FINAL REPORT

Neponset Water Management Act Planning Project

MassDEP Sustainable Watershed Initiative Grant
BRP 2012-06

June 30, 2013

neponset river WATERSHED ASSOCIATION

MAPC METROPOLITAN AREA PLANNING COUNCIL 50 YEARS SMART GROWTH AND REGIONAL COLLABORATION

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1.0 INTRODUCTION

1.1 Acknowledgements

This project was made possible by a SWMI Implementation grant from the Massachusetts Department of Environmental Protection using Commonwealth of Massachusetts capital funds DEP Project: BRP 2012-06 Sustainable Water Management Initiative Projects).

Special thanks goes to the Dedham Westwood Water District and its Executive Director Eileen Commane, for their willingness to serve as fiscal agent for the grant on behalf of all the study area communities and assume the administrative duties that this entailed, and for helping to ensure that all the study area communities were actively engaged and fully represented over the course of the project.

Thanks also to the state agency staff, including Jen D'urso, Duane LeVangie, Tom Lamonte, Leslie O'Shea, Richard Friend, Anne Carroll, and Michelle Drury for providing much of the data that supported this effort and for answering innumerable questions.

First and foremost though, we acknowledge the contributions of the many municipal staff from water, sewer, highway, public works, engineering, conservation and planning departments that made this effort possible by sharing their deep knowledge of their communities, and their trove of data and documents about the communities which they serve. These staff face a daunting challenge of providing the indispensable services that make modern society function and that protect the public health and our environment, services that no one ever seems to want to pay for, which are delivered so consistently and seamlessly that most people barely notice they are there, and about which everyone will complain immediately and loudly on the rare occasions when the slightest thing goes wrong. These are challenging jobs and we are lucky to have men and women willing to fill them.

The primary authors of this report included Blake Martin, Anthony Zerilli and Deb Lamoureaux of Weston and Sampson, Martin Pillsbury, Julie Conroy, Tim Reardon, and Armin Akhavan of the Metropolitan Area Planning Council, and Steve Pearlman and Ian Cooke of the Neponset River Watershed Association.

1.2 Report Overview

The report is organized into chapters that follow the project tasks as described below. Chapter 6 the Summary of Mitigation and Minimization Options, effectively serves as an executive summary that reviews the permitting implications of the SWMI Framework for each community and summarizes recommendations which are described more fully in the other chapters.

The chapters are as follows:

- Chapter 2: Demand Management Practices and Water Needs Forecasts
- Chapter 3: Wastewater Returns and Potential Inflow and Infiltration Reduction
- Chapter 4: Optimization, Alternate Sources of Supply, and Surface Water Releases
- Chapter 5: Stormwater Recharge Opportunities
- Chapter 6: Summary of SWMI Minimization and Mitigation Requirements and Alternatives

Details of the materials and analysis developed for each chapter are included in the appendix. A DVD which includes working copies of the spreadsheets, databases and other information developed for the project is available upon request. Note that due to the sensitivity of some of the information that was used for the project, not all elements of the DVD will be available to the general public.

1.3 Key References and Conventions Used in This Text

The Water Management Act and SWMI in particular are complex programs that touch on many different issues. There is a significant terminology associated with the SWMI Framework, which has specific regulatory connotations or definitions. Throughout this text, wherever terminology with a specific meaning under SWMI is used, we have endeavored to capitalize those key words to distinguish them from a more general usage of the same terms.

While this text does attempt to explain selected elements of the SWMI Framework as they apply to the study area, it by no means attempts to explain the full scope of the Framework. Readers are encouraged to familiarize themselves with the SWMI Framework by reading it.

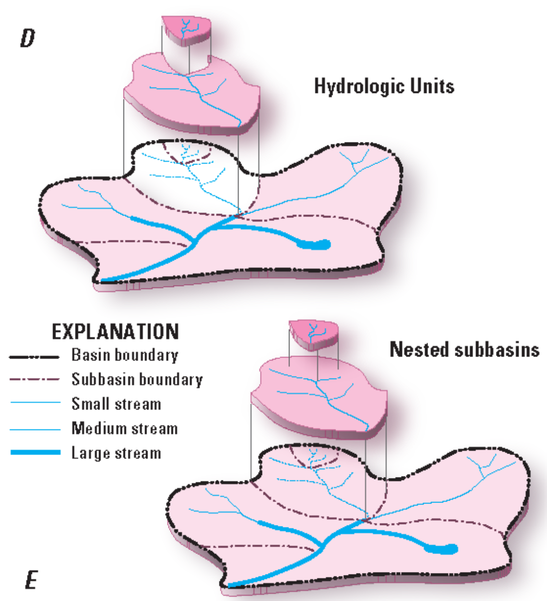
In addition, the SWMI Framework introduces an extensive geography of 1,400 drainage subwatersheds which have been delineated across the state and with which most readers will be unfamiliar. The study area touches 58 such subwatersheds. Readers are encouraged to review the MassDEP SWMI Interactive Map to familiarize themselves with this geography.

Both the SWMI Interactive Map and the SWMI framework can be found at:

http://www.mass.gov/eea/agencies/massdep/water/watersheds/sustainable-water-management-initiative-swmi.html

One final, important note on geography. The SWMI subwatersheds can be thought of in two different ways. Each subwatershed can be viewed as a separate, non-overlapping piece of land, like puzzle pieces laid flat on a table where the edges of the puzzle pieces touch each other but do not overlap. Alternatively, the subwatersheds can be thought of as a set of stacked or “nested” watersheds where each one includes all the areas upstream and together they resemble a stack of different sized pieces of paper laid on top of one another and sorted, with the smallest on top.

In this report, when subwatersheds are being described as puzzle pieces, they are referred to a Hydrologic Units. When they are being described to as overlapping nested basins, they are referred to as Sub-basins. This concept is illustrated in the graphic at right which was developed by the USGS who delineated the SWMI Sub-basins.



In chapters 2, 3 and 4, information presented by subwatershed has been calculated on the basis of Hydrologic Units and DOES NOT include the cumulative total of upstream areas. In chapter 4, information presented by subwatershed is generally presented by Sub-basin and DOES include the total of all upstream areas.

1.4 Project Background

The Sustainable Water Management Initiative (SWMI) has been a three-year, multi-stakeholder process to update the implementation of the Water Management Act (WMA). The WMA is the primary statute governing large water withdrawals in the Commonwealth.

In the fall of 2012 the Executive Office of Energy and Environmental Affairs (EEA) issued the final SWMI Framework, which spells out the goals and key concepts developed during the SWMI process. State agency staff from the Mass Department of Environmental Protection (MassDEP), the Mass Department of Conservation and Recreation (DCR), the Mass Department of Fish and Game (DFG) and EEA are presently working to finalize draft regulations and guidance materials that will translate the SWMI Framework into a detailed regulatory program. These draft regulations and guidance are expected to be released for public comment in early 2014 and finalized by the end of 2014.

While many of the fine details remain to be worked out, the broad picture of what the regulations will contain is now in place, and it is clear that SWMI will result in the most significant change to the administration of the Water Management Act since its enactment in the 1980's. It is also clear that it will represent a major change for permittees, particularly municipal drinking water suppliers who make up the bulk of the large water withdrawals across the state.

SWMI will require permittees to do substantially more analysis for permit applications and renewals than has historically been the case, and to take a more integrated approach to water supply planning that incorporates functions such as wastewater management, stormwater management, demand management and even habitat restoration—issues which most water suppliers have not had to consider in the context of their water withdrawal permits in the past. In some important respects, SWMI also has the potential to greatly streamline the permitting process for applicants, by eliminating the longstanding uncertainty about how agencies would evaluate the environmental impacts of a water withdrawal proposal and which has traditionally cause long delays in the permitting process and required extensive study before a decision could be made.

With the above in mind, the purpose of this project was to apply a watershed-based approach to help public water suppliers in the Neponset River Watershed understand and begin preparing for their potential future obligations under the SWMI Framework.

By undertaking this work on a watershed basis, the project hoped to achieve economies of scale as compared to multiple individual planning efforts by separate communities, to develop a more comprehensive understanding of how the SWMI Framework will affect the watershed as a whole, and to explore opportunities for regional collaboration in WMA compliance.

The study area was focused on the Neponset River Watershed and included all the communities in the Neponset River Watershed which supply their own water, specifically: the Dedham Westwood Water District, Canton, Stoughton, Sharon, Walpole and Foxborough.

Medfield and the Dover Colonial Water District were not active participants in the project, but were included in the analysis to the extent possible given the more limited data available in these communities. Lastly, some analysis was also conducted in the Town of Norwood, which although not a WMA permittee, could potentially serve as the location of mitigation activities under SWMI.

In spite of the fact that the project focused on the Neponset River Watershed, many of the participating communities are split between the Neponset, Charles, Taunton and/or Ten Mile River Watersheds. In recognition of the fact that these split communities need assistance in addressing all their WMA permit requirements (not just those in the Neponset Watershed) the study addressed the entire geographic area of all the participating towns. In the same vein, most of the information and recommendations generated by this project are presented on a town-by-town basis, because permitting and compliance occurs on a town-by-town basis.

The specific tasks included in the scope of services were:

- Task 1: Community Coordination and Public Outreach
- Task 2: Evaluate Demand Management and Review Water Needs Forecasts
- Task 3: Evaluate Wastewater Returns and Potential Inflow and Infiltration Reduction
- Task 4: Evaluate Optimization, Alternate Sources of Supply, and Surface Water Releases
- Task 5: Evaluate Stormwater Recharge Opportunities
- Task 6: Summary of SWMI Minimization and Mitigation Requirements and Alternatives
- Task 7: Project Management and Final Project Report

2.0 WATER DEMAND AND NEEDS FORECASTS

2.1 Introduction

Having a clear understanding of how much water a community is likely to need in the future, what tools are available (or required) to steer the future trend in demand and how much application of those tools might change the size of future demand is critical to enabling a community to respond effectively to the SWMI requirements.

In this chapter we review what conservation measures will be explicitly required of all communities in the Commonwealth under the SWMI "standard conditions." Since all communities in the study area Watershed are in subwatersheds that are Groundwater Categories 4 or 5, they are subject to the SWMI *"minimization"* requirements, which means they must also develop and implement a plan that (among other things) addresses the following to the maximum extent feasible:

- outdoor water restrictions tied to streamflow triggers;
- reasonable measures to conserve water consistent with health and safety; and
- The New England Water Works Association BMP toolbox

With this in mind, we discuss a range of recommended best practices, which communities may want to consider as they develop their required minimization plans.

In addition, we have developed a set of updated demand projections for the study area based on the latest available population and employment projections, and prepared a demand forecasting spreadsheet model for the study area which allows communities to evaluate a wide variety of assumptions about the future direction of demand.

Lastly we have developed a set of future water conservation scenarios, based on detailed work done in other jurisdictions, and applied these scenarios to the demand forecasting spreadsheet models to help demonstrate the potential for conservation programs to reduce either the size of the withdrawal volumes communities may elect to request under SWMI or the extent of mitigation requirements that the communities will ultimately have to implement.

2.2 Water Demand Projections

In order to provide communities in the Neponset River watershed an updated set of water demand projections, and a useful tool for planning, a water demand model was developed that uses local demographic and economic trends to estimate future demand, and evaluate the outcomes of alternative scenarios for growth and demand management. The model and the results of a 2030 projection scenario are described in this section.

2.2.1 Data Analysis

2.2.1.1 Population Trends and Projections

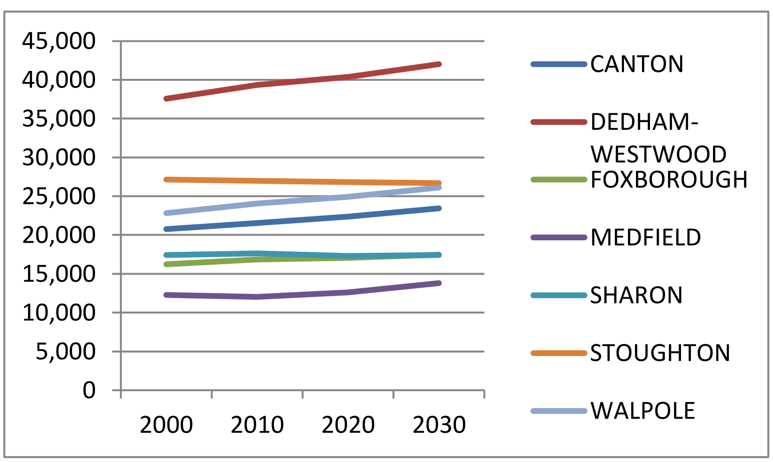
A water demand model has been developed to estimate future demand for each community and test alternative demand scenarios. The model is based on MAPC's latest projections of population, households, and employment in each community. The population projections were developed using a cohort survival method that incorporates age-specific fertility and mortality rates for each municipality as well as projected inter-town migration patterns. Age-specific headship rates are used to estimate the number of households associated with the future population. Employment projections are based on each municipality's estimated share of regional employment and were adjusted based on town-provided information about specific upcoming development projects.

Population trends and projections are summarized in Table 2-1 and Figure 2-1. The population of the eight Neponset watershed towns has grown at a modest rate of 2.5 percent over the last decade (2000 to 2010), and is projected to continue at a similar rate to the year 2030 (Table 2-1), increasing by a total of 8,500 over two decades. Among the towns, 20 year growth rates vary somewhat, with higher rates projected for Medfield (15%), Canton (8.8%), and Walpole (8.5%). Note that data for the towns of Dedham and Westwood have been aggregated to characterize the two-town water district.

Table 2-1
Population Trends, 2000-2010 and 2020-2030 Projections

Public Water Supplier	2000	2010	2020	2030	Change (%) 2010-2030
CANTON	20,775	21,561	22,375	23,458	9%
DEDHAM-WESTWOOD	37,581	39,347	40,378	42,007	7%
FOXBOROUGH	16,246	16,865	17,043	17,458	4%
MEDFIELD	12,273	12,024	12,609	13,793	15%
SHARON	17,408	17,612	17,284	17,430	-1%
STOUGHTON	27,149	26,962	26,804	26,695	-1%
WALPOLE	22,824	24,070	24,909	26,124	9%
TOTAL	**154,256**	**158,441**	**161,403**	**166,966**	**5%**

Figure 2-1
Change in Population, 2000-2010 Trends and 2030 Projections



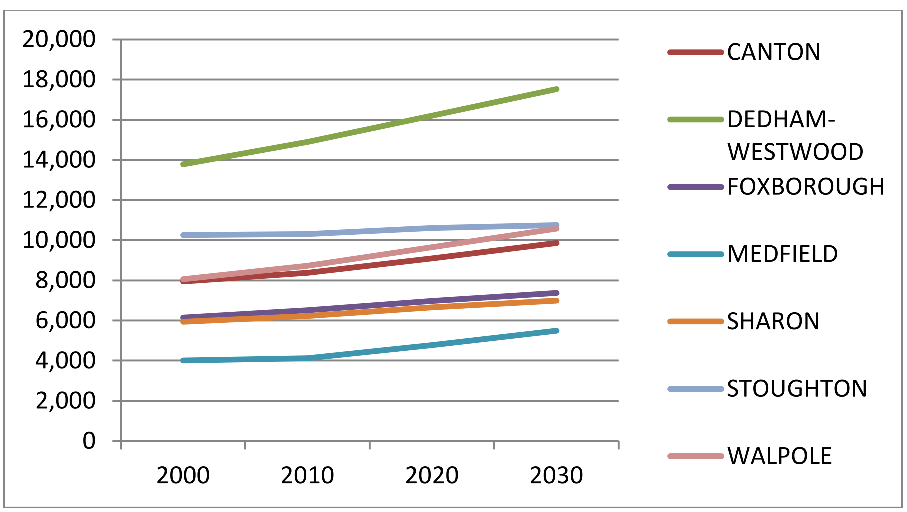
2.2.1.2 Household Trends and Projections

The number of households is projected to grow at a higher rate than population, a trend that is consistent throughout the region and beyond, as average household sizes decline. For the eight Neponset watershed communities, an additional 11,450 households are projected from 2010 to 2030, representing a 19% increase over 20 years (Table 2-2). Towns with the highest projected household growth rates are Medfield (33%) and Walpole (21%).

