**Acres**	**Percent**
Residential	6613.7	79.3%
Light Industry	920.7	11.0%
Limited Office	607.9	7.3%
Other Land		
Other (Transportation)	202.4	2.4%

3.3 Groundwater Aquifers

Groundwater aquifers are a valuable resource for providing businesses and individuals with potable water and sustaining baseflows in surface water bodies such as rivers and streams. The USGS identifies aquifers as low (<50 gpm), moderate (100-300 gpm) or high (>300 gpm) yield. Most public water supply withdrawals are located in the moderate to high yield aquifers.

Lancaster has several moderate yield aquifers within the Town and a few small areas with high yield aquifers. The largest high yield aquifer is located in the southeast corner of Town and also runs through Clinton and Bolton. Lancaster currently has two water supply wells within this aquifer that service the southern portion of Town. A moderate yield aquifer surrounds the high yield aquifer in this same area. Figure 3-3 identifies the aquifers and water supplies within Lancaster.

There are also two large moderate yield aquifers in the northern portion of Town. One is located adjacent to the Nashua River, most of it within the Fort Devens Military Reservation and the other is located near Fort Pond and Spectacle Brook. There are some community wells located within these aquifers, but the Town does not currently have a water supply in these sources.

MA DEP provides some regulation of water supply wells through Zone I and Zone II protective radii. The Zone I is the protective radius around the well or wellfield and is 400 feet for wells with approved yields of 100,000 gpd or greater. The Zone II is defined as the area of the aquifer which contributes water to a well under 180 days of pumping at the approved yield with no recharge from precipitation. It is bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock.

Most communities establish regulations that prohibit certain uses within the Zone I and Zone II, consistent with MA DEP recommendations. However, these are only protective of existing water supply sources and contributing areas, and offer no protection of the untapped aquifer, which may be needed for future water supply sources.

Lancaster has designated an 'Existing Water Resource Protection District' in the southeast and northern portions of Town. This overlay district provides some additional protection for these areas, however, it does not correspond with the Town's Zone II, leaving much of the Zone II unprotected. Additionally, the remaining aquifer is unprotected, leaving it susceptible to contamination and depletion from future development. A greater level of protection is required to preserve these sources for future use.

3.4 Flooding Conditions

Flood plain information currently available to the community was defined from a 1978 hydrologic and hydraulic study completed by the Federal Emergency Management Agency (FEMA). Local planners have used the study to develop regulations that include standards for the use of land within flood plains, elimination of dangers to health and public safety and prevention of loss and damage to property.

There are about 3,100 acres within the FEMA 100-year flood plain in Lancaster. The flood plains primarily follow streams and rivers with larger areas occurring along the Nashua and North Nashua Rivers and encompassing many of the Town's wetlands. Figure 3-4 identifies the land within Lancaster that is included in the FEMA 100-year flood plain.

Encroachment on flood plains, such as fill and new construction, reduces the flood-carrying capacity, while increasing the flood zone. The Town of Lancaster's Flood Plain Regulations prohibit all residential development in the floodplain, but allow other types of development if an applicant can show that encroachments on the flood plain do not increase the 100-year flood level. Additionally, under the provisions of the Massachusetts Wetlands Protection Act, local conservation commissions have the authority to impose an order of conditions to regulate alterations to wetland and flood plain areas, such as requiring compensation for storage for projects that create an impact to wetlands and/or reduce flood storage.

While the loss of flood plain volume from fill and new construction can be easily calculated, the cumulative effects of increased stormwater runoff from impervious surfaces or land use changes within the watershed are not as easily quantified. Pavement, rooftops, lawns and reduced vegetation create an environment that produces large volumes of stormwater and provides little if any infiltration. The result is the widening of existing floodplains and more frequent flooding.

3.5 Critical Habitats

Lancaster is home to many critical habitats that could be impacted by uncontrolled development. A critical habitat, as defined by the Endangered Species Act, is an area essential to the conservation of a listed species, though the area need not actually be occupied by the species at the time it is designated. Examples of critical habitats include cold water fisheries, critical wetlands and recreational waters. In Lancaster, most of these are within a designated Area of Critical Environmental Concern (ACEC), which comprises 10,100 acres of land in Lancaster. According to 301 CMR 12.00, ACECs are those areas within the Commonwealth where unique clusters of natural and human resource values exist and which are worthy of a high level of concern and protection. The natural and human resources within the ACEC consist of extensive surface waters, wetlands, floodplains and aquifers, as well as interrelated riparian and upland wildlife and rare species habitat, forest, farmlands, and publicly and privately owned open space. Portions of the ACEC are also included in the statewide Scenic Landscape Inventory, and reflect the unique cultural history and natural beauty of the area. The ACEC was designated by the Secretary of Environmental Affairs and includes the Central Nashua River Valley, located in portions of Bolton, Harvard, Lancaster and Leominster. The ACEC designation was based on the quality of the natural characteristics, productivity of the environment, uniqueness of the area, irreversibility and magnitude of impact, threat to the public health through inappropriate use, economic benefits and supporting factors. Figure 3-5 shows critical habitats within Lancaster.

Cold Water Fisheries. Both warm and cold water fisheries are located in Lancaster. Cold water fisheries are considered more critical since the cooler temperatures are more difficult to maintain as development occurs. When land is developed, stormwater runoff is heated from warmed paved surfaces and discharged into water bodies, which in turn raises the temperature of the water. Only one cold water fishery is present in Lancaster. This is the Wekepeke Brook, which supports trout in the Cooks Conservation area.

According to the Massachusetts Division of Water Pollution Control, the North Nashua River and the Nashua River within Lancaster were once classified as cold waters, but have degraded to Class B warm waters. Class B waters are designed as a habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Where designated they are suitable as a source of public water supply with appropriate treatment, as well as for irrigation and other agricultural uses and for compatible industrial cooling and process uses. Classification is based on dissolved oxygen, temperature, pH, fecal coliform bacteria, solids, color and turbidity, oil and grease, and taste and odor. However, as the water quality in the North Nashua River and the Nashua River improve, it may again support cold water fish and be re-classified as Class B cold waters. In 1991 a brook trout was caught in the North Nashua River below the Cook Conservation Area and attests to the improving waters associated with the North Nashua River and it tributaries.

Critical Wetlands. There is an extensive system of wetlands located in Lancaster. These wetlands are associated with the North Nashua River and Nashua River and their tributaries and are located within the ACEC. Additional critical wetlands that are also located within the ACEC are those associated with the Cooks Conservation Area and the Lancaster State Forest. The Cooks Conservation Area consists of 100 acres of wetlands.

The wetlands associated with the North Nashua and Nashua Rivers have been identified as priority wetlands by both the North American Waterfowl Management Plan and the Emergency Wetlands Resource Act of 1986, due to their critical importance in supporting waterfowl of the Atlantic Flyway. Since the Nashua River is a tributary to the Merrimack River, its wetlands were also cited on the U.S. Environmental Protection Agency Priority Wetlands of New England listing in 1987. The lands surrounding the various types of wetlands are also protected to help prevent contamination and provide a more varied wildlife habitat. There are many types of wetlands along the North Nashua and Nashua rivers which include wet sedge meadow, bushy oxbow swamps to forested wetlands and flood plains.

Recreational Waters. Recreational waters include waters designated for swimming, boating, fishing, and wildlife viewing. These waters include lakes, ponds, rivers, and brooks. Lancaster has several recreational waters in the study area which include:

- Turner Pond – Turner Pond is located in the northern end of Lancaster bordering Lunenburg. Turner Pond has few waterfront houses and is used for swimming, non-motorized boating, fishing, and wildlife viewing.

- Fort Pond – Fort Pond is located in the northern part of Lancaster just south of Turner Pond. Fort Pond has several waterfront houses, and a boat ramp. Fort Pond is used for swimming, motorized and non-motorized boating, fishing, and wildlife viewing.

- Little Spectacle Pond – Little Spectacle Pond is located just north of Spectacle Pond and just south of Route 2. Little Spectacle Pond has some waterfront housing and public access to the pond is limited. Little Spectacle Pond is used for swimming, motorized and non-motorized boating, fishing, and wildlife viewing.

- Spectacle Pond – Spectacle Pond is located just south of Little Spectacle Pond and Route 2. Spectacle Pond has several waterfront housing and public access to the pond is limited to the town beach. Spectacle Pond is used for swimming, motorized and non-motorized boating, fishing, and wildlife viewing. However, there is no public boat ramp for motorized boating. Access for non-motorized boating is available through the town beach.

- White Pond – White Pond is located on the northwestern side of Lancaster with a portion of the pond located in Leominster. White Pond has some waterfront housing and there is no public boat access ramp. White Pond is used for swimming, non-motorized boating, fishing, and wildlife viewing.

- Bartlett Pond – Bartlett Pond is located in the western portion of Lancaster, and access to the pond is gained off Route 117. Bartlett Pond is a small pond used for non-motorized boating, fishing, and wildlife viewing.

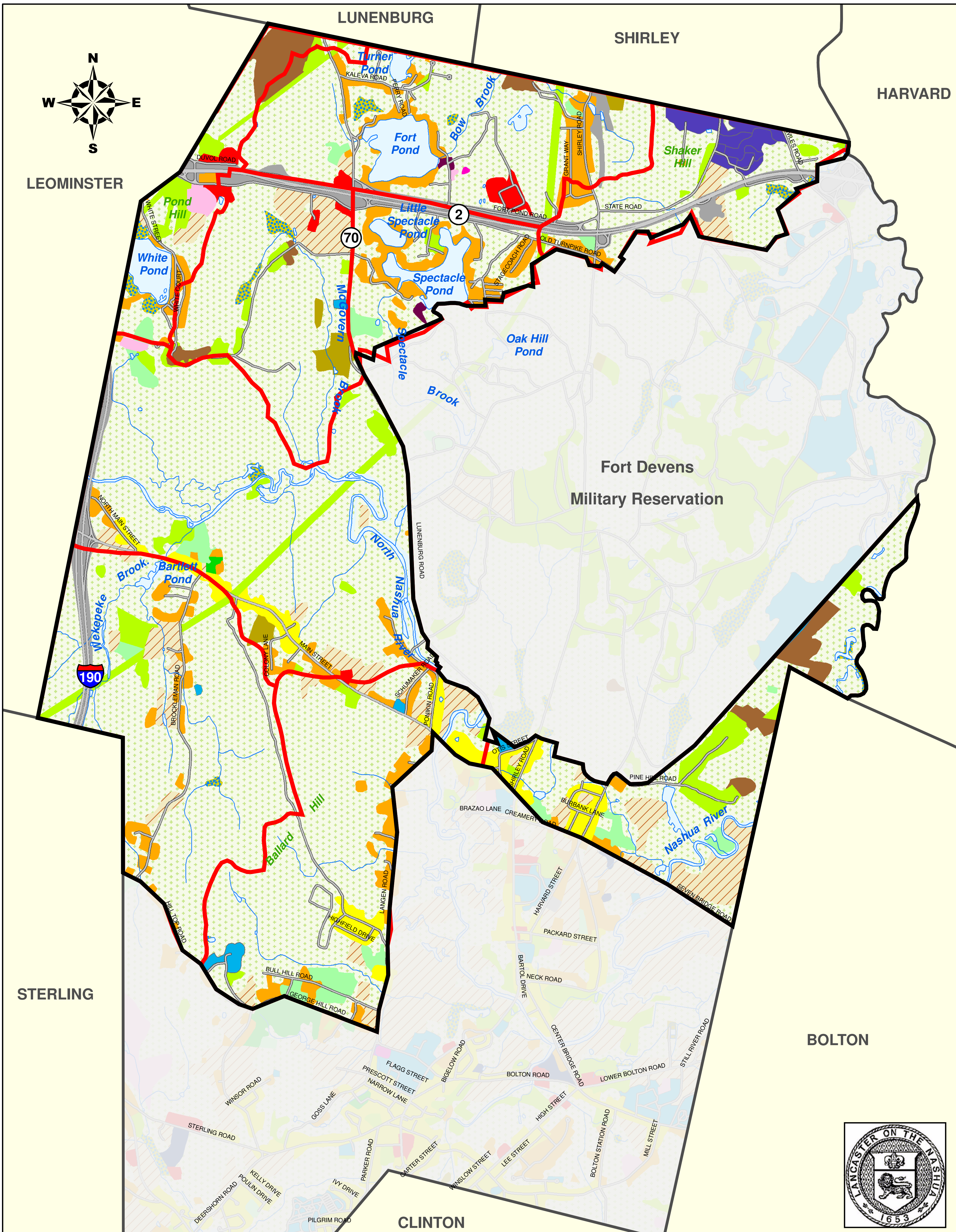
- McGovern Brook – McGovern Brook is located within the northern part of Lancaster and flows south through Lancaster State Forest and converges with the North Nashua River within Cooks Conservation Area. McGovern Brook is used for fishing and wildlife viewing.

- Spectacle Brook – Spectacle Brook flows south out of Spectacle Pond and joins with the North Nashua River just south of Cooks Conservation Area. Spectacle Brook is used for fishing and wildlife viewing.

- Wekepeke Brook – Wekepeke Brook is located in the western portion of Lancaster and flows north out of Leominster through Bartlett Pond and joins with the North Nashua River just southwest of Lancaster State Forest. Wekepeke Brook is used for fishing and wildlife viewing.

- North Nashua River – The North Nashua River flows southeast through Lancaster to the Nashua River. The North Nashua River is used for fishing, non-motorized boating (canoeing), and wildlife viewing. There are several boat ramps located within Lancaster and in the surrounding towns.

- Nashua River – The Nashua River starts in South Lancaster and flows northeast through Lancaster. The Nashua River is used for fishing, non-motorized boating (canoeing), and wildlife viewing. Access to the River is gained by boat ramps located along the Nashua River.



LEGEND

Land Use

- Crop Land
- Pasture
- Forest
- Non-Forested Wetland
- Mining
- Open Land
- Participation Recreation
- Spectator Recreation
- Water-Based Recreation
- Medium Density Residential
- Low Density Residential
- Commercial
- Industrial
- Urban Open
- Transportation
- Waste Disposal
- Water
- Woody Perennial

Hydrography

- Lake, Pond
- Stream, Brook
- IWRM Study Area

Data Source: MassGIS

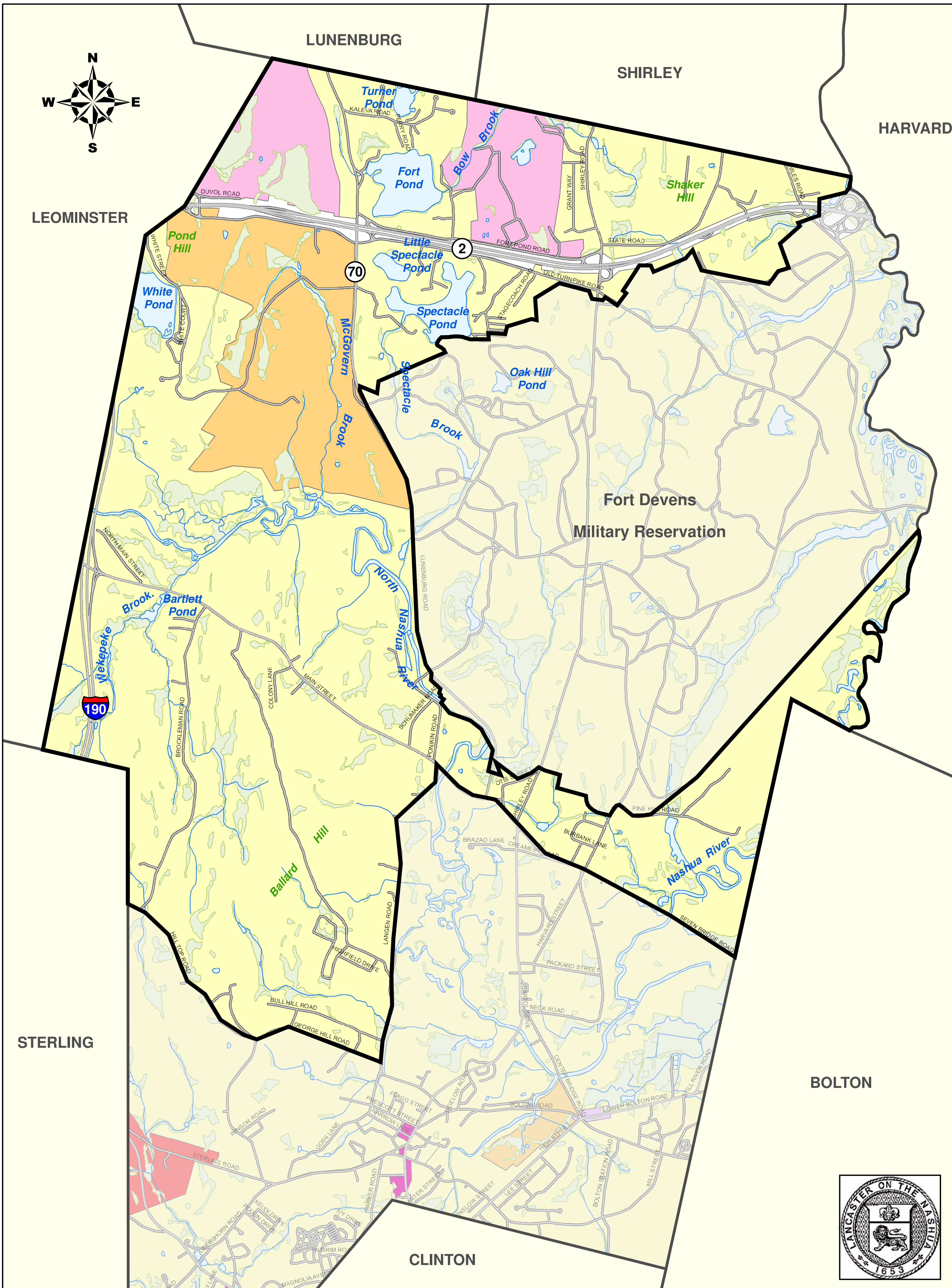
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 3-1

Land Use

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

Zoning Boundaries
- Residential
- Neighborhood Business
- Highway Business
- Limited Office
- Light Industry
- General Indusrty

Hydrography
- Lake, Pond
- DEP wetlands
- Stream, Brook
- IWRM Study Area

Data Sources: Town of Lancaster, MassGIS

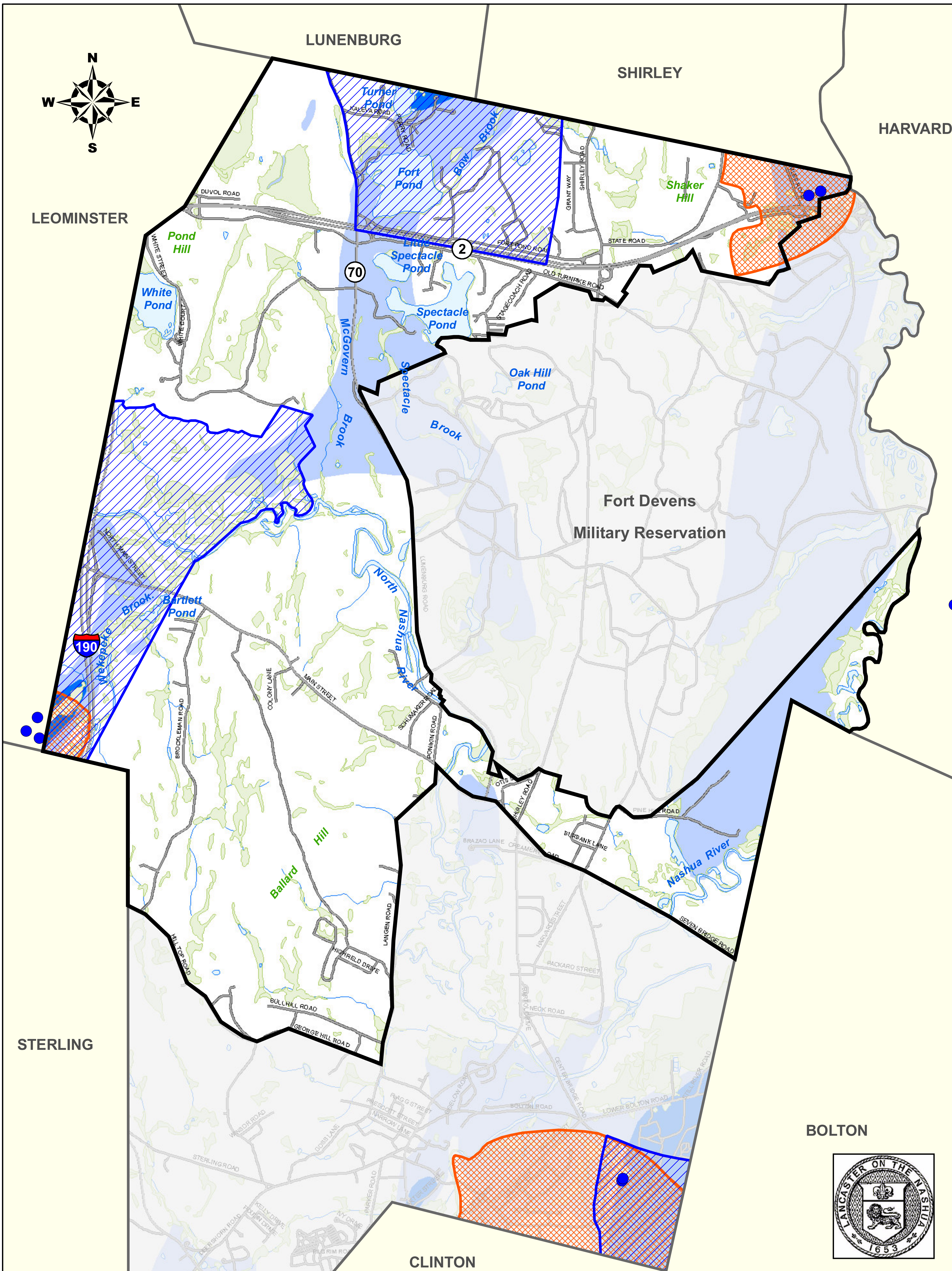
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 3-2

Zoning Map

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

- Public Water Supply
- ZONE II - Recharge Area
- Water Resource District

Aquifer Yield (Gallons per Minutes)

- 100-300
- >300

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook
- IWRM Study Area

Data Sources: Town of Lancaster, MassGIS, MADEP

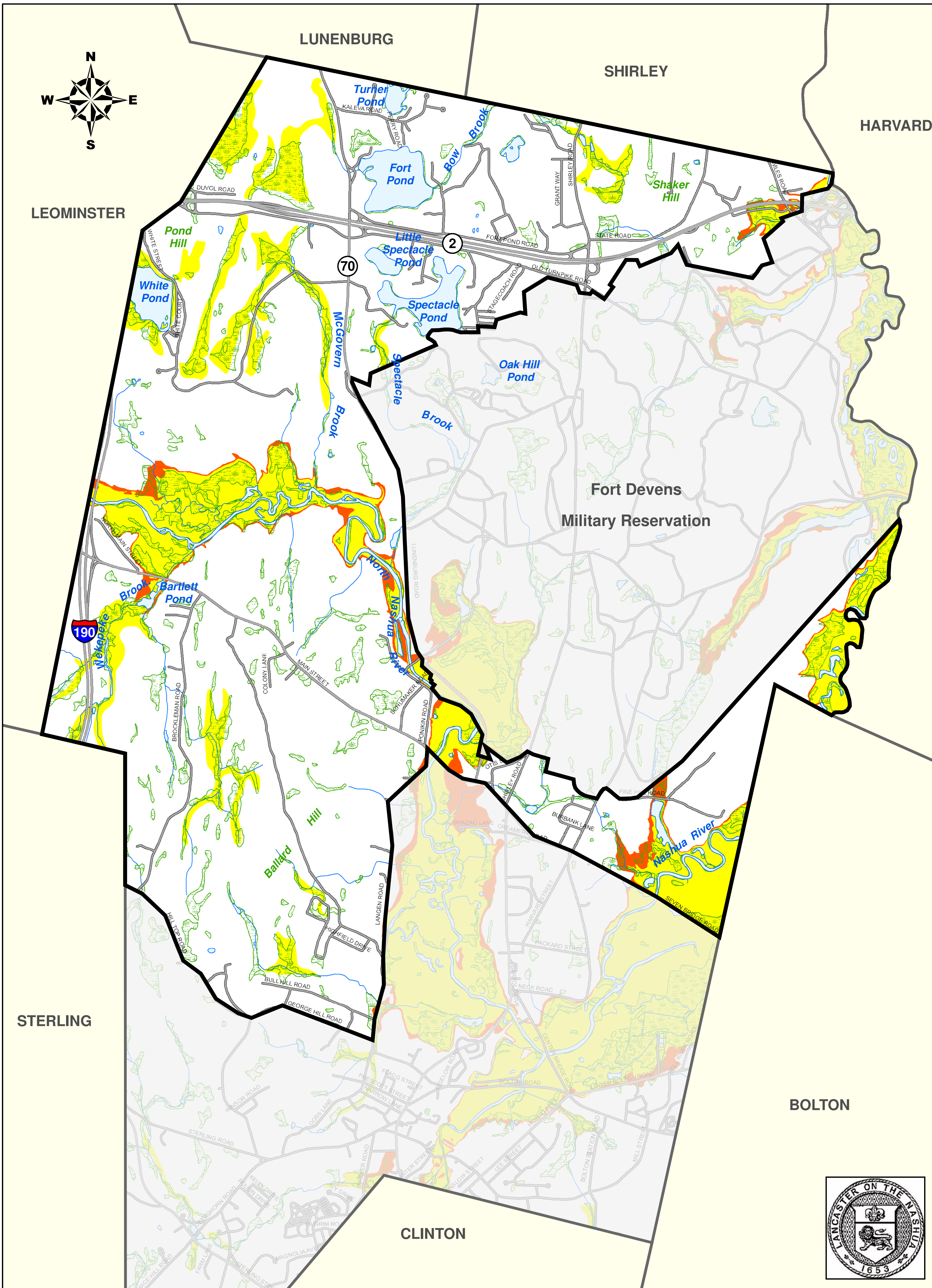
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 3-3