Table 2-2
Household Trends, 2000-2010 and 2020-2030 Projections

Public Water Supplier	2000	2010	2020	2030	Change (%) 2010-2030
CANTON	7,952	8,378	9,096	9,864	18%
DEDHAM-WESTWOOD	13,776	14,900	16,199	17,526	18%
FOXBOROUGH	6,141	6,504	6,979	7,376	13%
MEDFIELD	4,002	4,117	4,780	5,483	33%
SHARON	5,934	6,219	6,651	6,990	12%
STOUGHTON	10,254	10,295	10,609	10,756	4%
WALPOLE	8,060	8,730	9,642	10,568	21%
TOTAL	**56,119**	**59,143**	**65,976**	**70,593**	**19%**

Figure 2-2
Household Trends, 2000-2010 and 2030 Projections



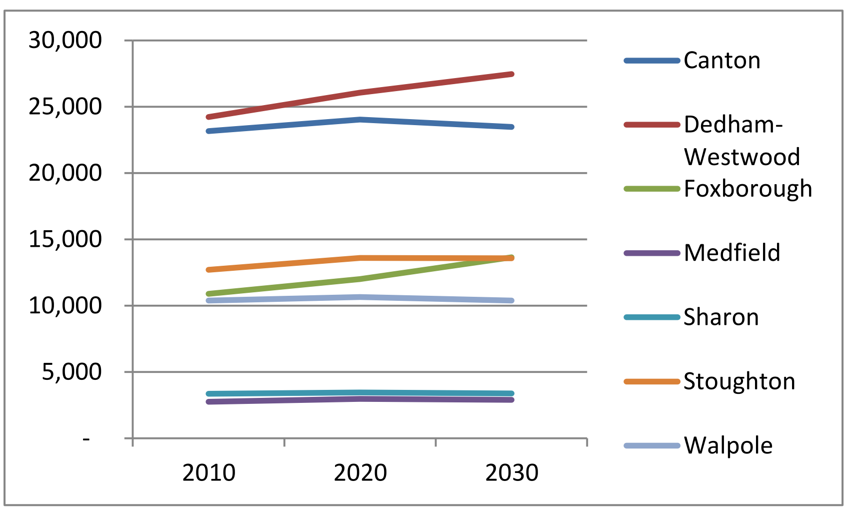
2.2.1.3 Employment Trends and Projections

Employment in the eight towns totaled 86,388 in 2010, and the projections for 2030 show an increase of 7,340 jobs, or 8.4% growth over 20 years. However, the distribution of changes in employment varies widely across the individual towns, to a much greater extent than population or household growth. Table 2-3 summarizes the 2030 employment projections by town, and shows that the greatest absolute increase is projected for Dedham-Westwood, with 3,224 jobs added by 2030. The greatest percentage increase is projected for Foxborough, with a 25.3% increase. Of the total 7,340 new jobs projected for the eight-towns by 2030, 81% are projected to be in Dedham/Westwood and Foxborough.

Table 2-3
Employment Projections 2010-2030

Municipality	2010	2020	2030	Projected change, 2010 - 2030	Percent change, 2010 - 2030
Canton	23,146	24,016	23,476	330	1.4%
Dedham-Westwood	24,230	26,053	27,453	3,224	13.3%
Foxborough	10,879	11,996	13,633	2,754	25.3%
Medfield	2,761	2,963	2,892	131	4.8%
Sharon	3,349	3,456	3,372	22	0.7%
Stoughton	12,691	13,605	13,566	875	6.9%
Walpole	10,376	10,653	10,379	3	0.0%
TOTAL	**87,431**	**92,742**	**94,771**	**7,340**	**8.4%**

Figure 2-3
Employment Projections, 2010-2030



2.2.2 Approach

The water demand model developed for this project disaggregates total community water use into four components, creates projections for future years for each component, and sums the component projections for an estimate of total community water demand. The four water use components are:

- residential use
- commercial and industrial use
- municipal, institutional, and other metered use
- unaccounted for water

Using different assumptions about change in population, households, employment, or the rates of water use for the components, the model generates alternative demand scenarios for each town. For this project, a "status quo" projection scenario was created, as well as conservation scenario, which is described Section 2.4. The “status quo” projection uses existing rates of water use per-capita and per-household for residential use, and existing per-employee water use for the commercial and industrial sectors. This is described in further detail below. Using the water demand model it would be relatively easy to create other alternative water demand projections to test the potential outcomes of various growth scenarios and/or demand management policies.

2.2.2.1 Residential Water Use

The residential use component was calculated in two different ways, using per household water demand and per capita water demand as the basis for the projections. The results of these two methods were then averaged in order to provide a residential use projection that counter-balances the inherent bias of each method. The residential projections for the model are based on the following steps:

- **Existing residential demand:** Existing residential demand for each town is based on the residential water use reported in the Annual Statistical Reports for 2009-2012. Existing residential demand was calculated as an average of the four-year period of 2009-2012, in order to buffer the influence of any abnormally dry or wet years.

- **Residential Water Use Factors:** Based on the population and number of households in each town and the average residential demand from 2009-2012, residential water use factors were estimated for each town both on a per household and per capita basis. These factors and the average 2009-2012 residential demand are shown in Table 2-4.

Table 2-4
Existing Residential Demand and Water Use Factors, 2009-2012

Public Water Supplier	Avg. Residential Demand, 2009 - 2012, MGY	Estimated Gallons per Household, 2009 - 2012	Gallons per Capita, 2009 - 2012
CANTON	518	169	67
DEDHAM-WESTWOOD	793	145	57
FOXBOROUGH	411	173	67
MEDFIELD	301	200	69
SHARON	367	162	57
STOUGHTON	463	123	48
WALPOLE	559	174	64
TOTAL	**3,413**	**164**	**61**

- **Households and Average Household size, 2010-2030**: Based on the population and number of households, the average household size was calculated for each town for 2010 and 2030. These are shown in Table 2-5 and Table 2-6. As shown in Figure 2-4, the general trend in all of the Neponset River watershed towns, as it is throughout the MAPC region and the state, is a decrease in average household size over time. This is because an increasing share of households will be occupied by people over the age of 60 with no children at home; at the same time, younger residents are forming families later in life and having fewer children than previous generations. Average household size for the eight towns is projected to decrease from 2.7 to 2.4 persons per household from 2010 to 2030. One result of this trend that is important for the water demand projections is that the number of people living in already existing housing units will be, on average, lower in 2030 than it is today. In the Neponset watershed towns, decreased water demand associated with this reduction in existing household size is more than offset by the increased water demand associated with new households, but this trend does tend to moderate the increase in residential demand based on the per capita method.

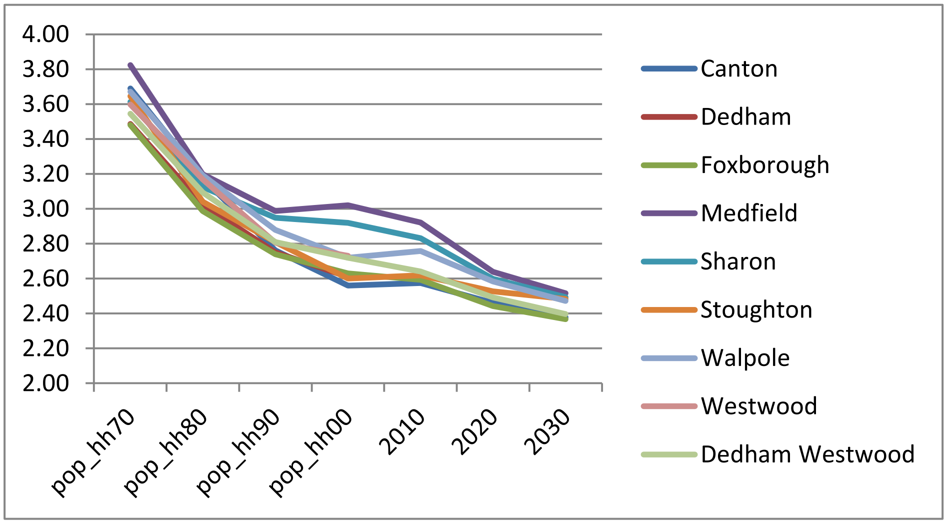
Table 2-5
Households and Population per Household, 2010

Public Water Supplier	Households, 2010	Population in Households, 2010	Average HH Size, 2010
CANTON	8378	21,243	2.5
DEDHAM-WESTWOOD	14900	38,247	2.6
FOXBOROUGH	6504	16,840	2.6
MEDFIELD	4117	11,982	2.9
SHARON	6219	17,542	2.8
STOUGHTON	10295	26,617	2.6
WALPOLE	8730	23,494	2.7
TOTAL	**59,143**	**155,965**	**2.7**

Table 2-6
Households and Population per Household, 2030

Public Water Supplier	Households, 2030	Population in Households, 2030	Average HH Size, 2030
CANTON	9,868	23,000	2.3
DEDHAM-WESTWOOD	17,530	40,600	2.2
FOXBOROUGH	7,374	17,400	2.3
MEDFIELD	5,487	13,700	2.3
SHARON	6,989	17,300	2.5
STOUGHTON	10,755	26,300	2.5
WALPOLE	10,570	25,500	2.3
TOTAL	**68,573**	**163,800**	**2.4**

Figure 2-4
Change in Average Household Size, 1970-2030



- **Estimated Residential Demand, 2030, Per Household Method:** Under the per Household method, residential demand is calculated separately for households in existing housing units and those households anticipated to live in new units constructed between 2010 and 2030. Per-household water use factors are applied separately to these "existing" and "new" households, which allow the model to use different assumed per household rates of water use for each. The Status Quo scenario projection applies the existing 2010 per household water use factor to both the 2010 and projected 2030 households. See Table 2-7 and Figure 2-5.

Table 2-7
Residential Demand Projection, 2030, Per-Household Method
Status Quo Scenario Projection

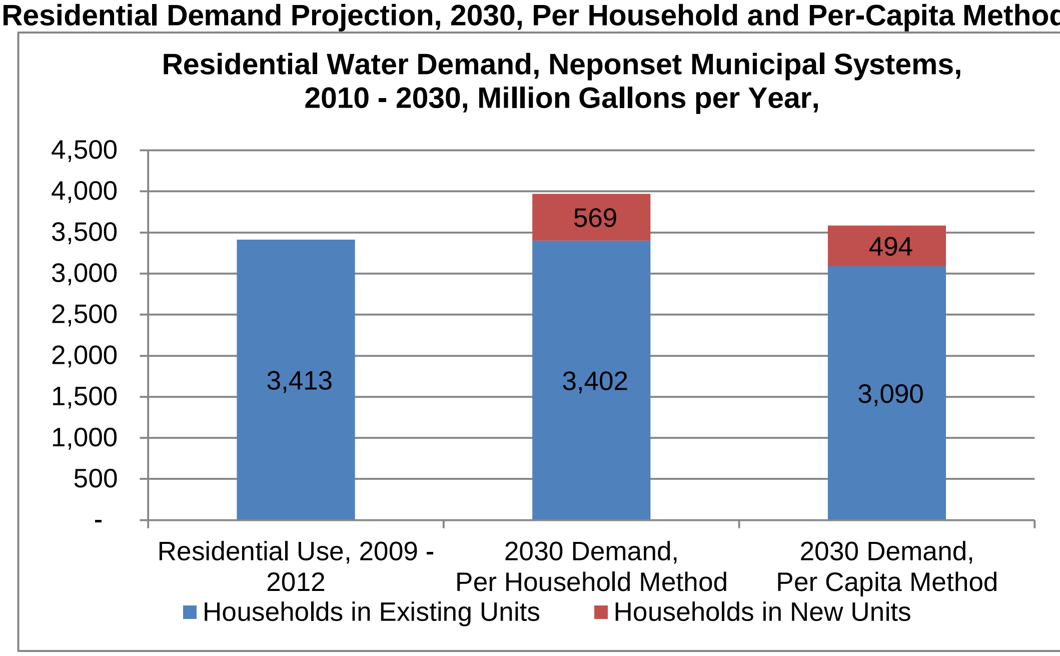
Public Water Supplier	Residential Use, 2009 - 2012 (MGY)	Projected Demand, Existing Housing Units, 2030, MGY	Projected Demand, New Housing Units, 2010 - 2030, MGY	Total Projected Residential Demand, 2030, MGY
CANTON	517.8	516.4	91.6	608.0
DEDHAM-WESTWOOD	793.0	790.0	139.2	929.2
FOXBOROUGH	411.3	410.3	55.0	465.3
MEDFIELD	301.4	300.9	99.8	400.8
SHARON	367.5	366.6	45.5	412.1
STOUGHTON	463.0	462.9	20.7	483.7
WALPOLE	558.8	554.5	116.7	671.2
TOTAL	**3,412.7**	**3,401.7**	**568.6**	**3,970.3**

- **Estimated Residential Demand, 2030, Per Capita Method:** Under the per capita method, residential demand is calculated separately for residents living in existing housing units and those residents anticipated to live in new units constructed between 2010 and 2030. of existing (2010) households, and residents of new households from 2010-2030. These are then summed to calculate the total residential demand. This allows the model to use different assumed rates of per capita water use for each. The Status Quo projection applies the existing 2010 per capita water use factor to residents of both the 2010 and projected 2030 households. See Table 2-8 and Figure 2-5

Table 2-8
Residential Demand Projection, 2030, Per-Capita Method
Status Quo Projection

Public Water Supplier	Residential Use, 2009 - 2012 (MGY)	Projected Demand, Residents of Existing Housing Units, 2030, MGY	Projected Demand, Residents of New Housing Units, 2010 - 2030, MGY	Total Projected Residential Demand, 2030, MGY
CANTON	517.8	475.6	84.3	559.9
DEDHAM-WESTWOOD	793.0	717.0	121.9	838.8
FOXBOROUGH	411.3	375.4	49.3	424.7
MEDFIELD	301.4	265.1	79.0	344.0
SHARON	367.5	322.3	39.9	362.3
STOUGHTON	463.0	437.5	19.8	457.3
WALPOLE	558.8	497.3	99.6	596.9
TOTAL	**3,412.7**	**3,090.1**	**493.9**	**3,584.0**

Figure 2-5
Residential Demand Projection, 2030, Per Household and Per-Capita Methods



- **Estimated Residential Demand, 2030, Average of Per Household and Per Capita Methods:** In the final step for residential demand, the results of the above per-household and per capita projections were averaged to produce a projection of 2030 residential water use. This is done because each of the two methods accounts for water demand differently, some aspects of which may be more closely associated with the number of people served (sanitary use, drinking) and other aspects of which may be more closely associated with households (outdoor water use, cleaning, etc.). The projection based on the average of the two methods is intended to create a balanced water use projection that accounts for both of these factors.

  The average method for the Status Quo scenario (Table 2-9) results in a 2030 residential demand of 3,777 MGY for the eight towns, an increase of 364 MGY, or 10.7 percent, over 2010. The largest volume increases are in Dedham-Westwood (91 MGY) and Walpole (75 MGY), while the largest percentage increases are in Medfield (23%), Walpole (13%), and Canton (12%).

Table 2-9
Residential Demand Projection, 2030, Average of Per Household and Per Capita
Status Quo Scenario Projection

Public Water Supplier	Residential Use, 2009 - 2012 (MGY)	Projected Demand, Existing Housing Units, 2030, MGY	Projected Demand, New Housing Units, 2010 - 2030, MGY	Total Projected Residential Demand, 2030,
CANTON	517.8	496.0	88.0	583.9
DEDHAM-WESTWOOD	793.0	753.5	130.6	884.0
FOXBOROUGH	411.3	392.8	52.2	445.0
MEDFIELD	301.4	283.0	89.4	372.4
SHARON	367.5	344.5	42.7	387.2
STOUGHTON	463.0	450.2	20.3	470.5
WALPOLE	558.8	525.9	108.2	634.1
TOTAL	**3,412.7**	**3,245.9**	**531.2**	**3,777.2**

2.2.2.2 Commercial and Industrial use

Commercial and industrial use was projected using MAPC's employment projections (completed in 2011) and applying water use factors per employee. The model follows the following steps:

- **Existing Commercial and Industrial Demand:** Existing (2010) demand is based on the commercial and industrial water use reported in the Annual Statistical Reports. This is calculated as an average of the four-year period of 2009-2012, in order to buffer the influence of any abnormally dry or wet years, or abnormal short term demands (or reductions) by users.

- **Existing Commercial and Industrial Water Use Factors:** Based on average employment in each town from 2009 – 2011 (2012 annual employment counts are not yet available from the Executive Office of Labor and Workforce Development), commercial/industrial water use factors were estimated (Table 2-10). The employee water use factor varies from 16.1 to 29.4 gallons per employee per day (GPED), and averages 24.6 GPED.

Table 2-10
Employment and Gallons Per Employee Per Day, 2009-2012

Public Water Supplier	Commercial & Industrial Use, 2009 - 2012	Average Employment, 2009 - 2011	Gallons per Employee per day, 2009 - 2012
CANTON	151.7	20,629.7	20.2
DEDHAM-WESTWOOD	231.5	24,581.3	25.8
FOXBOROUGH	127.3	11,849.7	29.4
MEDFIELD	30.3	2,829.0	29.4
SHARON	20.4	3,458.0	16.1
STOUGHTON	103.4	12,721.3	22.3
WALPOLE	109.5	10,318.7	29.1
TOTAL	**774.2**	**86,387.7**	**24.6**

- **Projected Commercial and Industrial Water Demand for 2030:** As was done with residential demand, the projections for commercial and industrial demand were calculated separately for existing (2010) employees, and for the increment of new employees added from 2010-2030. The two are then summed to derive the total demand for this sector. This allows the model to account for differing per employee rates of water use for the existing and new employment. The Status Quo scenario projection uses the existing 2010 per-employee water use rates for both existing and new employees in 2030 (see Table 2-11).

Table 2-11
Commercial/Industrial Demand Projections, 2030
Status Quo Scenario

Public Water Supplier	Projected 2030 Comm/Indust. Demand, Existing Employment, MGY	Projected 2030 Comm/Indust. Demand, New Employment, MGY	Projected 2030 Total Comm/Indust. Demand, MGY
CANTON	151.7	2.4	154.2
DEDHAM-WESTWOOD	231.5	30.4	261.9
FOXBOROUGH	127.3	29.6	156.9
MEDFIELD	30.3	1.4	31.7
SHARON	20.4	0.1	20.5
STOUGHTON	103.4	7.1	110.5
WALPOLE	109.5	0.0	109.6
TOTAL	**883.7**	**71.1**	**845.3**

2.2.2.3 Municipal, Institutional, and Other Metered Use

This category of water use includes all metered use by the municipality, non-profit institutions, and other metered users that are not included in the residential, commercial, or industrial categories (however it does not include agricultural use). The model allows for alternative scenarios to be run by inputting different assumptions. Projections for this category were calculated as follow:

- **Existing Demand for Municipal, Institutional, and Other Metered Users:** Existing (2010) demand is based on the municipal, institutional, and other water use reported in the Annual Statistical Reports. This is calculated as an average of the four-year period of 2009-2012, in order to buffer the influence of any abnormally dry or wet years, or abnormal short term demands (or reductions) by users.

- **Projected Municipal, Institutional, and Other Water Demand for 2030:** Projected demand for this category is calculated based on the percentage change in population, households, and employment from 2010 to 2030 (Table 2-12).

Table 2-12
Municipal, Institutional, and Other Metered Use Projections, 2030

Public Water Supplier	Existing Municipal, Institutional, Other Metered Use, 2009 - 2012	Projected Municipal, Institutional, Other Metered Use, 2030
CANTON	71.8	73.4
DEDHAM-WESTWOOD	47.6	52.0
FOXBOROUGH	33.8	37.3
MEDFIELD	20.3	22.9
SHARON	22.9	22.8
STOUGHTON	31.9	32.4
WALPOLE	20.7	21.7
TOTAL	**249.0**	**262.4**

2.2.2.4 Unaccounted For Water

Projections of unaccounted-for water are calculated as follow:

- **Existing Unaccounted-For Water:** Existing (2010) unaccounted-for water is based on the unaccounted-for water use reported in the Annual Statistical Reports. This is calculated as an average of the four-year period of 2009-2012, in order to buffer the influence of any abnormal years.

- **Projected Unaccounted-For Water:** For 2030 (or any future year), the model projects unaccounted-for water as a percentage of total finished water. The Status Quo scenario projection was calculated using the existing UAW percentages, but the model allows for alternative scenarios to be run by inputting different assumptions for the percentage of unaccounted-for water.

Table 2-13
Unaccounted-For Water Projections, 2030

Public Water Supplier	Existing Unaccounted For Water (2009–12) MGY	Unaccounted Water as percent of total finished water (2009–12)	Projected Unaccounted For Water, 2030 MGY
CANTON	110.1	13%	120.5
DEDHAM-WESTWOOD	337.7	24%	377.4
FOXBOROUGH	86.4	13%	96.5
MEDFIELD	109.7	24%	133.0
SHARON	68.1	14%	71.4
STOUGHTON	83.5	12%	85.6
WALPOLE	60.7	8%	77.7
TOTAL	**856.1**	**15%**	**962.0**

2.2.3 Summary of Results

Combining the projections of each of the above four water use categories yields the total projected water demand for each community. For the Status Quo scenario, total projected water demand for 2030 is summarized in Table 2-14:

Table 2-14
Projected Total Water Demand, 2030
Status Quo Scenario

Public Water Supplier	Residential (MGY)	Comm/Ind (MGY)	Muni/Inst (MGY)	UAW (MGY)	TOTAL (MGY)
CANTON	583.9	154.2	73.4	120.5	932.0
DEDHAM-WESTWOOD	884.0	261.9	52.0	377.4	1,575.3
FOXBOROUGH	445.0	156.9	37.3	96.5	735.7
MEDFIELD	372.4	31.7	22.9	133.0	560.1
SHARON	387.2	20.5	22.8	71.4	501.8
STOUGHTON	470.5	110.5	32.4	85.6	699.0
WALPOLE	634.1	109.6	21.7	68.0	833.6
TOTAL	**3,777.2**	**845.3**	**262.4**	**952.3**	**5,837.5**

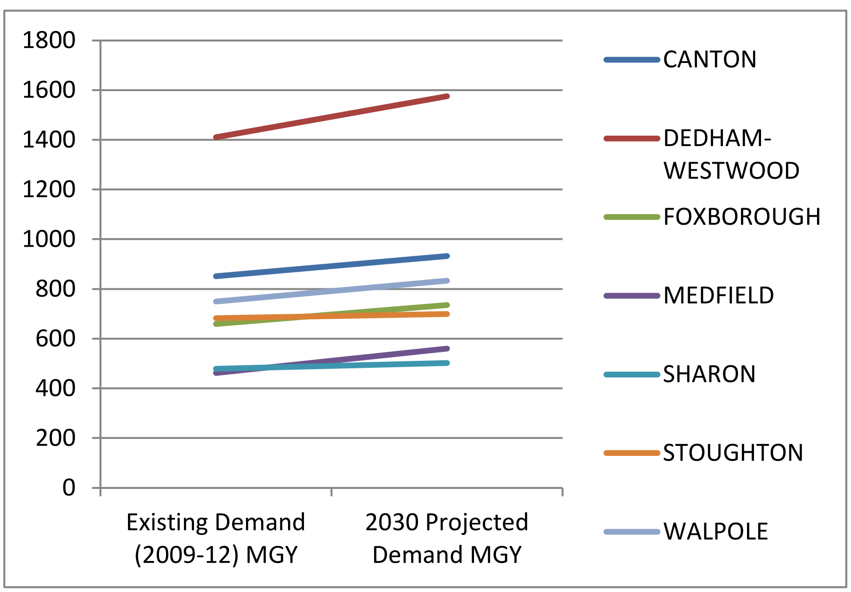
To summarize the projected demand trends across the watershed, Table 2-15 and Figure 2-6 compare the Status Quo 2030 demand projection to the existing demand (2009-12 average) by town.

Table 2-15
Comparison of Existing to Projected 2030 Demand by Town
Status Quo Scenario

Public Water Supplier	Existing Demand (2009–2012) MGY	Projected Demand 2030 MGY	Volume Difference, Existing to 2030 MGY	Percent Difference, Existing to 2030 MGY
CANTON	851.4	932.0	80.6	9.5%
DEDHAM-WESTWOOD	1,409.9	1,575.3	165.4	11.7%
FOXBOROUGH	658.7	735.7	77	11.7%
MEDFIELD	461.7	560.1	98.4	21.3%
SHARON	478.8	501.8	23	4.8%
STOUGHTON	681.9	699.0	17.1	2.5%
WALPOLE	749.7	833.6	83.9	11.2%
TOTAL	**5,292.1**	**5,837.5**	**545.4**	**10.3%**

While the average increase to 2030 for the eight towns is projected to be a modest 10.3 percent, there is considerable variation among the communities. Medfield stands out with the highest projected rate of demand growth, which at 21.3 is more than double the average. And on the low end of the growth scale, Stoughton is projected to see demand grow by 4.8 percent, and Sharon by only 2.5 percent. The rest of the towns are very close to the 10 percent average.

Figure 2-6
Comparison of Existing to Projected 2030 Demand by Town
Status Quo Scenario

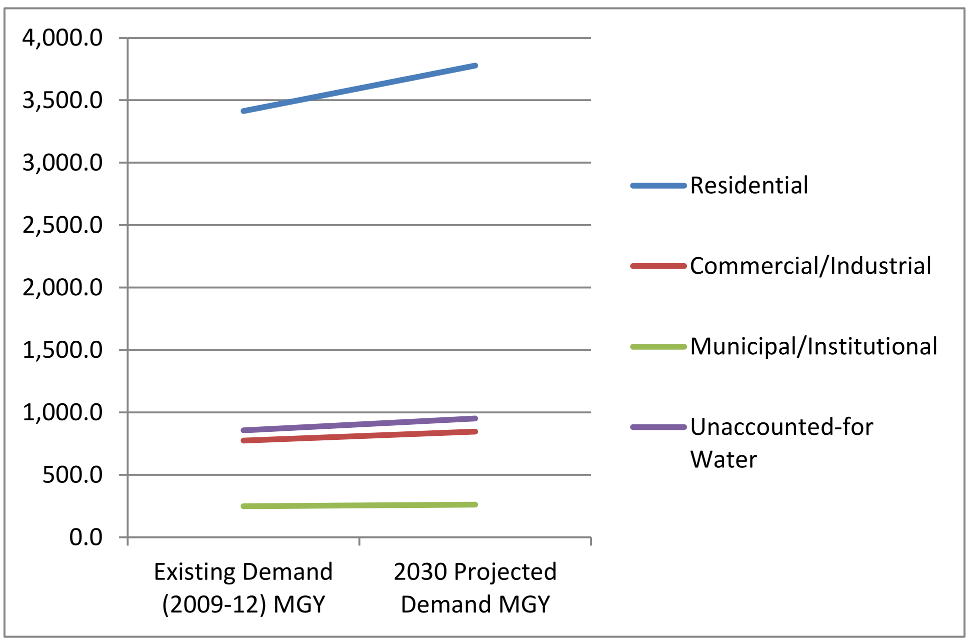


Finally, Table 2-16 and Figure 2-7 compare existing and projected demand for the eight towns by category of water use.

Table 2-16
Comparison of Existing to Projected 2030 Demand by Water Use Category
Status Quo Scenario

Public Water Supplier	Existing Demand (2009–12) MGY	Projected Demand 2030 MGY	Volume Difference, Existing to 2030 MGY	Percent Difference, Existing to 2030 MGY
Residential	3,412.7	3,777.2	364.5	10.7%
Commercial/Industrial	774.2	845.3	71.1	9.2%
Municipal/Institutional	249.0	262.7	13.7	5.5%
Unaccounted-for Water	856.1	952.3	96.2	11.2%
TOTAL	**5,292.1**	**5,837.5**	**545.4**	**10.3%**

Figure 2-7
Comparison of Existing to Projected 2030 Demand by Water Use Category
Status Quo Scenario



As would be expected among a group of towns whose land use is predominantly residential, the most significant component of existing as well as projected 2030 water use is in the residential sector. This comprises 67 percent of the total water demand, and with projected growth rate of 10.7 percent, it is in this sector that the greatest potential for conservation and demand management may be found. This is addressed further below.

SWMI Standard Conditions

The SWMI Framework (see SWMI Framework Appendix G) lays out a set of eight standard conditions that all WMA permittees in the Commonwealth will be required to comply with. Of these, conditions 4-7 have a direct bearing on water conservation. These conditions address:

- Condition 4. Performance Standard for Residential Gallons Per Capita Day Water Use (RGPCD)
- Condition 5. Performance Standard for Unaccounted for Water (UAW)
- Condition 6. Seasonal Limits on Nonessential Outdoor Water Use
- Condition 7. Water Conservation Requirements

The table below summarizes these conditions and the status of each study area community in complying with each.

As of 2012 Walpole and Canton do not yet meet the 65 RGPCD standard. In addition, DWWD, Sharon, Stoughton, and Foxborough are not currently in compliance with the 10% UAW standard. Communities not meeting these standards within 2 years must implement an RGPCD or UAW reduction plan and comply within an additional three years or implement the DEP functional equivalence plan.

No municipality in the Neponset Valley currently has restrictions on non-essential outdoor watering that fully support the requirements outlined in the SWMI standard conditions. While some communities have outdoor restrictions that are tougher than the standard conditions in some respects (Sharon and Foxborough), none of the communities in the study area has a trigger for “seven day low flow” conditions. In fact, DEP has yet to calculate what these 7-day low flow triggers are for each community. Thus, each of our towns will be required by their new permits to revise their water restriction bylaws or regulations at least to some degree.

MassDEP has indicated that they interpret the standard condition on water conservation requirements (#7) as meaning that applicants must comply with the requirements of the Massachusetts Water Conservation Standards. Appendix G of the SWMI framework only presents an outline of the requirements of the Mass Water Conservation Standards. The Massachusetts Water Resource Commission’s Water Conservation Standards (WCS) are much more detailed and demanding than the conditions listed in the Framework Appendix G.

We initially attempted to summarize the requirements of the Water Conservation Standards and indicate the status of each study area community in complying with these standards. However, the Water Conservation Standards are quite lengthy and include a very large number of both standards and general recommendations. In many cases, it is unclear which of these apply to municipalities, and the long list provides little clarity in how a community should prioritize their efforts. Lastly, Table 2 in Appendix G of the SWMI Framework, which purportedly summarizes the Water Conservation Standards, contains a number of statements which are substantively different from the Standards themselves, thus adding to the confusion.

Figure 2-9 SWMI Standard Conservation Conditions and Compliance Status

SWMI Standard Condition 4: Performance Standard for RGPCD

	Canton	DWWD	Foxboro	Medfield	Sharon	Stoughton	Walpole	Remarks
The RGPCD performance standard for all PWS permittees is 65 gallons	70	56	59	67	58	56	70	per 2012 ASRs

SWMI Standard Condition 5: Performance Standard for UAW

	Canton	DWWD	Foxboro	Medfield	Sharon	Stoughton	Walpole	Remarks
The UAW performance standard for all PWS permittees is 10% of total water withdrawal	3.90%	26.40%	19.80%	22.90%	14%	14.50%	7.60%	per 2012 ASRs

SWMI Standard Condition 6: Seasonal Limits on Outdoor Water Use

Note: Seasonal limits more protective than the standard are encouraged, refer also to applicable practices under water conservation standards below. The following has been re-worded from the EEA language for clarity.

	Canton	DWWD	Foxboro	Medfield	Sharon	Stoughton	Walpole
For prior year RGPCD <=65 (must comply with item 1 and choose either 2 or 3)							
When 7-day low flow trigger activates, nonessential allowed 1 day per week but not from 9-5, **and**	NA	No	No	NA	No	No	NA
Nonessential allowed 7 days per week from May to October, but not 9-5, **or**	NA	No	Yes	NA	Yes	No	NA
Nonessential allowed 7 days per week 24 hours per day from May to October, unless flows are below ABF and then nonessential allowed 7 days per week but not from 9-5	NA	No	Yes	NA	Yes	No	NA
For prior year RGPCD >65 (must comply with item 1 and choose either 2 or 3)							
When 7-day low flow trigger activates, nonessential allowed 1 day per week but not from 9-5, **and**	No	NA	NA	No	NA	NA	No
Nonessential allowed 2 days per week from May to October but not 9-5, **or**	No	NA	NA	No	NA	NA	No
Nonessential allowed 7 days per week 24 hours per day from May to October, unless flows are below ABF and then nonessential allowed 2 days per week but not 9-5	No	NA	NA	No	NA	NA	No

SWMI Standard Condition 7: Water Conservation Requirements

Refer to water conservation BMP reccomendations and summary of Water Conservation Standards

Therefore, we largely abandoned our efforts to summarize the Water Conservation Standards, and have focused instead on assembling and analyzing a list of priority conservation best management practices (BMPs) which draw in part on the Water Conservation Standards as well as other resources. As discussed below, we recommend that communities focus on these BMPs when evaluating how they will comply with SWMI Standard Condition #7 regarding water conservation requirements. We did however complete a spreadsheet summarizing the MA Water Conservation Standards which is included in the Appendix.

WATER CONSERVATION IN THE CONTEXT OF MINIMIZATION AND MITIGATION

As noted above, in addition to the SWMI WMA standard conditions, communities in the study area must also address “reasonable conservation measures” in the context of preparing a required minimization plan. Furthermore water conservation practices can also be used to meet or avoid the mitigation requirements associated with withdrawal requests over Baseline. In addition, some communities, particularly those who are currently over or near the 65 RGPCD and/or 10% UAW requirements may find that they will end up with a permitted volume which is, at least initially, close to their current demand. Such communities may find that it would be preferable to have a larger “margin of safety” or more “headroom” between their current use and their new permitted volume to provide more flexibility during very dry years or to accommodate short term economic development goals.

While the use of water conservation measures to meet mitigation requirements or reestablish headroom below a permit limit is optional, communities are likely to find that conservation measures are some of the few potential mitigation options which reduce operating costs rather than increasing them, and as such, communities are encouraged to consider implementing water conservation BMPs that go beyond the minimum required actions.

We had hoped to be able assign a meaningful quantitative water savings potential to a variety of conservation measures. Unfortunately, the outdoor water conservation savings potential identified in existing studies is highly dependent on climate as well as the number of in-ground automatic irrigation systems and the current local outdoor water use efficiency. Even for indoor water use, while we have presented the potential water savings from installation of the most water-efficient toilets, washing machines, showerheads and faucets, these estimates vary widely based on the efficiency of the existing fixtures in each home and the effectiveness of education and rebate programs in motivating people to implement retrofits. A better estimate can be made when setting efficiency standards for new development and redevelopment, especially where the extent of such development can be accurately predicted over time

While we cannot reliably indicate that implementing a specific BMP such as a showerhead distribution program will produce a specific volume of demand reduction in a set timeframe, there are several recent studies that establish benchmarks for indoor and outdoor use by homes at several distinct efficiency levels. Using these benchmarks, one can forecast the potential range of water savings that could be achieved through the implementation of a comprehensive water conservation program over a period of time. These benchmarks are discussed in greater detail below and were used to define the “conservation scenario” evaluated in the Demand Projections portion of the report. In addition, communities may also wish to consider conducting an assessment of the existing level of water-efficiency in their community using survey and sampling techniques to establish a starting point against which potential water savings may be measured.