Water Resources

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

FEMA Flood Zones

- Inundated by 100-Year Storm
- Inundated by 500-Year Storm
- IWRM Study Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP, FEMA

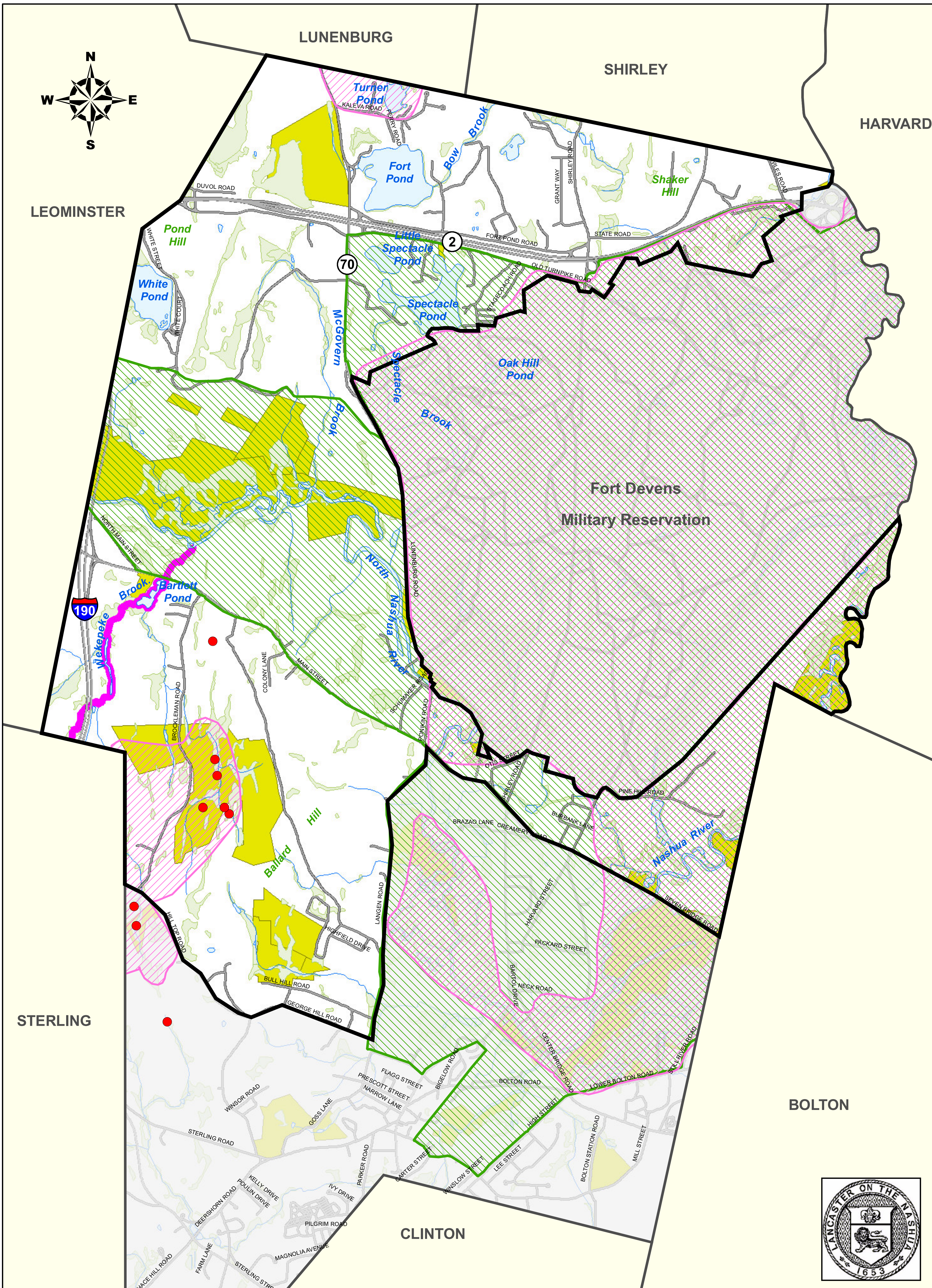
0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 3-4

Flood Zones

Lancaster, MA

Comprehensive Environmental Inc.



LEGEND

- Certified Vernal Pool
- Priority Habitats of Rare Species
- ACEC
- Protected and Recreational Open Space
- Cold Water Fishery

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook
- IWRM Study Area

Data Sources: Town of Lancaster, MassGIS, CEI

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 3-5

Critical Habitats

Lancaster, MA

Comprehensive Environmental Inc.

4.0 Buildout Assessment

The majority of the study area is currently undeveloped, so the buildout analysis is particularly important in evaluating and mitigating the impacts of future growth on the water balance. Prevention is a far more cost-effective approach than trying to reestablish a reasonable hydrologic balance when the land has already been developed.

The buildout analysis performed for Lancaster relied on the assumptions used by EOEA in its buildout analysis for the Town, however, a more detailed analysis of parcels was performed. Zoning, land use, wetlands and floodplain data layers were obtained from MA GIS. The 2003 parcel layer was obtained from the Montachusett Regional Planning Commission (MRPC). The 2006 assessor's database was obtained from the Lancaster Assessing Office.

A parcel level analysis was performed to determine existing parcel sizes, which parcels were already developed and which parcels remained to be developed within the study area. This analysis was performed using the 2003 parcel layer and the 2006 parcel database. This database identified the year parcels were developed, allowing for easy identification of developed and undeveloped parcels. The existing zoning classifications were applied to each parcel to determine whether the parcel was or would be developed as residential, limited office or industrial.

Undeveloped parcels were then analyzed further under current zoning to determine the potential number of residential lots that could be developed for each parcel in a residential scenario, and the total square footage of building that could be developed in a commercial/industrial scenario. The following assumptions were applied.

Residential Zoned Parcels – The amount of wetlands and floodplains on each parcel was determined using GIS. As with EOEA, it was assumed that 75% of wetlands and floodplains in the residential district would be included in lot sizing. Based on this, 75% of the wetlands and floodplains were added to the dry upland land. This was multiplied by a factor of 0.839, taken from EOEA, which accounts for roadway right of ways and property setbacks. The number was then divided by two acres to determine the number of new homes that could be developed on each parcel. Homes were rounded to a whole number. An average household size of 2.8, as obtained from the 2000 U.S. Census was applied to obtain the total population for each parcel.

Developed parcels that were greater than four acres were assumed to develop further at buildout. In these cases, one two acre lot was subtracted from the parcel and the remainder was assumed to be developable under the same assumptions identified above.

Limited Office/Industrial – The assumptions used in the EOEA buildout analysis for commercial/industrial development were applied. Wetlands were subtracted from each parcel and Floor Area Ratios (FAR) were applied to the remaining undeveloped land.

These were obtained from the EOEA buildout analysis, which considered building height and parking restrictions. A separate FAR was applied for land within and out of floodplains. The FARs used were:

Limited Office District:	**FAR**
Inside 100-Year Flood Zone:	0.39
Outside Wetland Area & 100-Year Flood Zone:	0.53
Light Industry District:	
Inside 100-Year Flood Zone:	0.32
Outside Wetland Area & 100-Year Flood Zone:	0.42
General Industry District:	
Inside 100-Year Flood Zone:	0.34
Outside 100-Year Flood Zone:	0.46

A summary of the buildout analysis is provided in Sections 5.0 and 6.0.

5.0 Environmental Overlay Districts

Stormwater and wastewater can cause specific problems for the environment. Stormwater runoff warms rivers and streams, produces flashy flows and contributes stormwater pollutants, while reducing groundwater recharge and baseflow. Wastewater discharges from septic systems and treatment facilities can also be harmful to aquatic life, by adding excessive nutrients to water bodies. All of these things are unhealthy for aquatic life. As described earlier, environmental overlay districts may provide the needed protection for identified environmental resources by tailoring protection to the source of pollution and towards a better balance of water in the hydrologic cycle.

A multi-layered approach was taken for the environmental overlay districts in this project to promote a more natural water balance and protect resources from increased pollutants and warming. Three overlays were included, two of them new and one expanded, as follows:

<u>1. Stormwater Overlay District.</u> This new district could either be townwide or could just cover the North Lancaster area. It targets stormwater controls to increase recharge, reduce pollutants and channel erosion, and to provide cooler stormwater discharges.

<u>2. Fisheries and Aquatic Habitat Overlay District (Fisheries Overlay).</u> This new district protects fisheries and aquatic life as well as recreational water resources through two methods. First, the Fisheries Overlay targets large wastewater discharges with requirements for additional treatment to reduce nutrients. It also requires certain stormwater practices related to cooling of stormwater, namely underdrain filters. This district's boundaries cannot be defined by a map, but includes any lot containing bordering vegetated wetlands or their 100-foot buffer.

<u>3. Expanded Water Resources Protection District.</u> The existing Water Resources Protection Overlay is expanded to include high and medium yield aquifer areas not previously included, as well as their zone of contribution as defined by the contour divide. Figure 5-1 shows the Revised Water Resources District. In addition to some modifications of the existing performance standards, the new district will also require certain pathogen and nutrient controls on large flow wastewater systems (>1,000 gpd).

Each of the overlay districts is associated with specific performance standards controlling development impacts. Together, the overlay districts proposed herein would provide the following environmental benefits:

1) Pollutant removal – pollutants are carried by stormwater into lakes and streams, creating an unhealthy environment for aquatic life. These should be removed before stormwater is discharged.

2) Temperature control – warm stormwater flows and reduced groundwater baseflows increase stream temperatures, creating an unhealthy environment

for aquatic life. Temperatures should be controlled or sustained by minimizing the impacts to stream baseflows and through the use of infiltration and underdrain outlets that cool stormwater runoff.

3) Groundwater recharge – streams are drying up or becoming intermittent because rain water that once infiltrated the soils is now reaching the streams as stormwater runoff, reducing the quantity of groundwater that would have otherwise flowed to the streams as groundwater baseflow. Recharge is needed to more closely resemble a natural hydrologic cycle.

4) Sustainable aquifers – In addition to increasing the flows to streams, increased recharge will also provide more sustainable aquifers for water supply withdrawals.

5) Flood control – increased runoff rates and volumes create flooding problems which must be controlled to prevent damage to property and future infrastructure repair costs.

6) Channel protection – increased frequency of runoff rates and discharge volumes to streams increase stream-bed scouring and channel erosion, even during smaller storms, which destroy aquatic habitat. Control of runoff from smaller storms is necessary to prevent this.

5.1 Stormwater Performance Standards & Overlay District

The Massachusetts Department of Environmental Protection has an existing Stormwater Management Policy that outlines performance criteria and controls to increase recharge and address pollutants. However, this policy only applies to discharges within jurisdiction of the Wetlands Protection Act, leaving most uplands unprotected unless a town chooses to adopt this as a town-wide requirement. Additionally, although the policy does require some recharge, runoff is allowed to increase significantly in quantity and the controls on quality are limited. Past damages to recharge to improve existing streamflow conditions are not considered, and the policy does not address the damage associated with small, frequent storms, which have recently been identified as a major concern for stream channels.

To address these areas of limited benefit, the performance standards developed for this pilot project focus on increased recharge, while addressing pollutants, warming and flooding – all on a study area-wide or town-wide basis. Performance criteria were developed based on soil types (Figure 5-2) and groundwater levels (Figure 5-3). The performance criteria and overlay district apply to the entire study area, since the benefits are universally needed, and all stormwater discharges ultimately reach a surface water body, no matter where the development occurs. More infiltration and recharge is promoted in more permeable soils and less for tighter soils, not so much to compensate for existing development, but to accommodate the potential increased runoff generated when the forest cover is lost and evapotranspiration is converted to runoff. Groundwater levels also dictate the type of stormwater treatment that can be provided. The following is a summary of the performance criteria:

A Recharge is required for groundwater depths greater than four feet at the quantities provided in the table below.