With these considerations in mind, we have identified a list of Priority Water Efficiency BMPs for consideration by communities as shown in the figure below. These BMPs respond to the requirements of the SWMI Standard Conditions as well as the requirements and key recommendations of the MA Water Conservation Standards. Several of these BMPs are discussed in greater depth below.

Comprehensive Planning and Drought Management

The MA Water Conservation Standards require communities to develop a written plan describing how they intend to implement the requirements of the Water Conservation Standards. This includes a Drought Management Plan that incorporates measures to address peak day demand under both drought conditions and normal weather conditions as well as an Emergency Management Plan. Only two of the communities in the study area have written water conservation plans. Given that this will become a requirement under SWMI we encourage communities to use the development of the required conservation plan to evaluate adoption of the other priority BMPs discussed below.

Conservation-Oriented Water Rates

Water rates have an important influence on efficiency. In the 20 years between 1991 and 2011, MWRA water rates tripled, while water use went down by a third (from 310 MGD to 210 MGD). Conservation-oriented rates can enhance conservation by targeting excessive use through application of seasonal rates, increasing block rates or a combination of both.

On the subject of rates, the Water Conservation Standards go beyond the “conditions” outlined in the SWMI Framework, stating that “increasing block or seasonal rate structures are preferred,” with the following recommendations:

- The volume of the first block for residential rates should be based on efficient indoor household water use [discussed further below].
- The difference between blocks should “create an incentive to conserve.”
- Higher seasonal rates should be set “according to demand and climate conditions.”

All the water suppliers in our study area, with one exception, have already adopted increasing block rates. However, in a number of cases these rates are not structured well to accomplish the fundamental goal of ensuring that the heaviest users pay higher average unit costs than the most efficient users to reflect the additional mitigation and peak capacity supply costs they impose on the system.

Figure 2.17 Summary of Priority Water Efficiency BMPs

Implementation of the BMPs summarized below will meet or exceed the requirements of the SWMI Standard Conditions and the MA Water conservation Standards. Refer to full report for additional details and discussion

Planning

- Water Conservation Plan, that identifies how system will comply with MA Water Conservation Standards and includes a drought management plan that addresses management of seasonal and peak day use and an emergency management plan

Metering

- 100% metering (including municipal) and quarterly billing
- Appropriate meter type, sizing and calibration including master meters (annually) and a budget for ongoing meter repair/replacement

Seasonal Restrictions on Non-Essential Use

- Default irrigation policy that limits irrigation (other than a hand held hose) to two days per week not from 9-5
- Other restriction levels are defined in a way that is very easy to communicate i.e. "no sprinklers" and "total outdoor water ban"
- Provides for no sprinklers or equivalent when low flow trigger is met
- Extend seasonal limits to private well users.

Performance Standards for Irrigation systems

- Prohibit new irrigation system connections to PWS and/or
- Regulate and register new and existing irrigation system per Town of Concord model with additional performance enhancements
- Targeted outreach, rebates and incentives for extreme over-watering in existing systems

Enhanced Indoor
Performance Standards and Rebates

- For development or redevelopment, require water sense (or better) fixtures and washing machines
- For existing facilities, offer rebates for WaterSense toilets/urinals and washers with water factor of <4.5, as well as free 1.5 GPM showerheads, 1.0 GPM bath aerators, and 1.5 GPM kitchen aerators

Water Bank

- New development responsible for offsetting their new demand through mitigation measures or a contribution to town conservation/ mitigation program

Leak detection

- Annual leak detection surveys and/or automated system, and prompt repairs
- Review customer usage (manually or with software) and notify customers of leaks

Outreach

- Reach all users at 4+ times per year through 4+ different means (bill stuffers, direct mail, circular advertising, web, schools, email, signage, demo projects, contests, social media, press, and face to face).
- Community specific content that targets priority users with appropriate messages
- Update/rotate materials and delivery methods annually
- Fund staff, consultants or regional cooperative to implement program

Conservation Oriented Rates

- Enterprise account and full cost pricing
- Increasing block, seasonal or both with limited fixed base fees or customer charges
- In block system, set block volumes appropriately and block prices should have significant spread (250-400%).
- Verify that least efficient 25-30% of users pay a higher average unit price at least seasonally.

Municipal facilities

- 100% metering and billing
- Audit and retrofit municipal buildings to WaterSense standard
- Weather based irrigation (or waterless) at all municipal facilities
- Use municipal facilities as demonstration sites for education

Even within the study area there is a wide diversity of rate structures and measurement units in use. In order to compare rates among communities in the study area, we converted all the rates into standard units of 1,000 gallons (refer to Appendix for complete analysis).

In addition, we analyzed billing data available from the Town of Sharon to develop a set of quarterly consumption volumes that are representative of a range of household efficiency levels. Specifically, we calculated the average quarterly consumption for the third of Sharon households which are most efficient, the third which are least efficient, and the middle third. These volumes of actual use were substantially lower than volumes often cited as "typical" by sources such as the AWWA.

Table 2-18: Quarterly Water Consumption for Efficiency Terciles Town of Sharon 2011

Sharon 2011 Billing Data	**Q1 Average (1000 gal units)**	**Q2 Average (1000 gal units)**	**Q3 Average (1000 gal units)**	**Q4 Average (1000 gal units)**	**Annual Average (1000 gal units)**
Most Efficient Third (of annual use)	7.23	8.78	9.00	7.84	35.55
Middle Third (of annual use)	11.64	14.09	15.28	12.39	55.57
Least Efficient Third (of annual use)	19.83	27.18	34.56	20.56	97.25

We then applied these standard volumes to the rate systems in each community to determine the quarterly and annual total costs per unit for the three classes of users (top third, middle third, and bottom third). To our surprise we found that even in the peak summer quarter, only two communities have rates that result in the most inefficient users paying more per unit for their water than the most efficient users. In most cases, this is because the block volumes are set too high, such that very little water is subject to the higher rates in the upper blocks, the price differences between the blocks are too small, and/or the base fees are set too high.

Table 2-19: Average Charges at Standard Consumption Volumes

Community	Q3 Most Efficient Third, Average $ per 1,000 Gal Unit	Q3 Least Efficient Third, Average $ per 1,000 Gal Unit
Canton	$3.59	$4.70
DWWD	$6.29	$4.17
Dover	$22.37	$14.89
Foxboro	$9.86	$8.96
Medfield	$4.31	$3.56
Stoughton	$4.14	$3.76
Sharon	$5.33	$8.83
Walpole	$4.54	$4.54

The effectiveness of conservation oriented water rates in encouraging conservation by heavy water users is a function not only of the volume differences between the lowest and highest blocks, but also the differential in the prices charged in each block, as well as the size of any fixed base charge. In Neponset communities, usage rates and base fees vary significantly.

For example, Walpole has no quarterly base fee, while the Dover Colonial Water Company has a base fee $158.70. Sharon has different winter and summer rates, while Canton and Walpole have different rates for normal use and for outdoor irrigation meters. Rates for the first block in the towns we studied were in the general range of $2 to $3 per 1,000 gallon, while the top block varied from $5.78 in Stoughton to $24.00 in Dover (Colonial Water Company). Most top blocks were in the range of $5 to $13.50. Finally, the break points between blocks (i.e. the number of gallons included in each block) in an ascending block rate structure are also a major consideration. To illustrate the diversity of block volumes among the communities we reviewed, the upper limit of the first block ranges from 2,240 gallons per quarter in DWWD to 19,450 gallons in Stoughton.

In light of the above, we recommend that the communities in the study area re-evaluate their increasing block rate systems to verify that they actually create the intended conservation incentives. In so doing we encourage the study area communities to consider the following recommendations which are consistent with both the recommendations and examples provided in the Water Conservation Standards.

- In a four block rate, the volume breaks between the blocks should correspond roughly to the average use level of the most efficient third, middle third and least efficient third of users in the community. A similar approach can be taken with other numbers of blocks.
- There should be a substantial spread between the charges for use across the various blocks. Charges in the top block should be on the order of 250% to 400% of the charges in the bottom block.
- Fixed charges should be kept to a minimum to preserve the incentive to conserve and communities should consider establishing a rate stabilization fund to help even out cash flow between dry and wet years as an alternative in increasing base fees.
- Communities should analyze billing data to determine the average quarterly use of appropriate classes of users (i.e. the top third, middle third, and bottom third) in their community and test the consumption volumes for each class against their proposed rate system to ensure that, at least during the peak summer months, there is a substantial differential between the average unit costs paid by the most inefficient and most efficient users.

Seasonal Restrictions on Non-Essential Use

As discussed above, the SWMI standard condition limiting non-essential outdoor use will require all the communities in the study area to revisit their current limitations on seasonal non-essential use. While doing so, we encourage them to consider additional features that go beyond the minimum SWMI requirements, as a cost effective way to minimize impacts from existing withdrawals, reduce their Mitigation volume and/or help reestablish adequate permit headroom.

Here again, the Water Conservation Standards go beyond the SWMI Standard Conditions, recommending:

- Minimization of lawn/landscape watering
- Application of watering restrictions to private wells as well as municipal uses
- Full enforcement of restrictions

Based on the experience of other communities in the study area and beyond we specifically recommend incorporating the following features:

- Establish standing restrictions that limit irrigation to two days per week outside the hours of 9 to 5 with an exception for the use of a hand held hose.
- Establish a limited number of additional restriction levels with an emphasis on ensuring that each level is easy to communicate such as "no sprinklers" and "total ban."
- When the required 7 day low flow threshold is reached restrictions should rise to the equivalent of a "no sprinklers" or "total ban" restriction.

The reason for recommending permanent two day per week restrictions for irrigation other than by hand-held hose is to help increase the efficiency of automated irrigation systems. Where a traditional "odd-even" or every other day restriction is used, it is common for irrigation systems to be set to operate every other day, irrespective of irrigation need. In our climate, more than adequate water for irrigation purposes can be applied in one to two irrigation sessions per week. Similar policies have already been implemented in two study area communities (Sharon and Foxborough). In both cases, the policy has been implemented without serious customer objection and is perceived to have resulted in significant efficiency gains. We recommend adopting this two day per week as a permanent, standing policy which is always in effect irrespective of weather conditions, because it will take a significant time to bring all irrigation systems into compliance with the rules, and it will reduce disruption for both customers and the water utility to keep them in place rather than changing the requirements from month to month. Provision or a hand held hose exemption provides flexibility for those who are not using an automated system or for incidental use.

The recommendation to simplify both the number and nomenclature for restriction levels recognizes the difficulty of getting the attention of the entire customer base when more stringent restrictions are needed and is designed to increase compliance by simplifying the message being communicated.

The recommendation to tighten restrictions when the seven day low flow criterion is triggered is simply a recognition that the trigger criterion is a very low flow, and that by the time area steams reach that level they are experiencing severe impacts and even where those impacts are not entirely caused by water withdrawals, any steps which can reasonably be taken to reduce further hydrologic stress on the stream will be extremely beneficial.

Regulation and Incentives for Automatic Irrigation Systems

Automated irrigation systems are a primary driver of seasonal demand. The "Analysis of New Single Family Homes" study finds that a majority of those who irrigate (52%) are applying more water than their landscape requires, and a small minority of this group is overwatering to an extreme degree, accounting for the majority of excess outdoor use for the population as a whole. This study also indicates that while newer homes use substantially less water indoors than older homes, total use by new homes is often higher than for older homes due to substantially higher outdoor use and a greater tendency to overwatering.

In light of the above, we recommend that communities in the study area consider a program to regulate the installation and operation of automated irrigation systems. Specifically we recommend one of two approaches:

- Prohibiting the connection of new automated irrigation systems to the public water supply as has been the case in Stoughton for many years;
- Regulating both new and existing irrigation systems based on a model adopted by the Town of Concord with additional enhancements

The Town of Concord has adopted a set of regulations for automated irrigation systems, a copy of which is included in the appendix. The main features of the Concord requirements are:

- Registration of all systems connected to the public water supply
- Controllers must be capable of being programmed to automatically limit operation to prescribed schedules and restrictions;
- Systems must be fitted with a rain sensor to automatically shut off systems during rain events; and
- Systems must be equipped with backflow prevention devices and systems installed after Oct. 9, 2003 must have a Reduced Pressure Zone backflow preventer.

In addition to the provisions of the Concord regulations, we also recommend that communities consider the following:

- Even where irrigation systems are not prohibited, a clear statement that the community prefers that they not be installed
- A prohibition against applying irrigation water to impervious surfaces or causing irrigation water to run off to impervious surfaces or storm drains
- Annual inspection for leaks
- For new systems only: use of WaterSense certified, weather-based irrigation controllers
- For new systems only: design/installation by a WaterSense certified professional

- For new systems only: payment of a water bank fee to offset increased demand

Note that we do not recommend requiring all existing irrigation systems to upgrade their controllers to WaterSense models or be evaluated by a WaterSense professional. The reason for this is that while 52% of irrigators are over-watering, 48% are under-watering. A blanket policy of upgrading controllers for all existing irrigation systems is likely to result in increasing use by the under-waterers which will partially offset the benefit of decreasing use by the over-waterers.

Thus, rather than a blanket requirement to upgrade all existing irrigation systems, we recommend a program of targeted outreach and incentives for the extreme over-waterers. Offering these customers site specific information regarding the optimal volume of irrigation for their property based on evapotranspiration, as well as rebates on WaterSense controllers and/or an irrigation system audit by a WaterSense irrigation professional are appropriate strategies for targeting this relatively small segment of users.

Indoor Efficiency Requirements for New Construction and Rebates for Existing Residences

The Water Conservation Standards require the implementation of a comprehensive water conservation program and specifically recommend, among other things, offering rebates for replacing inefficient indoor fixtures and appliances, and requiring water-efficient indoor fixtures/appliances for new construction.

The SWMI Framework is based on regulating annual daily average withdrawal levels, and while seasonal use is a significant concern, as discussed further below, indoor use accounts for roughly 85% total annual use in study area. Toilets, washing machines, shower heads, and faucets account for 80% of indoor water use in "inefficient" homes, according to an appendix to the Water Conservation Standards.

With that in mind we recommend that communities adopt rules requiring indoor efficiency levels better than the plumbing code for new development and incentive programs to encourage existing homes to upgrade to better than plumbing code standards.

For new homes or businesses in the study area, we specifically recommend requiring:

- WaterSense labeled toilets, preferably with GPF ratings of less than 1.28
- EnergyStar labeled clothes washers with a water factor of 4.5 or less
- WaterSense labeled showerheads, preferably with flow rates of 1.5 GPM or less
- Water sense labeled faucets, preferably with flow rates of 1.0 GPM for bathroom faucets
- For non-residential applications, lavatory faucets with a flow rate of 0.5 GPM, in compliance with existing federal law
- For commercial applications, WaterSense labeled urinals, preferably with GPF rating of less than 0.5

Performance standards similar to those indicated above have already been adopted by at least one state (Georgia). There is a very wide array of products available in the marketplace, from numerous competing manufacturers, that meet these standards and which are available at the same price points as more conventional fixtures. Adopting these standards will ensure that new homes and businesses will meet or exceed the consumptions levels indicated for the "high efficiency homes benchmark" discussed further below. Using methods developed by Amy Vickers and outlined in the MA Water Conservation standards (and detailed in the Appendix) we estimate that these requirements will save roughly 12,845 gallons per year per residential unit.

For existing homes, we encourage communities to consider establishing rebate and other incentive programs that will help increase overall indoor efficiency. Again using the procedures developed by Amy Vickers and detailed in the Appendix, we estimate that total water savings from retrofitting existing homes with the most water-efficient toilets, washing machines, shower heads and faucets lies somewhere between 11,490 and 53,171 gallons per household per year, depending on the water efficiency of the fixtures being replaced.

Specifically we recommend that communities in the study area consider rebate programs that address the following:

- Rebates of $75-200 for WaterSense labeled toilets, preferably with GPF ratings of less than 1.28
- Rebates of $75-200 for EnergyStar labeled clothes washers with a water factor of 4.5 or less
- Free distribution of 1.5 GPM Niagara Earth chrome showerheads which are both inexpensive (~$3.50 ea. in bulk) and favorably rated by third parties for shower quality
- Free distribution of pressure-compensating 1.0 GPM bath aerators and 1.5 GPM kitchen (~$0.60 ea.)

A number of communities in the study area already have existing rebate programs than include some or all of these items. Refer to the appendix for a summary of existing rebate programs in the study area.

Leak Detection

Leak detection and repair, both in the publicly owned distribution system and on the customer side is another very important component of maintaining an efficient system.

The MA Water Conservation Standards require a full leak detection survey every 2 years. However, we encourage all communities in the study area to conduct a system-wide leak detection and repair program annually. This is particularly encouraged for those suppliers that are not already in compliance with the SWMI 10% UAW requirement. Annual leak detection surveys are current practice in a number of the study area communities.

In addition, customer leaks represent a significant portion of overall household demand. Thus we recommend that communities adopt systems to alert customers of leaks on the customer side of the meter. This can be done on an automated basis using a growing variety of available software systems, or can be done in a more low-tech manner using spreadsheets to check billing data as is the current practice in Canton. Studies have shown that the majority of total customer leakage is associated with a relatively small number of accounts that have sizeable leaks such as a toilet flapper problem. In addition to its water saving benefits, such a program also has significant customer relations benefits.

Education & Outreach

Both the SWMI Standard Conditions and the Water Conservation Standards call for the implementation of an education and outreach program to raise awareness promote implementation of efficiency measures.

In order to be effective, such programs need to be tailored to their community or region, need to employ a variety of different outreach methods and need to be conducted on an ongoing basis. When designing an outreach and education program, we recommend that communities ensure that their program addresses the following points:

- The program should establish a goal for reaching all customers four or more times per year
- The program should utilize a variety of different communication methods to reach different constituencies effectively and to reinforce the information delivered through multiple means, including: bill stuffers, direct mail, circular advertising, website, classroom presentations in the schools, email, signage, demonstration projects, contests, social media, the press, and face to face interaction through community events, and presentations to community groups.
- The content needs to be community specific rather than generic
- Certain key constituencies such as heavy water users or automated irrigation system owners should be targeted with relevant information for their particular situation.
- Both materials and delivery methods need to be updated and/or rotated annually.
- In order to ensure that the program is carried out effectively, it will needed to be supported with dedicated staff, paid consultants or through a staffed regional cooperative

CONSERVATION SCENARIOS FOR DEMAND PROJECTIONS

The Massachusetts Department of Conservation and Recreation (DCR) has developed a set or water needs forecasts for each community in the Commonwealth. The DCR forecasts estimate water needs at five year intervals from 2015 to 2030.

For each community, DCR has developed a pair of forecasts, each using a different method. The first method is referred to the “current trends” forecast. It assumes that current water consumption rates for residential and other uses as well as unaccounted for water will continue unchanged into the future, and that population and employment will grow as predicted by the MAPC’s demographic projections.

The second method is referred to as the “65/10” forecast, in which it is assumed that applicants will comply with the goals of 65 gallons per capita per day for residential use and 10%

unaccounted for water. For the 2030 time period a “buffer” representing an additional 5% is allowed to account for uncertainty.

For both scenarios, DCR conducted consultations with each community, and the forecasts may have been further adjusted upwards in response to community-specific issues raised during those consultations. For many communities in the study area, who are already near or below the 65/10 goals, the DCR forecasts represent minimal, zero or even negative efficiency gains over a 20 year period. Given the trend of long term declines in water demand across the state and the country, in spite of population growth, the DCR forecasts likely overestimate long term water needs for most, if not all, communities in the study area.

While communities are welcome to apply for as much water as they would like under the Water Management Act, MassDEP has indicated that they expects most of the permits it issues will reflect the DCR 65/10 forecast volume. For some communities a request at this level would exceed Baseline and necessitate a significant volume of mitigation. As part of the WMA permitting, each community in the study area will need to decide how much water it would like to request, and to the extent that this volume exceeds Baseline, how it proposes to mitigate those additional withdrawals.

For purposes of this project, we presume that most communities will request the maximum volume available under their DCR water needs forecast, though some communities may opt to request less than this in order to reduce their mitigation obligations. However, one very important feature of the SWMI process is that while potential mitigation activities need to be identified at the time of permit application, they do not need to be implemented until shortly before any increased water volumes are actually needed. This raises the possibility that some communities may request a sizeable increase in withdrawal volume, but eventually need only a portion (or perhaps even none) of that increase. Thus understanding the range of potential future efficiency gains, which are not necessarily reflected in the DCR forecasts, is important in helping communities decide how much water to request. Even where the community elects to request the full DCR forecast volume, understanding the potential range of future efficiency gains is still a very important factor in developing a community’s mitigation plan.

As part of the project, a literature review was performed in an effort to establish a basis for estimating future demand under one or more water conservation scenarios. Many of the older references that were reviewed focused on disaggregating various end uses of water within a home (i.e. toilet use vs. shower use) applying a presumed efficiency improvement to each device and then re-combining the individual uses to create a new estimate of total demand per user. However, such approaches fail to take into account many of the complex dynamics surrounding real world water use behaviors and the actual performance of various technologies in the field.

Two more recent studies, both published in 2011, provide a more promising approach. The Analysis of Water Use in New Single Family Homes identified a large number of randomly selected single-family homes from communities across the country and aggregated them into three distinct groups based on the age of construction and the type of fixtures in use. The groups included:

- Older homes built before 2001
- New homes, built from 2001 to 2011, to standard water efficiency rules (i.e. the federal plumbing code requirements)
- New homes built since 2001 to higher efficiency standards which approximate the WaterSense new homes standard

Within each group, the project conducted very detailed monitoring of water consumption across each individual home, allowing the authors to establish total consumption rates for homes in each class. The detailed monitoring of the homes provided additional insight into how water was being used both for total indoor and outdoor use, as well as for various individual end uses such as toilet flushing. The consumption values for each class can be used as benchmarks for evaluating both the efficiency of existing households in a community, and to provide a basis for developing scenarios that quantify the volume of water that would be required per household if various levels of efficiency relative to the benchmarks could be attained.

The second of the two studies, the California Single Family Water Use Study, used similar methods across a more narrow geographic area to evaluate how much existing efficiency programs in those communities had already exhausted the potential for further efficiency gains, and to attempt to quantify the volume of remaining water that could be saved through additional efficiency efforts under various scenarios.

There are two major limitations in applying the results of these two research reports to our study area. The first is that they were not conducted in New England, but other in areas of the country with much higher demand for irrigation water and outdoor use than exists in Massachusetts. In spite of this, the information developed for indoor uses in these two studies is still directly applicable to our study area. In addition, some of the broad observations about outdoor water use relationships are also applicable even though the outdoor water use data itself is not. The second limitation is that both studies focus exclusively on single family homes, whereas available data for our study area aggregate residential uses of all types (single-family, multi-family, etc.) into a single block. Given that single family homes generally use more water per household than multi-family homes, applying the benchmarks developed for these studies in our area will tend to somewhat overstate the amount of water needed per housing unit in our study area.

In order to compare water use data from our study area to the indoor benchmarks in the two research reports, we made use of billing data from residential users in three communities (Sharon, DWWD, and Foxborough) to estimate the volume of extra water used in the summer months as a percentage of total annual consumption, and we presume that this volume is all being used outdoors. Only one year of billing data was readily available for each community. For Sharon and DWWD this was 2011, and for Foxborough it was 2012. The analysis found that for both Sharon and DWWD, the extra summer use was approximately 15% (within ± 0.5%) of annual use, while in Foxborough; the extra summer water was approximately 10% (9.9%) of annual use.

It may be that seasonal differenced between 2011 and 2012 account for the difference between Foxborough and Sharon/DWWD, or it may also be that indoor use in Foxborough is less efficient and outdoor use more efficient than in DWWD and Sharon. This latter possibility is consistent with the noticeably higher RGPCD reported by Foxborough as compared to Sharon/DWWD. These annual indoor/outdoor ratios also compare favorably with industry rules of thumb for septic system recharge which is generally assumed to be approximately 85% of water consumption annually.

These summer ratios were used to estimate the volumes of existing indoor and outdoor use on a gallons per household per day (GPHD) basis for each of the three community, using the figures developed by the MAPC for current (2009-2012) total GPHD refer to the Appendix for additional details of how these estimates were derived.

Table 2-.20 Estimated Existing Indoor and Outdoor Use Study Area

System	Estimated existing total use (2009 - 2012), GPHD	Summer increase as a % of annual use	Estimated existing indoor, GPHD	Estimated existing outdoor, GPHD
DWWD	145	15%	123	22
Foxborough	173	10%	156	17
Sharon	162	15%	138	24

Not surprisingly, the "Analysis of Water Use in New Single Family Homes" report identifies household population as the most important factor influencing the observed GPHD consumption for a given household. The report goes on to develop a set of mathematical relationships or curves that allow one to estimate GPHD as a function of household population. The shape of this curve varies depending on the underlying efficiency of the household—adding a person to an efficient household makes less of a difference than adding one to an inefficient household. As a result, the study provides three curves, one each for the older homes group, the standard homes group, and the efficient homes group. Adjusting the research report's indoor use benchmarks for the average household population in each community indicates that existing indoor use rates in the three communities fall between the older home and standard home benchmarks, with most being fairly close to the standard home benchmark, as illustrated in the table below. Note that Sharon is composed almost entirely of single family homes, whereas DWWD and, to a lesser degree, Foxborough have a mix of housing types represented, which may partially explain some of the variation observed in the table.

Table 2-21: Existing Indoor Use vs. Benchmarks, Adjusted for 2010 Household Population

System	Population per HH, 2010	Estimated existing indoor, GPHD	Benchmark indoor, older homes, 2010 HH Pop, GPHD	Benchmark indoor, standard homes, 2010 HH Pop, GPHD	Benchmark indoor, efficient homes, 2010 HH Pop, GPHD
DWWD	2.57	123	168	120	98
Foxborough	2.59	156	169	121	99
Sharon	2.82	138	179	127	103

Over time, indoor water use in existing homes in the study area can be expected to move toward the standard homes benchmark as the ongoing process of renovation brings existing housing stock into compliance with the plumbing code. Furthermore, with the now widespread availability of fixtures and appliances that are substantially more efficient than the plumbing code, one can expect existing housing stock to gradually move beyond the standard home efficiency benchmark. With the introduction of appropriate water conservation programs, the existing homes could be moved even closer to the high efficiency homes standard. It would also be possible to require new homes to comply with higher efficiency standards.

One other important observation is that over the term of the next round of 20 year WMA permits, demographics in the study area will continue to change. A number of new housing units will be added in each community. At the same time, the number of occupants per household in both new and existing homes is expected to decline. This decline in average household population is a long term trend, which slowed but did not stop during the recent recession. As the number of people living in existing households declines, the amount of water consumed in each of those existing homes will decline over time, even in the absence of any efficiency gains, and even taking into account the fact that homes with fewer occupants are less efficient than homes with more occupants.

The water demand forecast model developed by MAPC for this project uses three methods to project future water demands: the Household Method, the Per Capita Method and the Average Method. In the MAPC's "Status Quo" scenario they assume that population and employment both grow, that average household size falls and that there is no change in efficiency. In this scenario, the MAPC's Household Method ignores the water savings in existing homes that results from the falling number of average residents in each home. By contract the MAPC's Per Capita method ignores the additional water demand that results from the fact that people living in homes with fewer people use more water per person than those living in homes with more people. Thus the one method overestimates demand while the other underestimates it. The MAPC's Average Method falls between the other two approaches and has been proposed as a way to more accurately predict the effect of changing average household size on water demand.

In an attempt to validate this conclusion, we used the method outlined in the Single Family Homes study as an alternative way to estimate the amount of water savings that will result not from efficiency gain, but just from changing average household size. Using the MAPC Average Method results in an estimate of a 4.7% decrease in use by existing homes in the study area between 2010 and 2030. Using the Single Family Homes study method results in an estimate slightly more than 6.3% savings for the same group over the same time period. This would seem to corroborate the use of the MAPC Average Method as being preferable to either the Household or Per Capita Methods. It also points out that communities should anticipate a small but significant change in demand over time as the result of changing average household size above and beyond any efficiency gains associated with conservation, and this will partially offset additional demand from new households. More complete documentation of this analysis is included in the Appendix.

The California Single Family Water Use Study also discusses the patterns of outdoor water use and develops scenarios for potential reduction in outdoor water use. While benchmarks for outdoor water use taken from more arid climates cannot be applied to our study area, some of the patterns and recommendations for outdoor water use do seem applicable. One is the observation that a significant fraction (54%) of those who do irrigate are applying more irrigation water than their landscape requires. However, a small minority of these over-irrigators are applying extremely excessive volumes, and thus account for a disproportionate share of the outdoor water use which is truly wasted.

The report also discusses three levels of attainable outdoor efficiency gain. The least ambitious of these involves relatively limited modification of the behavior of some of the extreme over-irrigators to bring their use in line with the actual needs of their landscape, and this produce a 28% reduction in total outdoor water demand. This pattern of a very small number of homes accounting for a grossly disproportionate share of seasonal demand was also in evidence in an analysis of Sharon's water use data performed by the Neponset Watershed Association and thus we believe that the goal of a 28% reduction in outdoor water use should also be attainable in our study area.

Based on the above information, we developed a series of three potential water conservation scenarios for each of the three communities which are detailed in the appendix. These three scenarios estimate household use for both existing and new homes in each of the three communities for which we had seasonal use data (DWWD, Foxborough and DWWD). One important limitation of this approach is that community-specific seasonal use data was only available for three of the seven study area communities. With the availability of additional time and data, this analysis would ideally be performed individually for each community, using several years of seasonal use data. In the interest of simplifying the analysis for the project as a whole, the three town-specific scenarios were reduced to a single generic conservation scenario. The generic scenario consists of a uniform percentage reduction form existing GPHD use rates applied to all study area communities using the MAPC Demand Forecast Model. Communities who wish to explore scenarios other than the generic conservation scenario are encouraged to plug their own figures into the project Demand Forecast Model.

After consultation with the project team, a decision was made to use a hybrid scenario for evaluation in the MAPC Demand Forecasting Model. The selected scenario is referred to as the referred to as the 6.5/20 Scenario and entails the following assumptions:

- That indoor consumption for existing homes moves from its present level to the "standard homes benchmark" over 20 years. Of the three communities that were evaluated, we selected the level of change associated with the Town of Sharon, which is a 6.5% efficiency gain and which falls between the levels for DWWD and Foxborough.
- There is no change in per household outdoor water use for existing homes
- New homes built during the next 20 years will perform at the high efficiency benchmark for indoor use. Of the three communities that were evaluated, we selected the level of change associated with the DWWD, which is a 20% efficiency improvement relative to the existing homes and which is the smallest improvement for this metric among the three communities evaluated
- That new homes built during the next 20 years will use 14% less water outdoors than existing homes do today. This represents half of the 28% improvement which was the least optimistic outdoor conservation scenario in the Single Family Homes study
- That commercial and industrial use experiences a 10% increase in efficiency per employee over the next 20 years
- That there is no change in the existing level of unaccounted for water for each community.
- That any change in consumption due to changing average household size will be calculated using the MAPC's Average Method.

The 6.5/20 scenario was selected for further modeling and discussion purposes. We believe it represents a fairly modest level of conservation effort, presuming in effect that existing homes come into compliance with the plumbing code and that more substantial steps are taken to ensure that all new homes achieve standards better than the plumbing code but consistent with currently available technology. Realizing this scenario will require some effort on the part of study area communities, particularly in addressing requirements for new homes.
However, with more aggressive efforts greater efficiency gains than those outlined in the 6.5/20 are definitely feasible. Our maximum efficiency scenario would entail a 27% average increase in efficiency among the three communities. While it is unlikely that most communities will achieve this level of efficiency gain by the end of the next WMA permit term, over an extended time period, this scenario is not as unlikely as it might seem. This scenario assumes that only the least ambitious of the three feasible outdoor conservation goals developed for California be attained. Furthermore, the high efficiency homes indoor benchmark is not that efficient in comparison to indoor water using fixtures and appliances which are currently available. This benchmark equates to an indoor RGPCD of about 38, and approximately 25% of households in Sharon were already at or below this standard in 2011.

When the 6.5/20 Conservation Scenario is plugged into the project Demand Forecasting Model, the increased demands projected for 2030 under the "Status-Quo" Scenario are greatly reduced and in some cases fall below existing demand, in spite of population growth as illustrated in the table 2-22 below.

Table 2-22 Water Demand under "Status Quo" and "6.5/20 Conservation" Scenarios

System	Current Demand, 2009 - 2012, MGY	"Status Quo" Demand, 2030, MGY	"Status Quo" % Change 2010-2030, MGY	"6.5/20" Demand, 2030, MGY	"6.5/20" % Change 2010- 2030, MGY
Canton	851.4	932.0	9%	857.0	1%
Dedham-Westwood	1409.9	1,575.3	12%	1442.1	2%
Foxborough	658.7	735.7	12%	676.3	3%
Medfield	461.7	560.1	21%	508.4	10%
Sharon	478.8	501.8	5%	463.4	-3%
Stoughton	681.9	699.0	3%	648.5	-5%
Walpole	749.7	833.6	11%	760.9	1%
Neponset Total	**5292.1**	**5,837.5**	**10%**	**5356.5**	**1%**

One limitation to the 6.5/20 scenario is that we have applied the same percentage reduction factors to the existing use in each community in spite of the fact that different levels of efficiency gain are needed to reach the underlying "standard homes" benchmark in each community. Several of the study area communities who are presently over 65 RGPCD and/or 10% UAW will be will be expected to achieve greater efficiency gains than 6.5% among their existing homes under the SWMI Standard Conditions. One advantage of our conservation scenario relative to the DCR Water Needs Forecast Methodologies is that it contemplates the possibility of continued efficiency gains in the communities who are already in compliance with the 65 RGPCD and 10% UAW goals. As mentioned above, we would preferred to have access to community-specific summer-winter use information for all our communities, in which case we could have developed individualized conservation scenarios for each community based on their particular circumstances.