Performance Criteria	
Soil Type	**Recharge Over Impervious Surface (inches)**
A	1.25
B	1.00
C	0.65
D	0.10

B A water quality volume (WQV) of 1" over the impervious surface must be treated to remove pollutants before being discharged to surface waters. Acceptable treatment methods include:

1 Infiltration at a rate not to exceed 2.5 inches/hour
2 Bioretention with infiltration or an underdrained outlet structure
3 Wet pond with underdrained outlet
4 In all cases, the stormwater water quality volume must be treated through either infiltration or an underdrain discharge system that allows the water to cool before being discharged. An underdrain system works by forcing the stormwater through a soil filter located above a gravel-packed drain and allowing for slow release of the water. The cool soils and gravel help to cool the water before it is discharged.

C Post-development peak flows can not exceed pre-development peak flows for the 2-, 10- and 25-year, 24-hour storms. This will provide flood control for the larger storms.

D 24-hour extended detention of the 1-year, 24-hour storm must be provided. This reduces channel erosion in streams from the more frequent storms. This is not required for direct discharges to a lake, estuary or 4^{th} order stream. However, the recharge and water quality treatment requirements outlined above will still be required for these discharges.

E Steep slope considerations for slopes over 25% (see Appendix A).

Refer to the Logic Chart on Figure 5-4 for an overview of the stormwater performance criteria and how they apply.

5.2 Wastewater Performance Standards & Overlay Districts

The Integrated Water Resources Management Plan (IWRM) being prepared by Lancaster concurrently with this study considers wastewater facilities planning with a greater than normal consideration of innovative and alternative systems and options. It also considers water supply and stormwater impacts from sewering and weaves these three major aspects of the Town's services together to provide a more cost-effective solution to encouraging appropriate economic growth while providing a viable alternative to sprawl.

The expanded Water Resources District and the Fisheries Overlay take into account that the alternatives chosen by the Town to provide for wastewater treatment are not yet known (for North Lancaster) and may include continued Title 5 systems in some areas, decentralized wastewater treatment systems or large flow systems in some areas and central waste treatment for some areas.

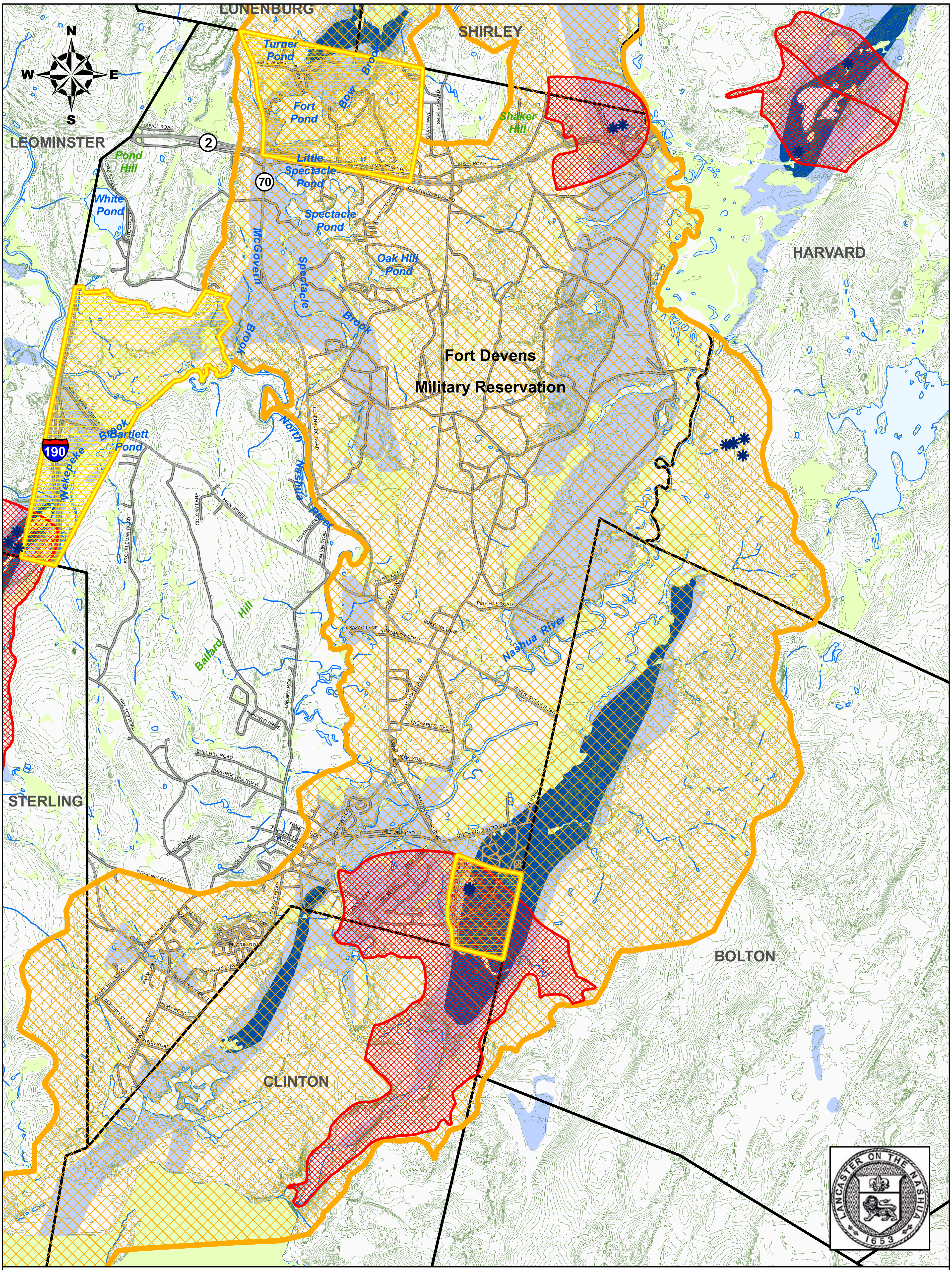
From a water balance perspective, individual onsite systems may provide the best solution, but they may also lead to sprawl and may not be feasible in some areas due to soils constraints. This may lead to the greater use of decentralized wastewater treatment systems or large flow systems (>1,000 gallons per day or gpd) that fall between centralized treatment and individual systems.[1] Due to their size, these systems do have greater potential to pollute nearby water resources or aquifers if not designed or sited correctly. On the other hand, these may be suitable for providing 'villages' with wastewater treatment at a considerably reduced cost from centralized treatment. Similar to individual onsite systems, they may also help keep the water within the area it was taken from, helping to maintain the water balance, whereas centralized systems may send it to an offsite location. These treatment systems may be combined with alternative collection systems such as grinder pumps to pressure collection systems or septic tank effluent gravity or pressure collection (STEG or STEP) systems. Each has potential for greater problems such as large sludge quantities or considerable septage management, but they may also provide considerable savings over gravity sewers which typically only become cost-effective with more than 100 houses per mile with business and industrial base and where distance to the main sewer line is within five miles. However, the water balance should also be considered when weighing options, as sewering could result in off-site flows, disrupting the water balance.

Boosting the treatment effectiveness of large flow systems is the aim of the revisions to the Water Resources Protection District and Fisheries Overlay Districts. In these overlays, nutrient and pathogen reduction technologies will be favored over less effective techniques, and the 'treatment trains' may include additional steps that will protect local aquifers from pathogens and nitrate pollution, and protect aquatic life from nutrient pollution. These will be done through the following performance goals:

[1] Title 5 covers up to 10,000 gpd systems, while CMR 314 covers systems 10,000 gpd and over. This performance standard uses 1,000 gpd as a supplemental threshold for additional treatment requirements since these large flow systems may be more likely to cause environmental damage or pollute aquifers. These are also more likely to handle commercial or industrial development or multiple residences in the North Lancaster area, and are more likely to occur in areas that remain unsewered by central systems.

- Large flow wastewater treatment systems (>1,000 gpd) in the revised **Water Resources Protection District** must meet 10 mg/L nitrate at the property boundary or limit of sensitive resource and must include pathogen treatment. Medical offices, veterinary hospitals and nursing homes that have the potential for high pathogen pollution from either large flow or individual systems must also include pathogen controls, for example, recirculating filters, use of alternate fields, or the addition of ultraviolet disinfection in some cases.[2]
- Large flow wastewater treatment systems (>1,000 gpd) in the **Fisheries Overlay** must also meet 10 mg/L nitrate at the property boundary or limit of sensitive resource, which may require the use of nutrient reduction technologies such as recirculating filters that provide aerobic/anaerobic steps for nitrification/denitrification to minimize any impacts on aquatic life or recreational resources.

[2] The Integrated Water Resources Management Plan describes technologies and their appropriate use in further detail.



LEGEND

- Public Water Supply
- Existing Water Resource Protection District
- MADEP ZONE II
- Revised Water Resource Protection District

Aquifer Yield (GPM)

- 100-300
- >300

Hydrography

- Lake, Pond
- DEP Wetlands
- Stream, Brook
- Elevation Contour
- Town Boundary

Data Sources: Town of Lancaster, MassGIS, MADEP, CEI

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 5-1

Revised Water Resource Protection District

Lancaster, MA

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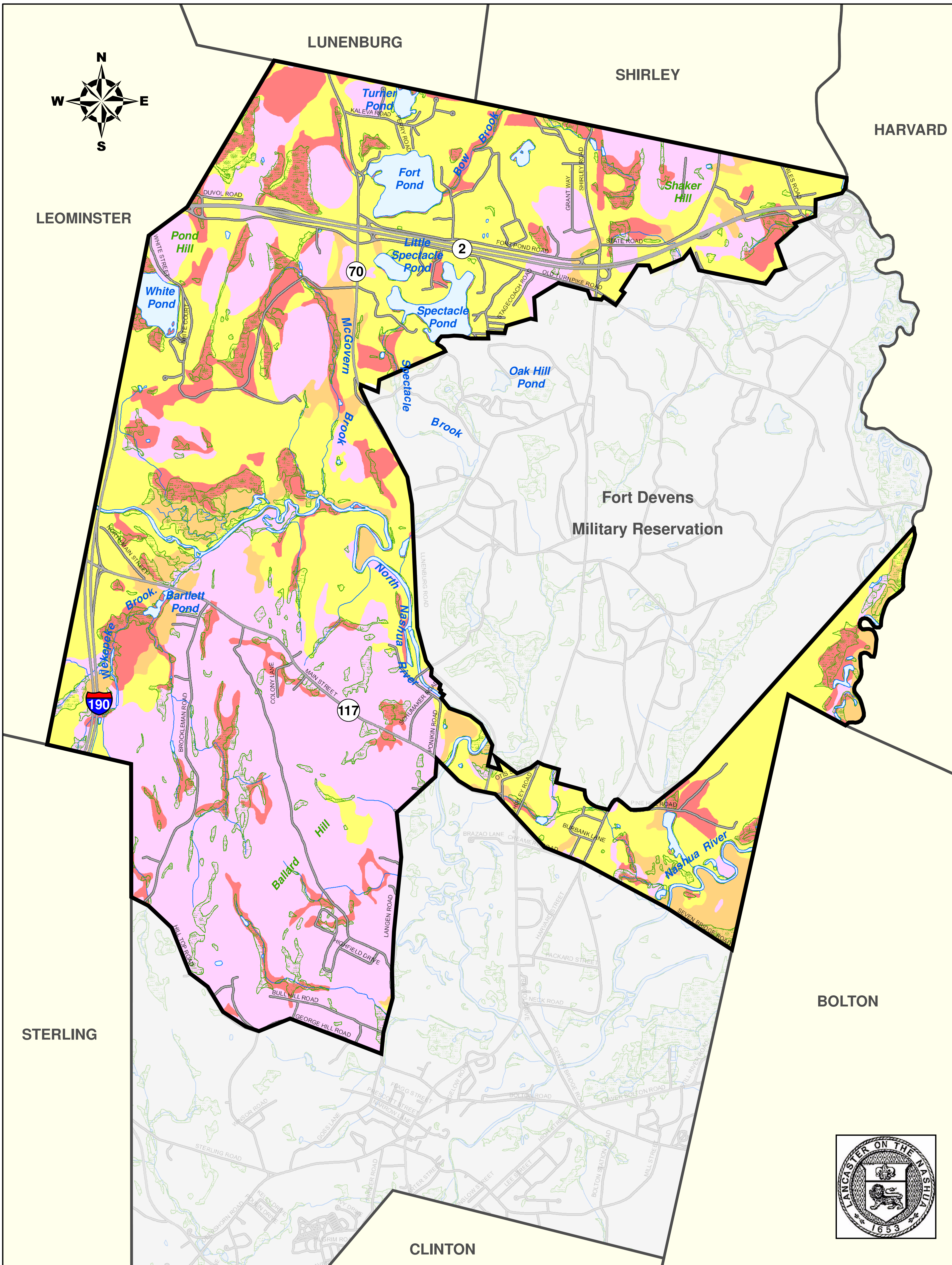