In spite of the limitations of our 6.5/20 Conservation Scenario, it still illustrates the potential of deliberate policies and programs to substantially reduce the need for additional withdrawal volumes in the future. With the exception of Medfield, all the communities in the study area will experience negligible or even negative growth in demand with the moderate level of conservation effort contemplated under this scenario.

APPENDIX 1

Neponset Watershed - SWMI Water Demand Projections, 2010 - 2030

Status Quo Scenario Projection

No change in existing per capita/per household demand

No change in existing and new per employee demand

28-Jun-13

Current Residential Consumption and Future Assumptions

					Per Household Assumptions		Per Capita Assumptions	
Muni_ID	System	Average Residential Demand, 2009 - 2012, MGY	Estimated Gallons per Household, 2009 - 2012	Estimated Gallons per Capita, 2009 - 2012	Gallons per Household, Existing Housing Units, 2030	Gallons per Household, New Housing Units, 2010 - 2030	Gallons per Person, Existing Housing Units, 2030	Gallons per Person, New Housing Units, 2010 - 2030
50	Canton	518	169	67	169	169	67	67
354	Dedham-Westwo	793	145	57	145	145	57	57
99	Foxborough	411	173	67	173	173	67	67
175	Medfield	301	200	69	200	200	69	69
266	Sharon	367	162	57	162	162	57	57
285	Stoughton	463	123	48	123	123	48	48
307	Walpole	559	174	64	174	174	64	64
	Neponset Total	**3,413**	**164**	**61**	**164**	**164**	**61**	**61**

Population Projections

Muni_ID	System	Households, 2010	Population in Households, 2010	Population per Household, 2010	Household Change, 2010 - 2030	Population in Households, 2030	Population per Household, 2030	Population Change, Existing Housing Units
50	Canton	8378	21,243	2.5	1,490	23,000	2.3	(1,679)
354	Dedham-Westwo	14900	38,247	2.6	2,630	40,600	2.2	(4,777)
99	Foxborough	6504	16,840	2.6	870	17,400	2.3	(1,741)
175	Medfield	4117	11,982	2.9	1,370	13,700	2.3	(2,507)
266	Sharon	6219	17,542	2.8	770	17,300	2.5	(2,143)
285	Stoughton	10295	26,617	2.6	460	26,300	2.5	(1,148)
307	Walpole	8730	23,494	2.7	1,840	25,500	2.3	(3,294)
	Neponset Total	**59,143**	**155,965**	**2.7**	**9,430**	**163,800**	**2.4**	**(17,288)**

Projected Residential Demand

			2030 Demand, Per Household Method			2030 Demand, Per Capita Method			2030 Average Method		
Muni_ID	System	Residential Use, 2009 - 2012	Demand, Existing Housing Units, 2030, MGY	Demand, New Housing Units, 2010 - 2030, MGY	Total Demand, 2030, MGY	Residents of Existing Housing Units, 2030, MGY	Residents of New Housing Units, 2010 - 2030, MGY	Total Demand, 2030, MGY	Demand, Existing Housing Units, 2030, MGY	Demand, New Housing Units, 2010 - 2030, MGY	Total Demand, 2030, MGY
50	Canton	518	516	92	608	476	84	560	496	88	584
354	Dedham-Westwo	793	790	139	929	717	122	839	753	131	884
99	Foxborough	411	410	55	465	375	49	425	393	52	445
175	Medfield	301	301	100	401	265	79	344	283	89	372
266	Sharon	367	367	45	412	322	40	362	344	43	387
285	Stoughton	463	463	21	484	437	20	457	450	20	470
307	Walpole	559	554	117	671	497	100	597	526	108	634
	Neponset Total	**3,413**	**3,402**	**569**	**3,970**	**3,090**	**494**	**3,584**	**3,246**	**531**	**3,777**

Commercial/ Industrial Use, Assumptions, & Projections

Muni_ID	System	Commercial & Industrial Use, 2009 - 2012	Average Employment, 2009 - 2011	Gallons per Employee per day, 2009 - 2012	Projected Employment Change, 2010 - 2030	Per Employee Assumptions: Gallons per employee, existing employment, 2030	Per Employee Assumptions: Gallons per employee, new employment, 2010 - 2030	Demand, Existing Employment, 2030	Demand, New Employment, 2010 - 2030	Total Commercial Demand, 2010 - 2030
50	Canton	151.7	20,630	20.2	330.4	20.2	20.2	151.7	2.4	154.2
354	Dedham-Westwo	231.5	24,581	25.8	3,223.6	25.8	25.8	231.5	30.4	261.9
99	Foxborough	127.3	11,850	29.4	2,754.4	29.4	29.4	127.3	29.6	156.9
175	Medfield	30.3	2,829	29.4	131.2	29.4	29.4	30.3	1.4	31.7
266	Sharon	20.4	3,458	16.1	22.4	16.1	16.1	20.4	0.1	20.5
285	Stoughton	103.4	12,721	22.3	875.0	22.3	22.3	103.4	7.1	110.5
307	Walpole	109.5	10,319	29.1	3.2	29.1	29.1	109.5	0.0	109.6
	Neponset Total	**774.2**	**86,388**	**24.6**	**7,340.2**	**24.6**	**24.6**	**774.2**	**71.1**	**845.3**

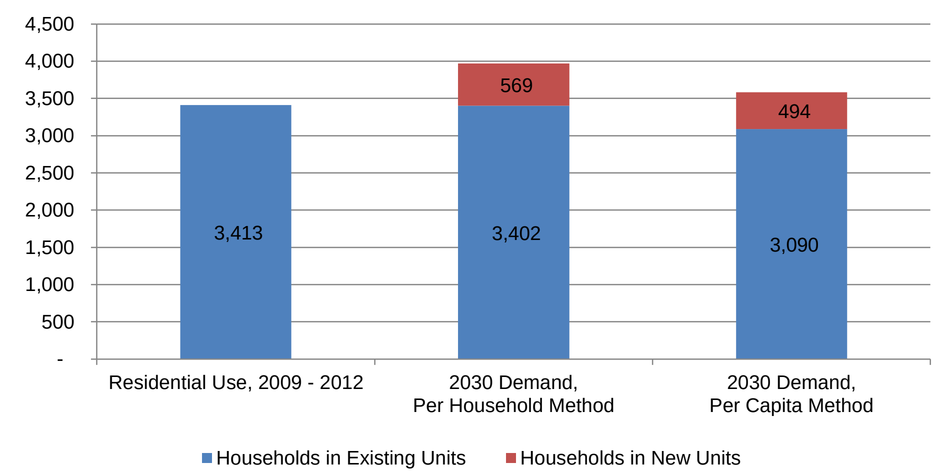
Municipal, Other, and Unaccounted-For Water

Muni_ID	System	Municipal, Institutional, Other Metered Use, 2009 - 2012	Municipal, Institutional, Other Metered Use, 2030	Unaccounted For Water, 2009 - 2012	Unaccounted Water, percent of total finished, 2009 - 2012	Unaccounted Water, percent of total finished, 2030	Unaccounted For Water, 2030
50	Canton	71.8	73.4	110.1	13%	13%	120.5
354	Dedham-Westwo	47.6	52.0	337.7	24%	24%	377.4
99	Foxborough	33.8	37.3	86.4	13%	13%	96.5
175	Medfield	20.3	22.9	109.7	24%	24%	133.0
266	Sharon	22.9	22.8	68.1	14%	14%	71.4
285	Stoughton	31.9	32.4	83.5	12%	12%	85.6
307	Walpole	20.7	21.9	60.7	8%	8%	68.0
	Neponset Total	**249.0**	**262.7**	**856.1**	**15%**	**15%**	**952.3**

Aggregate Total Water Demand Projections

Muni_ID	System	Total Water Demand, 2009 - 2012, MGY	Total Water Demand (Average Method), 2030, MGY
50	Canton	851.4	932.0
354	Dedham-Westwo	1,409.9	1,575.3
99	Foxborough	658.7	735.7
175	Medfield	461.7	560.1
266	Sharon	478.8	501.8
285	Stoughton	681.9	699.0
307	Walpole	749.7	833.6
	Neponset Total	**5,292.1**	**5,837.5**

Residential Water Demand, Neponset Municipal Systems, 2010 - 2030, Million Gallons per Year, Base Scenario



Neponset Watershed - SWMI Water Demand Projections, 2010 - 2030

6.5/20 Conservation Scenario

(Existing per capita/per household demand reduced by 6.5%; demand from new units reduced by 20%)

(existing and new per employee demand reduced by 10%)

(No change in Unaccounted For Water)

28-Jun-13

Current Residential Consumption and Future Assumptions

					Per Household Assumptions		Per Capita Assumptions	
Muni_ID	System	Average Residential Demand, 2009 - 2012, MGY	Estimated Gallons per Household, 2009 - 2012	Estimated Gallons per Capita, 2009 - 2012	Gallons per Household, Existing Housing Units, 2030	Gallons per Household, New Housing Units, 2010 - 2030	Gallons per Person, Existing Housing Units, 2030	Gallons per Person, New Housing Units, 2010 - 2030
50	Canton	518	169	67	158	135	62	53
354	Dedham-Westwo	793	145	57	136	116	53	45
99	Foxborough	411	173	67	162	138	62	53
175	Medfield	301	200	69	187	160	64	55
266	Sharon	367	162	57	151	129	54	46
285	Stoughton	463	123	48	115	99	45	38
307	Walpole	559	174	64	163	139	60	51
	Neponset Total	**3,413**	**164**	**61**	**153**	**131**	**57**	**49**

Population Projections

Muni_ID	System	Households, 2010	Population in Households, 2010	Population per Household, 2010	Household Change, 2010 - 2030	Population in Households, 2030	Population per Household, 2030	Population Change, Existing Housing Units
50	Canton	8378	21,243	2.5	1,490	23,000	2.3	(1,679)
354	Dedham-Westwo	14900	38,247	2.6	2,630	40,600	2.2	(4,777)
99	Foxborough	6504	16,840	2.6	870	17,400	2.3	(1,741)
175	Medfield	4117	11,982	2.9	1,370	13,700	2.3	(2,507)
266	Sharon	6219	17,542	2.8	770	17,300	2.5	(2,143)
285	Stoughton	10295	26,617	2.6	460	26,300	2.5	(1,148)
307	Walpole	8730	23,494	2.7	1,840	25,500	2.3	(3,294)
	Neponset Total	**59,143**	**155,965**	**2.7**	**9,430**	**163,800**	**2.4**	**(17,288)**

Projected Residential Demand

			2030 Demand, Per Household Method			2030 Demand, Per Capita Method			2030 Average Method		
Muni_ID	System	Residential Use, 2009 - 2012	Demand, Existing Housing Units, 2030, MGY	Demand, New Housing Units, 2010 - 2030, MGY	Total Demand, 2030, MGY	Residents of Existing Housing Units, 2030, MGY	Residents of New Housing Units, 2010 - 2030, MGY	Total Demand, 2030, MGY	Demand, Existing Housing Units, 2030, MGY	Demand, New Housing Units, 2010 - 2030, MGY	Total Demand, 2030, MGY
50	Canton	518	483	73	556	445	67	512	464	70	534
354	Dedham-Westwo	793	739	111	850	670	97	768	705	104	809
99	Foxborough	411	384	44	428	351	39	390	367	42	409
175	Medfield	301	281	80	361	248	63	311	265	72	336
266	Sharon	367	343	36	379	301	32	333	322	34	356
285	Stoughton	463	433	17	449	409	16	425	421	16	437
307	Walpole	559	518	93	612	465	80	545	492	87	578
	Neponset Total	**3,413**	**3,181**	**455**	**3,635**	**2,889**	**395**	**3,284**	**3,035**	**425**	**3,460**

Commercial/ Industrial Use, Assumptions, & Projections

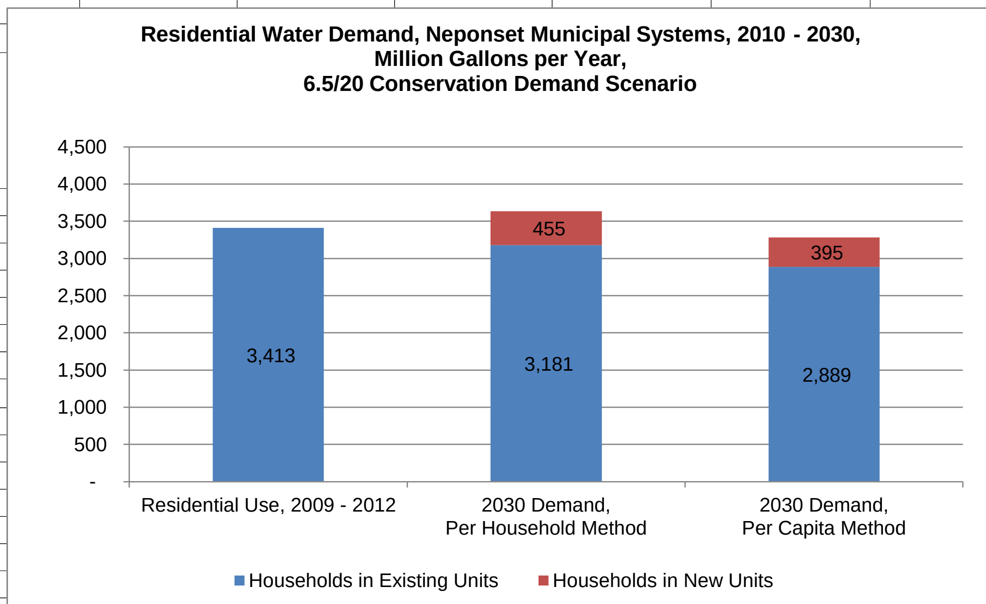
Muni_ID	System	Commercial & Industrial Use, 2009 - 2012	Average Employment, 2009 - 2011	Gallons per Employee per day, 2009 - 2012	Projected Employment Change, 2010 - 2030	Per Employee Assumptions: Gallons per employee, existing employment, 2030	Per Employee Assumptions: Gallons per employee, new employment, 2010 - 2030	Demand, Existing Employment, 2030	Demand, New Employment, 2010 - 2030	Total Commercial Demand, 2010 - 2030
50	Canton	151.7	20,630	20.2	330.4	18.1	18.1	136.6	2.2	138.7
354	Dedham-Westwo	231.5	24,581	25.8	3,223.6	23.2	23.2	208.4	27.3	235.7
99	Foxborough	127.3	11,850	29.4	2,754.4	26.5	26.5	114.6	26.6	141.2
175	Medfield	30.3	2,829	29.4	131.2	26.4	26.4	27.3	1.3	28.6
266	Sharon	20.4	3,458	16.1	22.4	14.5	14.5	18.3	0.1	18.5
285	Stoughton	103.4	12,721	22.3	875.0	20.0	20.0	93.1	6.4	99.5
307	Walpole	109.5	10,319	29.1	3.2	26.2	26.2	98.6	0.0	98.6
	Neponset Total	**774.2**	**86,388**	**24.6**	**7,340.2**	**22.1**	**22.1**	**696.8**	**64.0**	**760.8**

Municipal, Other, and Unaccounted-For Water

Muni_ID	System	Municipal, Institutional, Other Metered Use, 2009 - 2012	Municipal, Institutional, Other Metered Use, 2030	Unaccounted For Water, 2009 - 2012	Unaccounted Water, percent of total finished, 2009 - 2012	Unaccounted Water, percent of total finished, 2030	Unaccounted For Water, 2030
50	Canton	71.8	73.4	110.1	13%	13%	110.8
354	Dedham-Westwo	47.6	52.0	337.7	24%	24%	345.5
99	Foxborough	33.8	37.3	86.4	13%	13%	88.7
175	Medfield	20.3	22.9	109.7	24%	24%	120.7
266	Sharon	22.9	22.8	68.1	14%	14%	65.9
285	Stoughton	31.9	32.4	83.5	12%	12%	79.4
307	Walpole	20.7	21.9	60.7	8%	8%	62.1
	Neponset Total	**249.0**	**262.7**	**856.1**	**15%**	**15%**	**873.0**

Aggregate Total Water Demand Projections

Muni_ID	System	Total Water Demand, 2009 - 2012, MGY	Total Water Demand (Average Method), 2030, MGY
50	Canton	851.4	857.0
354	Dedham-Westwo	1,409.9	1,442.1
99	Foxborough	658.7	676.3
175	Medfield	461.7	508.4
266	Sharon	478.8	463.4
285	Stoughton	681.9	648.5
307	Walpole	749.7	760.9
	Neponset Total	**5,292.1**	**5,356.5**



APPENDIX 2

All rates converted to 1,000 gallon units

Compare block break points to standardized usage volumes of 9, 15 and 35 units during Q3 for most, middle and least efficient households

System	**Block 1 upper limit**	**Block 2 upper limit**	**Block 3 upper limit**	**Block 4 upper limit**	**Block 5 upper limit**	**Block 6 upper limit**	**Quarterly Base Fee**	**Block 1 Rate**	**Block 2 Rate**	**Block 3 Rate**	**Block 4 Rate**	**Block 5 Rate**	**Block 6 Rate**
Canton Residential as of 2011	11.22	29.92	74.80	infinite			10.00	2.84	4.73	7.80	9.81		
Canton Irrigation as of 2011	29.92	74.80	infinite				5.00	4.73	7.46	9.38			
DWWD residential as of 2011	2.24	31.42	56.10				35.52	0.00	3.12	5.06	6.56		
Dover/Colonial 2012	5.00	15.00	25.00	60.00	100.00	infinite	158.70	4.20	5.40	12.30	16.50	21.00	24.00
Foxborough 2013	5.61	22.44	56.10	infinite			60.12	0.00	8.44	8.86	9.31		
Medfield as of 2012	10.00	35.00	70.00	infinite			38.81	0.00	3.43	5.45	7.72		
Sharon as of 2012													
Resid Oct-Mar	7.50	15.00	22.50	infinite			15.00	3.00	6.00	8.00	12.50		
Resid Apr-Sept	7.50	15.00	22.50	infinite			15.00	4.00	7.00	9.00	13.50		
Commerc/Industrial	7.50	15.00	22.50	infinite			30.00	4.00	4.50	5.00	5.50		
Irrigation only	infinite						37.50	10.00					
Stoughton residential 2012	19.45	44.13	infinite				11.76	2.83	4.17	5.78			
Walpole													
Residential as of 2012	infinite						0.00	3.54					
May-Oct 2nd meter (irrigation)	infinite						0.00	4.21					

The standardized, per-account usage volumes presented below were developed based on an analysis of anonymous account-level usage data from the Town of Sharon for the 2011 calendar year. The dataset includes almost exclusively single family homes. The DPW used the town census to estimate the population for each household. The Watershed Association could not verify the accuracy of the census address matching because it received only anonymous data. Within each household size, the Watershed Association divided accounts into terciles representing the most efficient third, middle third, and least efficient third of households of each size. Each tercile was averaged to develop the typical usage figures below. Approximate RGPCD figures were derived using sharon's average household population of 2.92.

	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)		Q1 Approx. RGPCD	Q2 Approx. RGPCD	Q3 Approx. RGPCD	Q4 Approx. RGPCD	YR Approx. RGPCD
Most Efficent Third (of annual use)	7.23	8.78	9.00	7.84	35.55		27	33	34	29	33
Middle Third (of annual use)	11.64	14.09	15.28	12.39	55.57		44	53	57	47	52
Least Efficent Third (of annual use)	19.83	27.18	34.56	20.56	97.25		74	102	130	77	91

	Est Q2 Outdoor Use (1,000 gal)	Est Q3 Outdoor Use (1,000 gal)
Most Efficent Third (of annual use)	1	1
Middle Third (of annual use)	2	3
Least Efficent Third (of annual use)	7	14

In Standardized	**In Standardized Units of 1000 gals**				
	Block Upper Limit	**Block Rate**	**Block Base Fee**		**Block max charge**
Block 1	2.24	0	35.52		35.52
Block 2	31.42	3.12	0		126.54
Block 3	56.10	5.06	0		251.44
Block 4	infinite	6.56	0		infinite
Block 5	na	na	0		0
Block 6	na	na	0		0

Standardized Consumption Values	**Q1 Average (1000 gal rounded)**	**Q2 Average (1000 gal rounded)**	**Q3 Average (1000 gal rounded)**	**Q4 Average (1000 gal rounded)**	**Annual Average (1000 gal rounded)**	**Q1 Tot $**	**Q2 Tot $**	**Q3 Tot $**	**Q4 Tot $**	**Yr Tot $**	**Q1 $/m**	**Q2 $/m**	**Q3 $/m**	**Q4 $/m**	**Yr $/m**	**Excl Base Q1 $/m**	**Excl Base Q2 $/m**	**Excl Base Q3 $/m**	**Excl Base Q4 $/m**	**Excl Base Yr $/m**
Most Efficent T	7.23	8.78	9.00	7.84	35.55	51	56	57	53	217	7.06	6.37	6.29	6.76	6.09	2.15	2.32	2.34	2.23	2.10
Middle Third (c	11.64	14.09	15.28	12.39	55.57	65	72	76	67	281	5.57	5.14	4.99	5.42	5.05	2.52	2.62	2.66	2.55	2.49
Least Efficent T	19.83	27.18	34.56	20.56	97.25	90	113	142	93	439	4.56	4.17	4.12	4.51	4.51	2.77	2.86	3.09	2.78	3.05

In Standardized Units of 1000 gals

	Block Upper Limit	Block Rate	Block Customer Charge		Block max charge
Block 1	11.22	2.48	10		37.83
Block 2	29.92	4.73	0		126.28
Block 3	74.80	7.8	0		476.34
Block 4	infinite	9.81	0		infinite
Block 5	na	0	0		0
Block 6	na	0	0		0

Standardized Consumption Values	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)	Q1 Tot $	Q2 Tot $	Q3 Tot $	Q4 Tot $	Yr Tot $	Q1 $/m	Q2 $/m	Q3 $/m	Q4 $/m	Yr $/m	Excl Base Q1 $/m	Excl Base Q2 $/m	Excl Base Q3 $/m	Excl Base Q4 $/m	Excl Base Yr $/m
Most Efficent T	7.23	8.78	9.00	7.84	35.55	28	32	32	29	121	3.86	3.62	3.59	3.76	3.42	2.48	2.48	2.48	2.48	2.29
Middle Third (c	11.64	14.09	15.28	12.39	55.57	40	51	57	43	192	3.42	3.65	3.73	3.50	3.45	2.56	2.94	3.08	2.69	2.73
Least Efficent T	19.83	27.18	34.56	20.56	97.25	79	113	162	82	436	3.96	4.17	4.70	3.99	4.49	3.46	3.80	4.41	3.50	4.08

In Standardized Units of 1000 gals

	Block Upper Limit	Block Rate	Block Bae Fee		Block max charge
Block 1	5.00	4.20	158.7		179.7
Block 2	15.00	5.40	0		233.70
Block 3	25.00	12.30	0		356.70
Block 4	60.00	16.50	0		934.20
Block 5	100.00	21.00	0		1,774.20
Block 6	infinite	24.00	0		infinite

Standardized Consumption Values	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)	Q1 Tot $	Q2 Tot $	Q3 Tot $	Q4 Tot $	Yr Tot $	Q1 $/m	Q2 $/m	Q3 $/m	Q4 $/m	Yr $/m	Excl Base Q1 $/m	Excl Base Q2 $/m	Excl Base Q3 $/m	Excl Base Q4 $/m	Excl Base Yr $/m
Most Efficent T	7.23	8.78	9.00	7.84	35.55	192	200	201	195	788	26.52	22.79	22.37	24.88	22.17	4.57	4.72	4.73	4.63	4.31
Middle Third (c	11.64	14.09	15.28	12.39	55.57	216	229	237	220	901	18.52	16.24	15.52	17.72	16.22	4.88	4.97	5.13	4.92	4.79
Least Efficent T	19.83	27.18	34.56	20.56	97.25	293	393	514	302	1502	14.78	14.45	14.89	14.69	15.45	6.78	8.61	10.29	6.97	8.92

In Standardized Units of 1000 gals																							
	Block Upper Limit	Block Rate	Block Base Fee		Block max charge																		
Block 1	5.61	0	60.12		60.12																		
Block 2	22.44	8.44	0		202.17																		
Block 3	56.10	8.86	0		500.39																		
Block 4	infinite	9.31	0		infinite																		
Block 5	na	na	0																				
Block 6	na	na	0																				
Standardized Consumption Values	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)		Q1 Tot $	Q2 Tot $	Q3 Tot $	Q4 Tot $	Yr Tot $		Q1 $/m	Q2 $/m	Q3 $/m	Q4 $/m	Yr $/m		Excl Base Q1 $/m	Excl Base Q2 $/m	Excl Base Q3 $/m	Excl Base Q4 $/m	Excl Base Yr $/m
Most Efficent T	7.23	8.78	9.00	7.84	35.55		74	87	89	79	328		10.21	9.89	9.86	10.07	9.24		1.89	3.05	3.18	2.40	2.47
Middle Third (c	11.64	14.09	15.28	12.39	55.57		111	132	142	117	502		9.54	9.35	9.28	9.47	9.03		4.37	5.08	5.34	4.62	4.70
Least Efficent T	19.83	27.18	34.56	20.56	97.25		180	244	310	186	920		9.08	8.98	8.96	9.06	9.46		6.05	6.77	7.22	6.14	6.99

In Standardized Units of 1000 gals					
	Block Upper Limit	**Block Rate**	**Block Base Fee**		**Block max charge**
Block 1	10.00	0	38.81		38.81
Block 2	35.00	3.43	0		124.56
Block 3	70.00	5.45	0		315.31
Block 4	infinite	7.72	0		infinite
Block 5	na	0	0		0
Block 6	na	0	0		0

Standardized Consumption Values	**Q1 Average (1000 gal rounded)**	**Q2 Average (1000 gal rounded)**	**Q3 Average (1000 gal rounded)**	**Q4 Average (1000 gal rounded)**	**Annual Average (1000 gal rounded)**	**Q1 Tot $**	**Q2 Tot $**	**Q3 Tot $**	**Q4 Tot $**	**Yr Tot $**	**Q1 $/m**	**Q2 $/m**	**Q3 $/m**	**Q4 $/m**	**Yr $/m**	**Excl Base Q1 $/m**	**Excl Base Q2 $/m**	**Excl Base Q3 $/m**	**Excl Base Q4 $/m**	**Excl Base Yr $/m**
Most Efficent T	7.23	8.78	9.00	7.84	35.55	39	39	39	39	155	5.37	4.42	4.31	4.95	4.37	0.00	0.00	0.00	0.00	0.00
Middle Third (c	11.64	14.09	15.28	12.39	55.57	44	53	57	47	201	3.82	3.75	3.73	3.79	3.62	0.48	1.00	1.19	0.66	0.83
Least Efficent T	19.83	27.18	34.56	20.56	97.25	73	98	123	75	368	3.66	3.60	3.56	3.65	3.79	1.70	2.17	2.44	1.76	2.19

In Standardized Units of 1000 gals

	Block Upper Limit	Block Rate	Block Base Fee	Block max charge
Block 1	19.45	2.83	11.76	66.80
Block 2	44.13	4.17	0	169.72
Block 3	infinite	5.78	0	infinite
Block 4	na	0	0	0
Block 5	na	0	0	0
Block 6	na	0	0	0

Standardized Consumption Values	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)	Q1 Tot $	Q2 Tot $	Q3 Tot $	Q4 Tot $	Yr Tot $	Q1 $/m	Q2 $/m	Q3 $/m	Q4 $/m	Yr $/m	Excl Base Q1 $/m	Excl Base Q2 $/m	Excl Base Q3 $/m	Excl Base Q4 $/m	Excl Base Yr $/m
Most Efficent T	7.23	8.78	9.00	7.84	35.55	32	37	37	34	140	4.46	4.17	4.14	4.33	3.94	2.83	2.83	2.83	2.83	2.62
Middle Third (c	11.64	14.09	15.28	12.39	55.57	45	52	55	47	198	3.84	3.66	3.60	3.78	3.57	2.83	2.83	2.83	2.83	2.72
Least Efficent T	19.83	27.18	34.56	20.56	97.25	68	99	130	71	369	3.45	3.64	3.76	3.47	3.79	2.86	3.21	3.42	2.90	3.31

In Standardized Units of 1000 gals

	Block Upper Limit	Block Rate Winter	Block Rate Summer	Block Base Fee		Winter Block max charge	Summer Block max charge
Block 1	7.5	3.0	4.0	15		37.5	45
Block 2	15.0	6.0	7.0	0		82.50	97.50
Block 3	22.5	8.0	9.0	0		142.50	165.00
Block 4	infinite	12.0	13.5	0		infinite	infinite
Block 5	na	0	0	0		0	0
Block 6	na	0	0	0		0	0

Standardized Consumption Values	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)		Q1 Tot $	Q2 Tot $	Q3 Tot $	Q4 Tot $	Yr Tot $		Q1 $/m	Q2 $/m	Q3 $/m	Q4 $/m	Yr $/m		Excl Base Q1 $/m	Excl Base Q2 $/m	Excl Base Q3 $/m	Excl Base Q4 $/m	Excl Base Yr $/m
Most Efficent T	7.23	8.78	9.00	7.84	35.55		37	46	48	40	171		5.07	5.29	5.33	5.04	4.80		3.00	3.58	3.67	3.13	3.11
Middle Third (o	11.64	14.09	15.28	12.39	55.57		62	84	85	67	298		5.36	5.94	5.56	5.39	5.36		4.07	4.87	4.58	4.18	4.28
Least Efficent T	19.83	27.18	34.56	20.56	97.25		121	206	305	127	759		6.11	7.57	8.83	6.18	7.81		5.35	7.02	8.40	5.45	7.19

In Standardized Units of 1000 gals

	Block Upper Limit	Block Rate	Block Customer Charge	Block max charge
Block 1	infinite	4.54	0	infinite
Block 2	na	0	0	0
Block 3	na	0	0	0
Block 4	na	0	0	0
Block 5	na	0	0	0
Block 6	na	0	0	0

Standardized Consumption Values	Q1 Average (1000 gal rounded)	Q2 Average (1000 gal rounded)	Q3 Average (1000 gal rounded)	Q4 Average (1000 gal rounded)	Annual Average (1000 gal rounded)	Q1 Tot $	Q2 Tot $	Q3 Tot $	Q4 Tot $	Yr Tot $	Q1 $/m	Q2 $/m	Q3 $/m	Q4 $/m	Yr $/m	Excl Base Q1 $/m	Excl Base Q2 $/m	Excl Base Q3 $/m	Excl Base Q4 $/m	Excl Base Yr $/m
Most Efficent T	7.23	8.78	9.00	7.84	35.55	33	40	41	36	149	4.54	4.54	4.54	4.54	4.20	4.54	4.54	4.54	4.54	4.20
Middle Third (c	11.64	14.09	15.28	12.39	55.57	53	64	69	56	242	4.54	4.54	4.54	4.54	4.36	4.54	4.54	4.54	4.54	4.36
Least Efficent T	19.83	27.18	34.56	20.56	97.25	90	123	157	93	464	4.54	4.54	4.54	4.54	4.77	4.54	4.54	4.54	4.54	4.77

APPENDIX 3

Summary of Study Area Rebate Programs				
Community	**Toilets**	**Washers**	**In-ground Irrigation**	**Shower Heads/Aerators**
DWWD	$50 low flow & $75 high efficiency	$100 for front loaders		Free via MWRA
Canton (ended 9/30/12)	$100 up to 2 toilets; old >= 1.6 gpf, new <=	$75 Energy Star Water Factor of 4.5 or less		Free
Sharon	Up to $200 for 1.28 gpf	Up to $200 if Energy Star Water Factor <=6.0	Up to $200 for climate based controllers	Free
			$300 to decommission an existing system irrigating 5,000 sf or more	
			Up to $200 for audit done by WaterSense-certified person	
Foxborough	$100 replace high flow w/ low			At cost
Stoughton (ended 12/31/12)	$75 new 1.28gpf, old 3.5 gpf	$75 if Energy Star Water Factor of 4.5 or less		Free
	$10 conversion kit for 1.6 gpf			
Walpole	$75 new 1.28gpf, old 3.5 gpf	$75 if Energy Star Water Factor of 6.0 or less		Free via MWRA
Examples Outside Study Area				
Reading	Up to $120, new 1.6 gpf, old 3.5 gpf or	$200 for high-efficiency	$25 per irrigation system moisture sensor	
			$25 for Rain Barrel	

APPENDIX 4

Town of Concord, Massachusetts
22 Monument Square, Concord, MA 01742

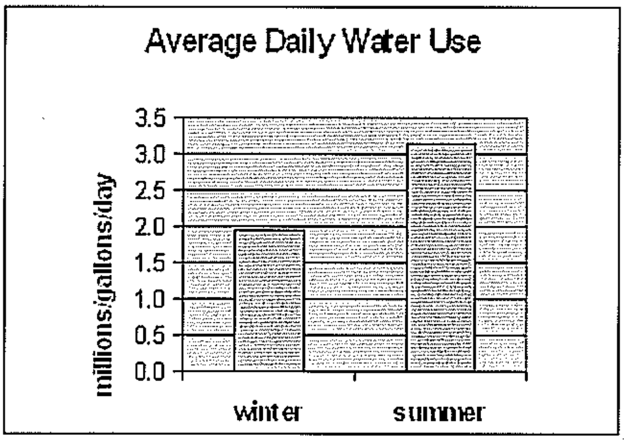
In-ground Irrigation Bylaw

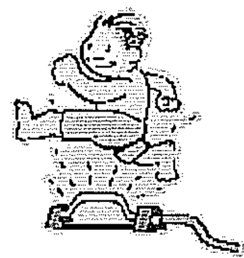
In Spring 2002 Town Meeting voted to require registration of all automatic in-ground irrigation systems permanently connected to the public water supply. In addition, to insure irrigation water is used safely and efficiently all systems are required to be equipped with the following:

- **Controller** – capable of being programmed to automatically limit operation to prescribed schedules and restrictions
- **Rain sensor** – to automatically shut off systems during rain events
- **Backflow prevention device** – to protect quality of drinking water. Systems installed after October 9, 2003 must have a Reduced Pressure Zone backflow preventor.