LEGEND

Soils - Hydrologic Group

- A (High Permeability)
- B
- C
- D (Low Permeability)

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook
- IWRM Study Area

Data Sources: Town of Lancaster, MassGIS, MADEP, USGS

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 5-2

Soils Hydrologic Classification

Lancaster, MA

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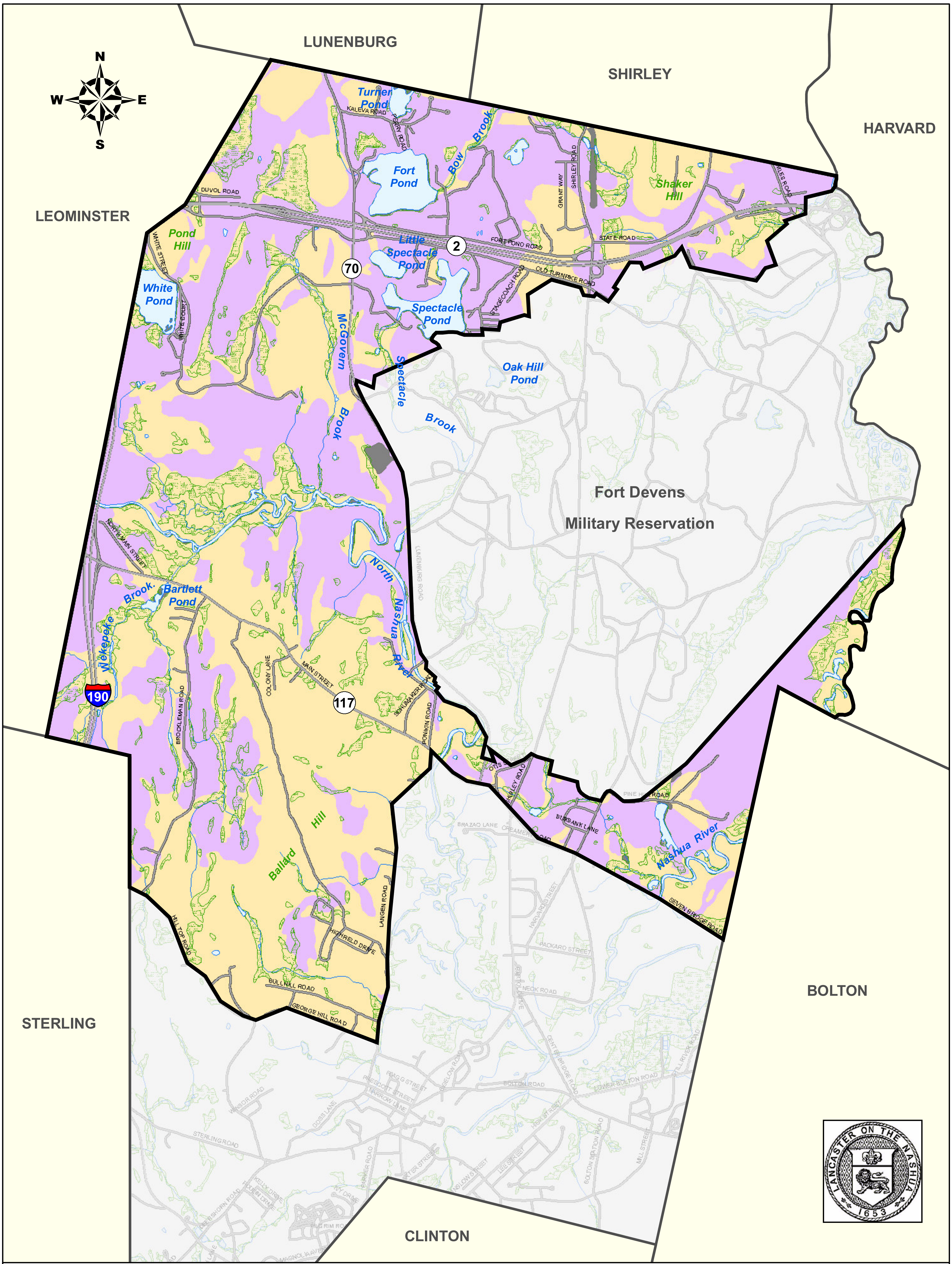


LEGEND

Soils - Depth to GW

- <4.0'
- >4.0'
- Urban, Udorthent Area

Hydrography

- Lake, Pond
- DEP wetlands
- Stream, Brook
- IWRM Study Area

Data Sources: Town of Lancaster, MassGIS, MADEP, USGS

0 2,000 4,000 6,000 8,000 10,000 Feet

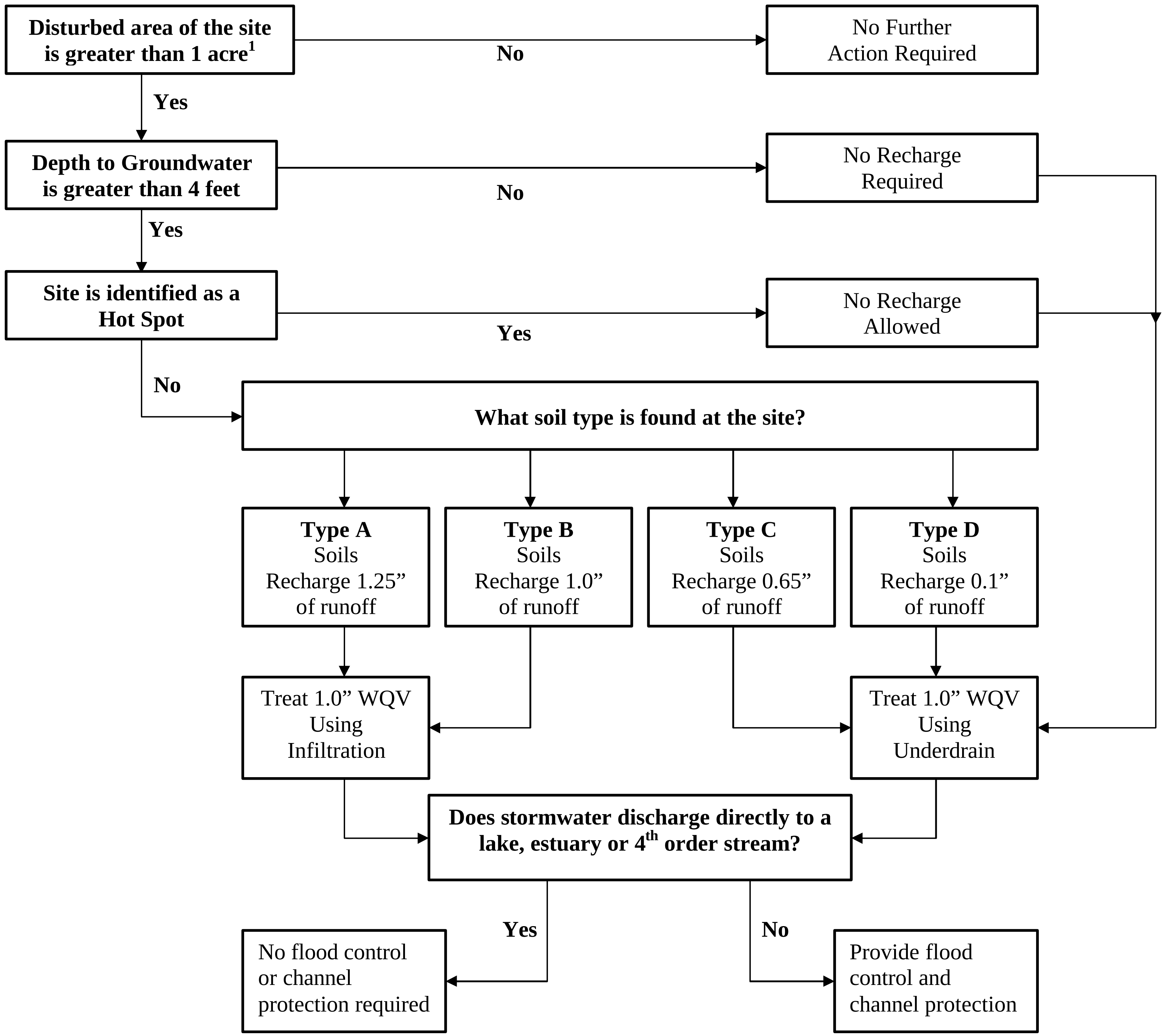
Figure 5-3

Soils
Depth to Groundwater

Lancaster, MA

Comprehensive Environmental Inc.

Figure 5-4
Performance Criteria Logic Chart



DEFINITIONS

WQV – Water Quality Volume. This must be treated to remove sediments, nutrients, hydrocarbons, metals and pathogens associated with stormwater runoff.

Infiltration – Primary focus is to treat stormwater runoff, with a secondary benefit of recharging the groundwater. It requires a maximum infiltration rate to allow for adequate pollutant removal.

Recharge – Primary focus is to replenish groundwater. It does not necessarily treat the water and does not have a restriction as to the maximum recharge rate. For example, in Type A soils, only 1” of the recharge volume requires treatment, and the remaining 0.25” can be recharged without treatment.

Channel Protection – Must be provided through 24-hour extended detention of the 1-year, 24-hour storm. This can be provided through water quality BMPs and detention structures for flood control.

Flood Control – Post development peak flows can not exceed Pre development peak flows for the 2-year, 10-year and 25-year, 24-hour storms.

Hot Spot – Hot Spots are defined as:

1. Stormwater discharges associated with Standard Industrial Classifications [NPDES stormwater permit program requirements apply]
2. Auto salvage yards (auto recycler facilities)
3. Auto fueling facilities (gas stations)
4. Fleet storage areas (cars, buses, trucks, public works)
5. Vehicle service, maintenance and equipment cleaning areas
6. Road salt storage and loading areas (if exposed to rainfall)
7. Commercial nurseries
8. Flat metal (galvanized metal or copper) rooftops of industrial facilities
9. Outdoor storage and loading/unloading areas of hazardous substances
10. SARA 312 generators (if materials/containers exposed to rainfall)
11. Marinas (service, repainting and hull maintenance areas)

Notes:
[1]A 1-acre of disturbed area threshold was chosen for the site to be consistent with EPA’s Phase II Stormwater Management Program requirements.

6.0 Water Balance

A water balance was performed for virgin (undeveloped), existing and buildout conditions to evaluate the impacts of development on the water cycle and to evaluate how the proposed overlays and performance criteria for adoption address these impacts to protect and sustain the health of the Town's watershed hydrologic cycle. Water balances for virgin and existing conditions were performed strictly as a point of comparison, since it is not realistic to assume that these conditions can be met under a buildout scenario, even with performance criteria in place.

The study area was broken into nine subwatersheds (Figure 2-3) to allow for the evaluation of flows in and out of various areas of the Town. The subwatershed divisions were based on USGS topography and the locations of prominent water bodies.

The water balance considered three factors: 1) precipitation and stormwater (stormwater runoff, recharge and evapotranspiration); 2) wastewater imports and exports; and 3) water withdrawals. A simple mass balance equation was used to evaluate recharge as follows:

$$Re = P - ET - Q$$

Where:

Re = Recharge
P = Annual precipitation
ET = Evapotranspiration
Q = Runoff

The water balance was then evaluated using the following simplified mass balance equation:

$$GW = Re + WWG - WS - WWE$$

Where:

GW = Available groundwater for baseflow
Re = Recharge
WWG = Total wastewater generated (includes wastewater generated from septic systems that remain within the study area, as well as sewer systems that export water from the study area)
WS = Water supply withdrawals
WWE = Wastewater exports out of subwatershed (this is the sewered portion that leaves the study area)

The following explains the assumptions used to calculate each of these three factors:

Precipitation and Stormwater

Average annual precipitation is 49.5 inches/year on average. Precipitation was converted into gallons of water entering the study area on an annual basis by multiplying the precipitation by the total land area for each zoning district in each subwatershed. The remaining developable land areas calculated for existing conditions and buildout analysis with GIS were then broken up into typical components, including impervious, lawn and forest. The assumptions used in these calculations are provided in the following table.

Percent Land Type Used in Water Balance			
	Residential	Limited Office	Light Industry
Land Type			
Impervious	14%	85%	64%
Lawn	36%	15%	30%
Forest	50%	0%	6%

Runoff coefficients were then developed for each land use and soil type. These are summarized in the following table:

Runoff Coefficients Used in Water Balance								
Soil Type	**Forested**	**Impervious**	**Lawn Residential**	**Lawn Limited Office & Light Industrial**	**Wetland**	**Flood Plain**	**Roads**	**Water**
A	0.059	0.95	0.18	0.05			0.75	0.95
B	0.11	0.95	0.20	0.10			0.75	0.95
C	0.15	0.95	0.23	0.13			0.75	0.95
D	0.20	0.95	0.25	0.17	0.75	0.2	0.75	0.95

Notes:

1. The lawn runoff coefficients for Limited Office and Light Industrial assume the majority of greenspace will be landscaped areas, which have a lower runoff coefficient than residential lawns.
2. The roads runoff coefficient represents roadways and right of ways within the study area as identified by MassGIS.

The runoff coefficients were applied to the appropriate land uses using the equation:

$$Q = C*P*A*27,154$$

Where:

Q = total runoff (gal/year)
C = runoff coefficient (unitless)
P = annual precipitation (inches)

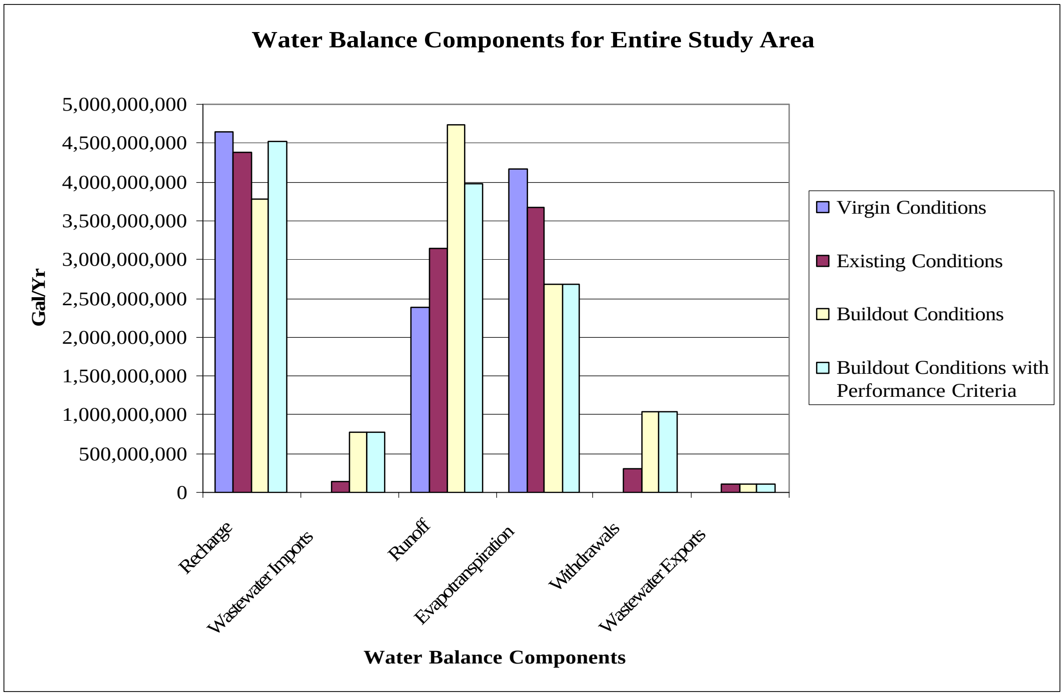
A = land area (acres)
27,154 = conversion factor (43,560 sq.ft./acre*7.4805 gal/ft^3÷12 inches/ft)

Evapotranspiration was assumed to be 40% for forested areas and 25% for lawns and wetlands of the annual precipitation. This was calculated and both the runoff and evapotranspiration were subtracted from the total precipitation to estimate annual recharge for a given area. The performance criteria described above were applied to the precipitation/stormwater runoff balance. The results are summarized in Table 6-1 by zoning district.

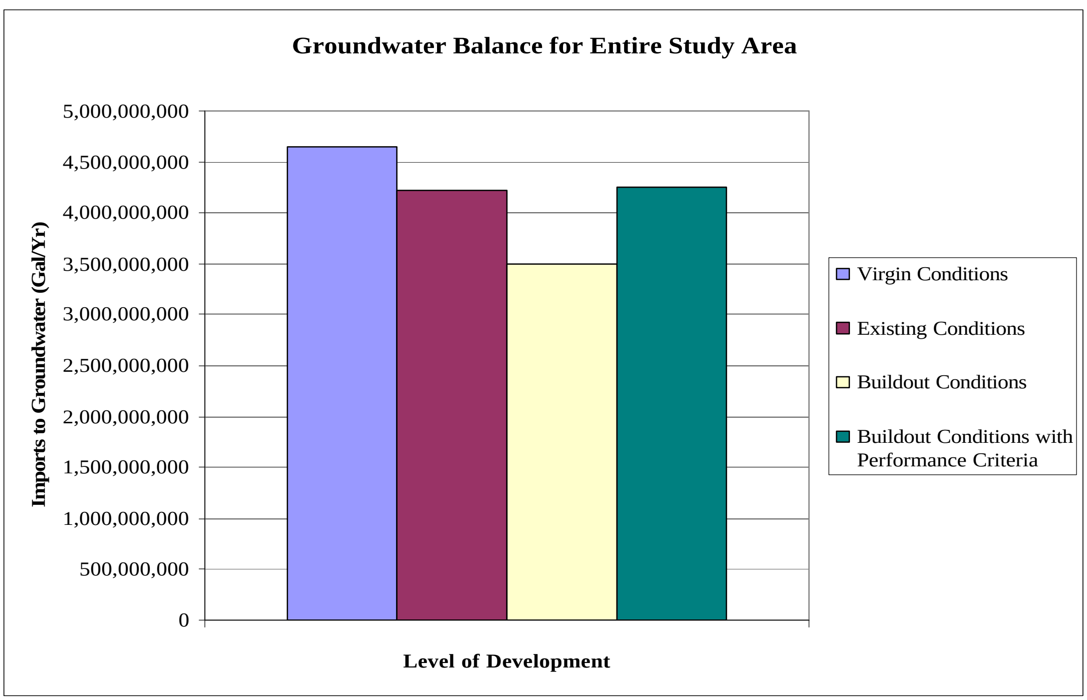
<u>Water Withdrawals</u>
There are no public water supply wells within the study area. Most of the drinking water is supplied through private wells, however, there are several existing properties located along Route 117 that are on the municipal water supply. The municipal water supply source is located outside of the study area, therefore water consumption associated with these properties was excluded from the water balance. It was assumed for buildout purposes that future development would be supplied with private water supply wells since Lancaster's water supply is already at capacity. To estimate the withdrawals occurring from private systems, it was assumed that 75 gallons per capita per day was consumed. This is an assumption used by EOEA in their buildout analysis. DEP is pushing for 65 gpcpd in high and medium stressed basins, but this can be difficult and may take some time to achieve. A summary of the results of this analysis are provided in Table 6-2.

<u>Wastewater Imports and Exports</u>
Wastewater imports and exports into the study area were also evaluated. Currently, all but one development within the study area uses an on-site wastewater disposal system. The Division of Youth Services in the Shaker Hill subwatershed discharges their waste to the Devens Community wastewater treatment facility. Both wastewater imports and wastewater exports are reflected in the table to show how much is retained within the study area and the quantity that leaves the study area. It was assumed for buildout purposes that no additional sewering would be provided and all wastewater would be handled on-site, resulting in no additional losses from wastewater. Other alternatives that consider sewering will be considered under the Integrated Water Resources Management (IWRM) plan. A summary of the results of this analysis are provided in Table 6-3.

A complete water balance for the study area was completed using the individual stormwater, water and wastewater analyses. The components involved in the water balance are provided in Table 6-4. Table 6-5 shows the total water balance based on the equation provided above and represents the amount of water that would be recharged into the groundwater. The following figure summarizes the annual water balance components for the study area under virgin, existing, buildout and regulated buildout (overlay and performance criteria) conditions.



The following figure shows the groundwater balance for the entire study area and represents the amount of water that would normally infiltrate through the ground to replenish groundwater.



The results show a significant increase in the amount of water retained within the subwatershed when the performance criteria are applied versus the buildout conditions without any BMP standards applied. The performance criteria also help to maintain existing conditions at buildout. The majority of water losses can be attributed to stormwater runoff associated with development. The losses from water withdrawals are minor in comparison for this particular study area. This emphasizes the importance of an overlay district and performance criteria to control the stormwater impacts from development in the study area.

Additionally, the proposed criteria will assist with cooling stormwater runoff by requiring the majority of storms to discharge through an underdrain system. A study by Maine Department of Environmental Protection found the temperature within a wet pond to cool by 15 degrees Fahrenheit by discharging through an underdrain structure (personal communication, Jeff Dennis, 2006).

The following figure shows a breakdown of the water balance by subwatershed for virgin, existing, buildout and regulated buildout conditions. The data is summarized in Table 6-6. The detailed analyses by subwatershed are provided in Appendix A.

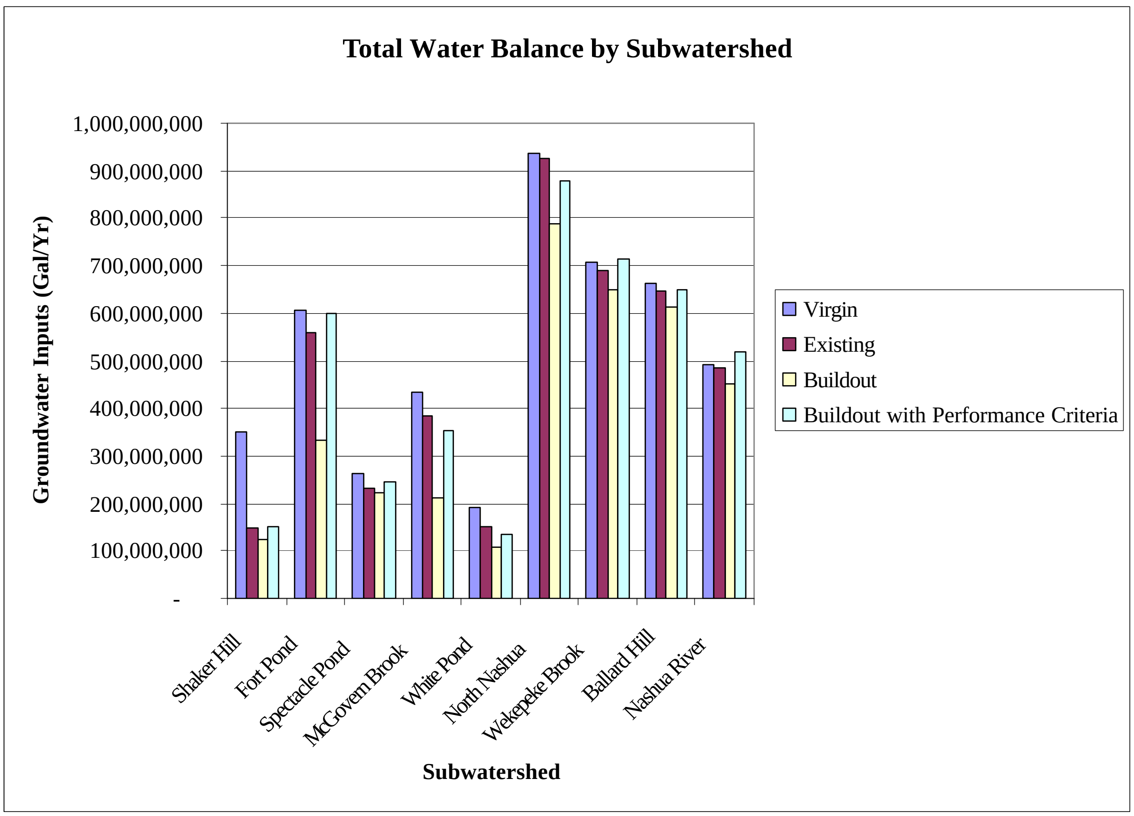


Table 6-1. Precipitation Water Balance for Entire Study Area (gal/yr)											
	Residential		Limited Office		Light Industry		Roads/Water		Total		
	Existing	Buildout	Existing	Buildout	Existing	Buildout	Existing	Buildout	Existing	Buildout	Buildout with Performance Criteria
Precipitation	8,166,290,128	8,166,290,128	893,973,339	893,973,339	1,226,789,431	1,226,789,431	902,541,250	902,541,250	11,189,594,149	11,189,594,149	11,189,594,149
Runoff	1,768,217,185	2,526,264,926	309,994,737	700,951,648	312,051,536	753,962,411	747,066,111	747,066,111	3,137,329,570	4,728,245,096	3,979,321,564
Evapotranspiration	2,989,055,338	2,431,617,804	276,106,239	80,576,507	412,971,773	173,515,545	-	-	3,678,133,350	2,685,709,856	2,685,709,856
Recharge	3,409,017,605	3,208,407,398	307,872,363	112,445,184	501,766,122	299,311,476	155,475,139	155,475,139	4,374,131,229	3,775,639,196	4,524,562,728

Table 6-2. Water Withdrawals for Entire Study Area (gal/yr)									
	Residential		Limited Office		Light Industry		Total Water Withdrawals Generation		
	Existing Development	Additional Development	Existing Development	Additional Development	Existing Development	Additional Development	Existing Development	Additional Development	Buildout
No. of Lots	859	1,404							
Building Square Footage			6,331,234	9,713,858	2,681,650	11,696,716			
Water Consumption	50,052,450	164,720,850	173,317,529	265,916,851	73,410,165	320,197,606	296,780,145	750,835,307	1,047,615,452

Table 6-3. Wastewater Generation for Entire Study Area (gal/yr)								
Residential		Limited Office		Light Industry		Total Wastewater Generation		
Existing Development	Additional Development	Existing Development	Additional Development	Existing Development	Additional Development	Existing Development	Additional Development	Buildout
61,452,860	153,739,460	138,654,024	212,733,481	58,728,132	256,158,085	258,835,016	622,631,026	881,466,041

Table 6-4. Water Balance Components for Entire Study Area (gal/yr)						
	Recharge	Wastewater Imports	Runoff	Evapotranspiration	Withdrawals	Wastewater Exports
Virgin Conditions	4,640,777,461	0	2,387,509,875	4,161,306,812	0	0
Existing Conditions	4,374,131,229	146,550,102	3,137,329,570	3,678,133,350	296,780,145	112,284,913
Buildout Conditions	3,775,639,196	769,181,128	4,728,245,096	2,685,709,856	1,047,615,452	112,284,913
Buildout Conditions with Performance Criteria	4,524,562,728	769,181,128	3,979,321,564	2,685,709,856	1,047,615,452	112,284,913

Table 6-5. Groundwater Balance for Entire Study Area (gal/yr)					
	Recharge	Wastewater Imports	Withdrawals	Wastewater Exports	Total Water Balance
Virgin Conditions	4,640,777,461	0	0	0	4,640,777,461
Existing Conditions	4,374,131,229	146,550,102	296,780,145	112,284,913	4,223,901,187
Buildout Conditions	3,775,639,196	769,181,128	1,047,615,452	112,284,913	3,497,204,873
Buildout Conditions with Performance Criteria	4,524,562,728	769,181,128	1,047,615,452	112,284,913	4,246,128,404

Water Balance Summary Entire Study Area

Table 6-6. Total Groundwater Balance by Subwatershed (gal/yr)				
	Virgin	Existing	Buildout	Buildout with Performance Criteria
Shaker Hill	350,782,404	146,796,724	123,243,864	153,063,613
Fort Pond	606,435,253	557,967,239	332,797,741	597,966,641
Spectacle Pond	261,766,445	233,706,865	221,607,133	247,437,795
McGovern Brook	432,864,036	384,071,897	211,577,368	352,904,478
White Pond	192,052,958	151,308,488	106,187,515	133,827,180
North Nashua	936,992,474	924,691,178	786,429,072	878,431,983
Wekepeke Brook	705,602,626	691,736,133	650,270,994	714,105,385
Ballard Hill	661,970,572	647,131,273	612,566,324	650,814,560
Nashua River	492,310,694	486,491,390	452,524,862	517,576,769
Total	**4,640,777,461**	**4,223,901,187**	**3,497,204,873**	**4,246,128,404**

Notes:
Some existing homes in the North Nashua River, Wekepeke Brook, Ballard Hill and Nasua River Subwatersheds are on the municipal water supply, which withdraws outside of the study area. This is reflected in the above tables.

7.0 Stormwater BMP Restoration and Offset Locations

One piece of balancing the hydrologic cycle is offsetting water supply withdrawals and wastewater discharges. Offsets are a means to keep the water within the study area by reducing or replacing what is taken from surface and groundwaters. Massachusetts Department of Environmental Protection (DEP) through its Water Management Act Program is in the process of requiring water suppliers and wastewater dischargers to 'offset' their withdrawal and discharge increases, but the types and amounts of potential offsets have not been established. This section addresses some potential offsets found in Lancaster.[1]

7.1 Defining Offsets

Prioritization of the offsets identified here considers the ability of the existing stormwater practices to provide infiltration and groundwater recharge, amount of impervious surface, proximity to Lancaster's water supply aquifer, underlying soils, land use within the drainage area, and the condition and amount of impervious surfaces. Potential offset categories and criteria included:

A Demand Management Offsets

1. Comprehensive water audits
2. Metering and upgrades to billing programs
3. Low Impact Development (LID) measures
4. Landscape design improvements that increase organic matter in soils and require adequate topsoil (to reduce irrigation demands)
5. Plumbing code improvements
6. Indoor water conservation programs
7. Facilities improvements such as LEED certification
8. Leak detection (note that this requires repeating and is not a permanent offset so it should not get a 1:1 offset)
9. Xeriscape landscaping or reduction of cleared area to reduce irrigation demands
10. Conversion of wet ponds for irrigation use to offset use of finished drinking water for irrigation
11. Use of cisterns or other storage for irrigation

B Withdrawal Offsets

1. Stormwater performance criteria that call for greater recharge amounts, on a widespread basis, by providing regulatory changes that affect new and redevelopment (e.g., the stormwater overlay recommended in this report)
2. Infiltration of roof leaders to groundwater
3. Detention or retention basin conversions to infiltration basins with pretreatment

[1] Note that the limited development in Lancaster resulted in limited offsets since they tend to be development related.

4 Retrofit of parking lots, road corridors and other impervious areas with storage and infiltration features instead of offsite piping of all runoff (see Table 7-1 and Figure 7-1 at the end of the report for a matrix of Lancaster sites)
5 Use of pumped storage facilities such as bermed reservoirs (as opposed to dammed streams) for flood skimming of increased runoff volumes from developments[2]
6 Aquifer storage projects that mound groundwater as storage

C Environmental Offsets

1 Extended detention of less than one year storms for channel protection (since this essentially offsets withdrawals from the aquifer)
2 Soil filtration treatment of stormwater discharges for fisheries protection (since this also delays and cools runoff, mimicking baseflow discharges from groundwater)

7.2 Existing Offsets

To help manage water withdrawals, the Town of Lancaster recently adopted an Outdoor Water Use Bylaw to restrict or prohibit water use as necessary to protect the Town's water supply. Restrictions include limiting outdoor watering to daily periods and particular days of the weeks, while prohibited water uses include filling swimming pools and use of automatic irrigation sprinklers.

7.3 Offset Sites Matrix Evaluation

In addition to the general categories listed in section 7.1 above, a number of specific sites in Lancaster were evaluated for offset potential. Each of the sites was evaluated using specific criteria and a point system associated with each of the criteria. The sum of points provided a ranking of sites, with the highest points representing the highest priority and the lowest points representing the lowest priority. The criteria used in the evaluation are outlined below.

Existing Stormwater BMPs. Field investigations were conducted throughout the Town of Lancaster to identify existing stormwater drainage systems, which collect and direct runoff to BMPs providing some form of detention (e.g., ponds and swales). Closed drainage systems were primarily found on commercial and institutional properties. Systems that could potentially be retrofitted to provide recharge received points.

Potential Impervious Area for Water Offset. Measurements of the impervious surfaces for restoration and offset locations were calculated using an ortho image of Lancaster.

[2] Pumped storage facilities are usually reservoirs that do not dam streams or rivers, but are instead filled when high flows occur and water is diverted and pumped to the storage reservoir. These reservoirs can capture some of the excess runoff that occurs with development as evapotranspiration is released as clearing occurs. These systems can help provide a balance that maintains a more natural flow regime while storing excess flows for human or low flow release purposes. These reservoirs may also increase in viability as climate change results in high intensity events followed by droughts in some areas.

Parking lots and building areas were identified and delineated using GIS software. Points were assessed based on the amount of impervious area and associated runoff that could potentially be collected for stormwater offset.

Recharge to Aquifer. Restoration and offset locations were mapped for comparison to the aquifer areas in Lancaster. An aquifer base map was used to identify which locations fell within an aquifer area. Due to the importance for recharging the Town's water supply aquifers, opportunities for stormwater infiltration BMPs in aquifer areas rated higher than in other areas.

Soils. USGS soil information was reviewed for each of the potential restoration and offset locations to determine if stormwater infiltration is feasible. Type A and B soils are considered more adequate for providing the desired infiltration rate required to recharge stormwater in a reasonable period of time. Type C and D soils provide lower infiltration rates and may not meet the desired criteria for stormwater infiltration designs. Prioritization points are based on the hydrologic soils group identified at each restoration and offset location. Soils with high infiltration rates received more points than those with low infiltration rates.

Land Use. Concerns for potential pollutant loads were evaluated during field investigations. Although stormwater practices can be designed to remove most targeted pollutants, recharging stormwater with certain mobile, volatile pollutants is not usually appropriate. Land uses that generate contaminants associated with stormwater pollution were noted and points are prioritized according to the pollutant categories (e.g., oil, nutrients and sediment).

Impervious Surfaces. Roof leaders from buildings located at each location were noted to determine those that are not now but might be infiltrated. Conditions of impervious surfaces (parking lots and road surfaces) were evaluated for integrity and condition, in that retrofits of parking lots may be less expensive if the lot needs paving anyway.

Table 7-1 and Figure 7-1 show the twenty-five potential restoration and offset locations within Lancaster and their ranking based on the point system described above.

Table 7-1
Restoration and Offset Site Decision Matrix

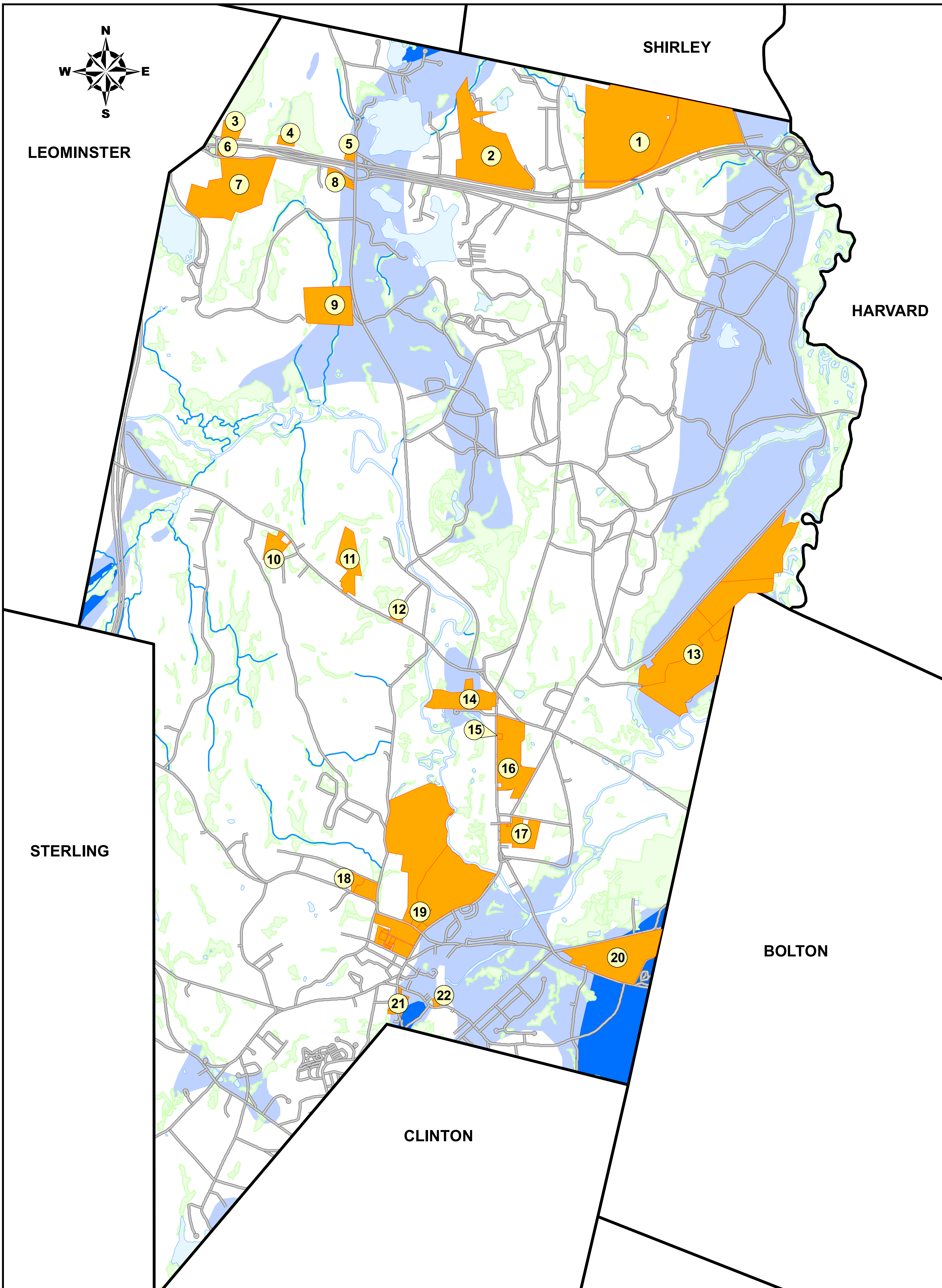
	Site	Potential Impervious Area for Water Offset (acres)	Points: Potential Impervious Area for Water Offset (acres)	Recharge to Aquifer	Points: Recharge to Aquifer	Hydrologic Soil Group	Points: Hydrologic Soil Group	Contamination Potential	Points: Contamination Potential	Condition of Asphalt	Points: Condition of Asphalt	Sum of Ranking Criteria	Comments
1	6-DIVISION OF YOUTH SERVICE Prison	41.0	4	No	0	A	3	Low potential	2	Good	0	9	Large prison buildings surrounded by grass/fields/woods No stormwater BMPs observed
2	5-26 Rockport Shoes (101-104)	11.0	3	No	0	A	3	Low potential	2	Good	0	8	Heavy sand built up in parking lot, drainage system appears to end at leaching CBs
3	3-2 Showboat Theater (11-26)	2.5	1	No	0	C	1	Low potential	2	Good	0	4	Very large parking lot. Some sand built up at lower end No drainage structures No stormwater BMPs observed
4	4-ROUTE 2 Visitors Center (1-8)	2.0	1	No	0	A, D	3	Sediment, oil and grease	0	Good	0	4	Heavy sand buildup in parking lot Trash collected at CBs No stormwater BMPs observed
5	4-10A Boy Scouts	0.5	1	Yes	2	A	3	Low potential	2	Good	0	8	Small parking lot No drainage structures No stormwater BMPs observed
6	3-3 D'Ambrosio Eye Care (105-107)	1.0	1	No	0	A	3	Low potential	2	Good	0	6	Parking lot was clean Hooded catch basins Large detention pond (dry) with outlet control structure to allow infiltration
7	4-11 Lancaster Golf (108-115)	1.0	1	No	0	A, C, D	3	Low potential	2	Good	0	6	Grass Swale Small amount of sand built up No stormwater BMPs observed before discharging to swale
8	9-9B Toyota Car Dealer	4.0	1	Yes	2	B, C	2	Sediment	2	Good	0	7	Large detention pond/forebay Grassed swale Small amount of sand Some bank erosion off edge of pavement
9	14-4 Insurance Auto Auction (91-96)	2.0	1	Yes	2	Mix: A, B, C , D	3	Automotive chemicals	0	Good	0	6	Large parking lot with new leaching catch basins Cars are delivered to site for wholesale auction Area where cars are stored is primarily dirt
10	24-2 Route 117 Used Auto Parts (junked cars)	0.5	1	No	0	C, D	1	Oil/Grease	0	Good	0	2	Small parking lot in front of office building No stormwater BMPs observed
11	24-74 Nursery	1.0	1	No	0	C	1	Fertilizer/Nutrients	0	N/A	0	2	Mostly pervious surface, small paved area at entrance and one main building Trees are B&B and plants are in containers No stormwater BMPs observed

Table 7-1
Restoration and Offset Site Decision Matrix

Site		Potential Impervious Area for Water Offset (acres)	Points: Potential Impervious Area for Water Offset (acres)	Recharge to Aquifer	Points: Recharge to Aquifer	Hydrologic Soil Group	Points: Hydrologic Soil Group	Contamination Potential	Points: Contamination Potential	Condition of Asphalt	Points: Condition of Asphalt	Sum of Ranking Criteria	Comments
12	24-65 River Terrace Health Care	1.5	1	No	0	C	1	Sediment	2	Fair	1	5	Large amount of sand built up in a small parking lot No stormwater BMPs observed
13	26-1, 26-2, 26-3, 31-3, 31-4, Sand Pit Mining Operation (85-89) (Lot 26-2 is Town owned)	0.0	1	Yes	2	A	3	Low potential	2	N/A	0	8	Open Space Trees are beginning to reclaim old mined areas Grass/sod has been planted in some areas
14	30-154 Mary Rowlandson Elementary School/ Luther Burbank Middle School (76-78)	5.0	2	No	0	B	2	Low potential	2	Good	0	6	Large parking lot with hooded catch basins Ball fields off back of property
15	Lancaster Fire Station	1.5	1	No	0	C, D	1	Low potential	2	Good	0	4	Small detention pond in front of station (dry) Collects sheet flow from the driveway/parking
16	34-132 Franklin Perkins School (79-84)	5.0	2	No	0	C	1	Low potential	2	Good	0	5	School facility with large lawn area Several parking areas and driveway winds through site Closed drainage system along driveway, leaching basins along building, roof leaders into dry wells
17	34-91 Town Hall (27-45)	4.0	1	No	0	C, Quarry	1	Sediment	2	Fair	1	5	Sand in parking lot Some roof leaders discharge to dry wells Closed drainage system discharges to grass adjacent to wetland area
18	37-10 & 37-10B Horse Farm (73-75)	1.0	1	No	0	C	1	Low potential	2	N/A	0	4	Mostly pervious surface with woods buffer Runoff from fields sheets into wooded area and swale along Langen Road
19	Atlantic Union College (71-72)	17.0	3	Yes/No	2	A	3	Low potential	2	Fair/Poor	2	12	Several small parking lots with sand built up Closed drainage systems look pretty old Roof leaders into dry wells
20	39-4 220 Old Common Road (56-70) Division of Capital Asset Management (DCAM) Children's Action Corps	8.0	2	Yes	2	A	3	Sediment	2	Fair/Poor	2	11	Several small parking lots with sand built up Little closed drainage system, some hooded catch basins Large lawn/field areas available for BMPs
21	41-236 South Lancaster Commercial Area (primarily behind auto body shop) (46-51)	8.0	2	Yes	2	Mix: A, C and Quarry	3	Low potential	2	Good	0	9	Large paved area behind auto body shop Drain pipe running below RxR tracks and paved area Impervious area was clean and looked like it gets very little use No stormwater BMPs observed
22	42-19 Pack and Post (52-55)	0.5	1	Yes	2	B	2	Sediment	2	Good	0	7	Sand in parking lot Drainage system discharges to a swale and small wetland area

Ranking Point System:

Impervious Area for Offset: 0-4 acres = 1, 5-9 acres = 2, 10-20 acres = 3, >20 acres = 4
Aquifer Recharge: Yes=2, No=0 (Sites within medium and high yield aquifers received 2 points)
Hydrologic Soil Group: A=3, B=2, C=1, D=0
Contamination Potential: Yes=0, No=2
Asphalt Condition : Good=0, Fair=1, Poor=2 (Asphalt condition was based on surface conditions, whether crack had formed and if resurfacing could be required in the near future)



LEGEND

	Resotration and Offset Sites	**Hydrography**	
Aquifer Yield (Gallons per Minute)			Lake, Pond
	100-300		DEP Wetlands
	>300		Stream, Brook

Data Sources: Town of Lancaster, MassGIS, MADEP

0 2,000 4,000 6,000 8,000 10,000 Feet

Figure 7-1

Restoration and Offset Locations

Lancaster, MA

Comprehensive Environmental Inc.

8.0 Recommendations

The results of the water balance highlight the importance of protecting streams and aquifers from the impacts of development. Although most people likely assume that new developments have little or no impact on the environment, the reality is that today's developments can have significant impacts on the overall hydrologic budget, as described below.

> *There is a rule of thumb that each acre of land produces roughly one million gallons of water per year (1 MG). If that acre is forested A or B soil, about half the 1 MG is evapotranspiration that reenters the water cycle through the atmosphere while about half is recharge. If that same acre of land is paved for a parking lot, using today's stormwater controls, evapotranspiration is close to nothing, as is recharge. The shocker is that 1 MG is now new runoff! While this is perhaps an extreme example, it shows that change is needed to avoid losing this water quickly downstream, creating flooding and damaging banks and aquatic habitat. It is now also lost to human use unless there is a major reservoir downstream. The river or stream becomes flashy during rainfall and dry during even minor droughts as the groundwater table falls below the bottom of the stream.*

In addition to the flow component of the water balance, water quality must also be considered. Reduced baseflows and increased runoff lead to increased pollutant loadings and stream warming. Without proper treatment, recreational water bodies, aquatic habitat and organisms and downstream water supplies will suffer.

Currently, the North Lancaster area is only lightly developed, so the time is perfect for putting good land use controls in place. These controls are not unusually expensive for the development community, especially in comparison to the benefit of being able to develop their land and the benefits to the Town of Lancaster as a whole.

One concept, to be developed further in the IWRM that is now ongoing, is that the area south of Route 2 could become a secondary 'village' of mixed use, with retail developments as an anchor and tax base staple, but also industrial/business office components and perhaps even limited, connected housing for nearby workers. Recreational facilities, such as trails and green space, bike paths and the like, could link the businesses to residents in North and South Lancaster. Retail businesses might include the type of stores not appropriate for downtown south Lancaster as well, but these would need to fit the village design concept instead of a massive commercial strip. Lancaster is now working on a revised Master Plan that may include some of these elements, so there is no need for this report to go further into the planning aspects of economic development except to clearly state what has become obvious to Lancaster officials already – some form of sewer and water services will be needed to attract the necessary economic growth in this area. Since this same sewer and water may also bring environmental impacts, it is critical that the protective controls be put in place prior to this occurrence.

CEI's recommendations are as follows:

1. Lancaster should expand and modify the existing Water Resources District Overlay – the existing district has some land use restrictions and also prohibits septic systems that discharge more than 440 gpd per acre. The additional treatment requirements on large flow systems (>1,000 gpd) should be added to these restrictions. The area covered should also be expanded as shown on the map in Figure 5-1 to cover additional high and medium yield aquifers that are not now included. Although there may not be immediate plans to tap these aquifers for public water supplies, they may be needed at some future date by either the Town or by private entities for larger developments such as may occur with the village concept for North Lancaster discussed previously.

2. Develop Fisheries and Aquatic Habitat District Overlay – Lancaster should develop a fisheries overlay district that applies to any lot containing bordering vegetated wetlands or their 100-foot buffer. This can be used to provide extra controls on large flow septic systems and their potential contaminant contributions to minimize impacts on aquatic life. Since these types of systems may well be likely considering the political and economic issues in some portions of North Lancaster, these types of controls can only benefit the Town and its important environmental resources at minimal cost to developments.

3. Stormwater Overlay – Lancaster should incorporate the Stormwater Overlay and associated performance criteria from Section 5.0 into Lancaster's regulations. This will help control impacts from development to maintain a healthier water balance and aquatic habitat. This includes stormwater performance criteria, as well as criteria for the proposed Water Resources Protection and Fisheries Overlay.

4. Model Development – MA DEP, in conjunction with Riverways, should consider developing the model created for this project into a more user-friendly version. The model is a valuable tool in identifying the impacts of different development, sewering and water supply scenarios and can be used to evaluate the most cost-beneficial options in a CWMP or IWRM.

5. Developer's Guide to the Environmental Overlay Districts – There is a need for a Developer's Guide to go with the regulatory changes and overlays. Although meeting the performance criteria is technically all that is needed, developer's may need additional guidance on some techniques (such as the underdrained filters for cooling stormwater) and Lancaster/DEP/Riverways may wish to limit the types of techniques allowed to promote Low Impact Development. This could have wide application across the state, and could be an adjunct to the Stormwater Policy by including engineer's plan review checklists and other materials to help both developer's engineers and engineering reviewers understand how LID concepts differ from 'design as usual'.