Why the Town wants to know about your in-ground sprinkler

Did you know that Concord's water demand jumps by 50 percent during the summer months, largely due to outdoor water use? A properly designed and operated irrigation system will result in "smarter sprinkling" by avoiding lawn watering during or after rainfall when the ground doesn't need it and by timing watering early in the morning when it is most likely to be absorbed. When the over 600 in-ground irrigation systems in Concord are registered and properly equipped:





- Peak period water consumption will be reduced.

- Water emergencies and bans will be less likely.

- There will be less wear and tear on the Town's water pumping systems.

- Homeowners will realize long-term savings, as the devices pay for themselves in one-to- two years.

- Water quality protection will be enhanced.

In-Ground Irrigation Registration Form

System Information con't

Backflow Prevention Device (for new installations only)

Manufacturer:_________________________ Model: _________________________

General Operation

When was the irrigation system installed?
pre 1980 1980-1989 1990-1994 1995-1998 1999 –2001 2002-2004 2005-2007 2009 Don't Know

What is the approximate area covered by the irrigation system?
Area in acres or portions of an acre: _________________________

Or the following areas:

Front yard __________ feet by __________ feet Back yard __________ feet by __________ feet

Side yard __________ feet by __________ feet Side yard __________ feet by __________ feet

Name of maintenance company: _________________________

Address: _________________________

Phone: _________________________

Are you currently having any problems with your irrigation system? If so, please describe _________________________

____

Completed Registrations should be sent to:

Irrigation Registrations
Concord Public Works
135 Keyes Road
Concord, MA 01742

Questions? Call 978-318-3250

☐ **Check here if you would like a free irrigation system check-up.**

System Information con't

Backflow Prevention Device (for new installations only)

Manufacturer:______________________________ Model: ___________________________

General Operation

When was the irrigation system installed?

pre 1980   1980-1989   1990-1994   1995-1998   1999 –2001   2002-2004   2005-2007   2009 Don't Know

What is the approximate area covered by the irrigation system?
Area in acres or portions of an acre: _______________________________________

Or the following areas:

Front yard __________ feet by ___________ feet   Back yard _________ feet by __________ feet

Side yard __________ feet by ___________ feet   Side yard _________ feet by __________ feet

Name of maintenance company: _________________________

Address: ____

Phone: ____

Are you currently having any problems with your irrigation system? If so, please describe ___________________
____

Completed Registrations should be sent to:

Irrigation Registrations
Concord Public Works
135 Keyes Road
Concord, MA 01742

Questions? Call 978-318-3250

☐ **Check here if you would like a free irrigation system check-up.**

APPENDIX 5

Estimates of Water Saved through Stricter Performance Standards and Retrofits

Based on methods developed by Amy Vickers and outlined in the MA Water Conservation Standards

WATER EFFICIENT TOILETS.

Vickers says that the average frequency of toilet use is 5.1 times a day per person. Thus the gphpy is derived by multiplying 5.1 by the number of gallons per flush of the toilet times 365 times 2.64 (the size of the average US household). Thus moving to a 1.0 gpf toilet saves:

- 1,349 gphpy if the current toilet is a 1.28 gpf (such toilets have been installed from 1997 until the present)
- 2,795 gphpy if the current toilet is a 1.6 gpf , the current MA Plumbing Code standard. So *2,704 gphpy per household is probably the amount of water that would be saved by towns with bylaws requiring 1.0 gpf toilets in new developments)*
- 12,286 gphpy if the current toilet is a 3.5 gpf (such toilets were installed from 1980 until 1994).

WATER EFFICIENT CLOTHES WASHERS.

Vickers states that the average household does 0.98 loads per day. Therefore, moving to a 15 gallon per load (gpl) energy star rated washer saves:

- 2,862 gphpy if the current washer is 23 gpl, which is the current standard non-energy star rated washer. *This would also probably be the water savings if new/re-development were required to use a 15 gpl machine*.
- 4,292 gphpy if the current washer uses 27 gpl available from 1998).
- 8,585 gphpy if the current washer uses 39 gpl washer (also available from 1998)
- 12,877 gphpy if the current washer uses 51 gpl (available from 1980-1990)

WATER EFFICIENT SHOWER HEADS.

Vickers says that the average person showers for 5.3 minutes per day. Therefore, installing a 1.5 gpm rated shower head will save:

- 3,373 gphpy if it replaces a 2.5 gpm shower head (these were installed from 1994 until at least 2001)
- 4,240 gphpy if it replaces a 2.75 gpm shower head (these were installed from 1980 – 1994)
- 5,107 gphpy if it replaces a 3 gpm rated shower head (these were installed from 1980 – 1994)
- 8,480 gphpy if it replaces a 4 gpm rated shower head (these were installed from 1980 – 1994)

WATTER EFFICIENT FAUCETS

Vickers states that an average household runs faucets for 21.4 minutes a day. Therefore, moving to a 0.5 gpm rated faucet saves:

- 7,811 gphpy if the current faucet is rated at 1.5 gpm (these were installed from 1994 until at least 2001)
- 15,622 gphpy if the current faucet is rated at 2.5 gpm (these were installed from 1994 until at least 2001)
- 17,575 gphpy if the current faucet is rated at 2.75 gpm (these were installed from 1980 to 1994)
- 19,528 gpcpy (13,588 gphpy) *if the current faucet is rated at 3.0 gpm* (these were installed from 1980 to 1994)

Moving to a 1.0 gpm rated faucet saves:

- 3,906 gphpy if the current faucet is rated at 1.5 gpm;
- 11,717 gphpy if the current faucet is rated at 2.5 gpm;
- 13,669 gphpy if the current faucet is rated at 2.75 gpm
- 15,622 gphpy if the current faucet is rated at 3.0 gpm

Education & Outreach

Both the SWMI Framework permit conditions and the Water Conservation Standards call for Education & Outreach efforts. NepRWA has worked with a number of towns in developing and implementing such efforts and has found that it takes a considerable amount of work to be effective. We recommend that implementation entail reaching all customers 4 times a year via 5 different media listed in the MA Water Conservation Standards (e.g., bill stuffers, meetings, websites). Messages should be changed or at least rotated annually.

APPENDIX 6

Conservation Scenarios Based on Change relative to Aquacraft Benchmarks, without regard to potential change in average household population

"Status Quo"

Both new and existing homes have no efficiency increase by 2030

System	**Existing homes GPHD 2030**	**New homes GPHD 2030**
Dedham-Westwood	145	145
Foxborough	173	173
Sharon	162	162
Average	160	160

Scenario 1 "Limited Efficiency"

Indoor use for both new and existing homes move to the Aquacraft standard homes benchmark by 2030, and there is no change in irrigation use for new or existing homes

System	Existing homes GPHD 2030	Existing homes, Δ from base, %	New homes GPHD 2030	New homes, Δ from base, %
Dedham-Westwood	142	-2.2%	142	-2.2%
Foxborough	138	-20.2%	138	-20.2%
Sharon	151	-6.5%	151	-6.5%
Average	144	-9.6%	144	-9.6%

Scenario 2 "Intermediate Efficiency"

Existing homes move to the Aquacraft standard homes benchmark and achieve a 14% reduction in outdoor use. New homes move to the Aquacraft efficient homes benchmark and achieve a 14% reduction in outdoor use.

System	**Existing homes GPHD 2030**	**Existing homes, Δ from base, %**	**New homes GPHD 2030**	**New homes, Δ from base, %**
Dedham-Westwood	139	-4.3%	117	-19.5%
Foxborough	136	-21.3%	114	-34.0%
Sharon	148	-8.4%	124	-23.2%
Average	141	-11.3%	118	-25.6%

Scenario 3 "Maximum Efficiency"

Both new and existing homes move to the Aquacraft efficient homes benchmark over 17 years, and make a 28% outdoor efficiency gain

System	**Existing homes GPHD 2030**	**Existing homes, Δ from base, %**	**New homes GPHD 2030**	**New homes, Δ from base, %**
Dedham-Westwood	114	-21.6%	114	-21.6%
Foxborough	111	-35.6%	111	-35.6%
Sharon	120	-25.5%	120	-25.5%
Average	115	-27.6%	115	-27.6%

APPENDIX 7

Summary of Key Provisions:
MA Water Conservation Standards and (where substantvely different)
SWMI Framework Appendix G Table 2 Requirements

COMPREHENSIVE PLANNING AND DROUGHT MANAGEMENT

SWMI Table 2 Requirements

NONE

MA 2012 Water Conservation Standards

*A **drought management plan** following AWWA 2002 Guidelines, including strategies to reduce daily and seasonal peak demands and contingency plans for seasonal shortages*
An emergency management plan per DEP requirements
*A **written program to comply with the MA Water Conservation Standards** and where possible Reccomendations as well*
Make above documents available to all municipal departments

SYSTEM WATER AUDITS AND LEAK DETECTION

SWMI Table 2 Requirements

Full leak survey every 3 years in per AWWA standards and have repair reports available for inspection by MassDEP
Full leak survey when UAW increases by 5% or more over last ASR. Submit report detailing leak survey, dates of repairs and estimated water savings.

MA 2012Water Conservation Standards

Annual ASR water audit per DEP water audit guidance
*Conduct complete system-wide **leak detection survey every 2 years**, or if leakage is insignficant, work with agencies to develop an alternte schedule*
Conduct field surveys for leaks and repair programs per AWW Manual and MassDEP Guidance
Repair leaks as expeditiously as possible; establish a priority system; fix leaks affecting public safety or causing property damage immediately.

METERING

SWMI Table 2 Requirements

Calibrate all source and finished water meters at least annually
Meters to meet AWWA calibration and accuracy standards.
Ongoing meter inspection, repair and replacement and checks for tampering

MA 2012 Water Conservation Standards

Ensure 100% metering of all water uses, including municipal
Residential bills based on actual, not estimated meter readings
Bill at least quarterly
Water meter repair/replacement policy and program per AWWA Manual M6 with an annual budget line item
Seal all metering systems against tampering and inspect periodically.
Calibrate any meter used to record quantity per AWWA Manual 6
Properly size all service lines and meters

Establish regulations and controls to ensure that owners of large (>=1.5") meters calibrate annually and report results.

PRICING

SWMI Table 2 Requirements

Apply full-cost pricing where rates cover, capital, operating, conservation, depreciation and all other system costs
Perform rate evaluation at least every 3 – 5 years
Decreasing block rates prohibited

MA 2012 Water Conservation Standards

A full-cost pricing structure includes, but is not limited to:		
	A water conservation program that could include the following:	
		Purchase of hardware for retrofit and rebate programs
		Water audits
		Public education materials and staff time
		Leak detection equipment, services, and repairs
		Metering/billing including replacement/repair program
		Automated meter readers including installation and maintenance
	Staff to run all aspects of system, including staff benefits and training	
	Pumping, maintenance, electricity/fuel	
	Treatement and association plant costs	
	Distribution system O,M&R	
	Purchase/protection of watershed lands, well sites, aquifer lands and a stormwater recharge system	
	Capital replacement fund, depreciation account and debt service	
	Rate stabilization fund	
Increasing block or seasonal rate structures are preferred *(see the*		
following MA 2012 Water Conservation Standards Recommendations)		
	For homes, 1st first block should be based on efficient indoor household water use	
	Difference between blocks should create incentive to conserve	
	Higher seasonal rates set according to demand & climate conditions	

RESIDENTIAL

SWMI Table 2 Requirements

Meets standards of state Plumbing Code and 1992 FERC Policy

MA Water Conservation Standards

Enforce MA Plumbing Code and 1992 FERC Policy.		
Implement comprehensive 2012 MA Water Conservation Program Standard Recommendations, including some or all of the following:		
	Offer rebates for replacing inefficient fixtures and appliances	
	Strongly recommend water-efficient fixtures/appliances for new constr.	
	Promote use of dual flush, power flush and hign efficiency toilets (HETs)	
		< 1.28 gpf
	Provide residential water audits	
	Promote efficient non-landscape outdoor water use such as covering pools, sweeping drives, washing cars	

Promote waterless plumbing fixtures
Encourage consumers to minimize use of sink garbage disposals
Educate homeowners on how conservation benefits water quality
During site design, incorporate LID and use of drought resistant plants

PUBLIC SECTOR

SWMI Table 2 Requirements

Municipal buildings:	
	Submit a report of municipally owned public buildings retrofitted with water savings devices
	Submit a schedule for retrofitting remaining buildings within 2 years
	Water districts and water companies must demonstrate "best effort" to work with town and complete retrofits
	Municipally owned public buildings scheduled for rehab or demolition my be exempted from this condition.

MA Water Conservation Standards

Municipal Bldgs:	
	Conduct indoor and outdoor water audits
	Analyze existing water-use data
	ID where greatest efficiencies and $ saving can be realized
	New public bldgs: use equipment that reduces water use
	Focus on replacing/retrofitting water-consuming equipment in bldgs
Meter or estimate contractor use of water from fire hydrants	
Strictly apply plumbing code and incorporate other conservation measures in new and renovated bldgs.	

INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL

SWMI Table 2 Requirements

Review the records for industrial, commercial and institutional water users and develop an inventory of the largest users
Develop and implement an outreach program designed to inform and (where appropriate) work with ici useres on ways to reduce water use
Upon request by dep, submit a report on conservation results. Dep will take whatever action it deems appropriate to promote the interests of the water management act, including requiring additional actions.

MA Water Conservation Standards

For municipal buildings: Carry out a water audits and use results as basis for conservation actions such as:	
	Recycling/reusing cooling water
	Using non-potable water
	Using heat-sensitive valves to control colling equipment
	Replacing water cooling with air cooling
	Installing/retrofitting efficient sanitary devises
	Performing regular meter maintenance and calibration, and xeriscaping
For new and renovated bldgs. use best available technologies for conservation and reuse treated wastewater to the extent possible.	
Practice good lawn and landscape water use; see "Lawn and Landscape,"	

see below

LAWN AND LANDSCAPE / SEASONAL OUTDOOR LIMITS

SWMI Requirements: See discussion of standard condition #6 above

MA Water Conservation Standards

Seasonal demand management plan (part of drought management plan) using	
	Water supply and environmental indicators (such as stream flow) to trigger restrictions
	Increasingly stringent water use restrictions
Adopt water restriction bylaw that applies to both municipal and private wells	
Fully enforce water-use restrictions	

EDUCATION & OUTREACH

SWMI Table 2 Requirement

Develop and implemnt Education Plan. Permit will list the following outreach techniques from the 2012 MA Water Conservation Standards

MA Water Conservation Standards

Develop and Implement an education plan that includes most if not all of the following items	
	Target the largest users early on to realize the greatest potential savings and to demonstrate the benefits of a conservation program.
	Include in bill stuffers or bills a work sheet on the reverse to enable customers to track water use and conservation efforts and estimate the dollar savings. Also, provide a table enabling the recipient to estimate the household gpcd to see how it compares with the 65 rgpcd standard (see Appendix C).
	Use public space advertising/media to highlight stories on successes (and failures).
	Take advantage of social networking tools to communicate water conservation messages and alerts.
	Establish conservation information centers perhaps run jointly with electric or gas company.
	Encourage speakers for community organizations.
	Partner with garden clubs, farmers' markets, environmental organizations, and others on campaigns promoting wise water use.
	Sponsor public service announcements and radio/T.V./audio-visual presentations on supply sources and current status.
	Conduct joint advertising with hardware stores to promote conservation devices.
	Use civic and professional organization resources.
	Sponsor special events such as Conservation Fairs.
	Make available multilingual materials as needed.
	Incorporate contests and recognition for innovation into the public education program.
	Organize water conservation workshops for the general public and include them in the school curriculum.
	Provide information on water-wise landscaping, gardening, efficient irrigation, and lawn care practices.
	Include education information in retrofit and rebate programs.
As part of public education program, address issue of why it is equally important for self-supplied water users to conserve	

3.0 EVALUATION OF WASTEWATER RETURNS AND POTENTIAL INFLOW AND INFILTRATION REDUCTION

3.1 Introduction

The Sustainable Water Management Initiative (SWMI) is directed towards water withdrawals and their impact on streamflow (SWMI Pilot Project, 2012). Due to increased development in Massachusetts, the balanced use of water resources for water supply withdrawals while maintaining streamflows for aquatic wildlife is an increasingly difficult goal. Highly developed areas have altered the hydrologic cycle, as increased impervious areas limits groundwater recharge, generally require the withdrawal of larger volumes of water, and create wastewater that is often collected, treated and discharged to a single point through municipal sewer systems. Chapter 3 focuses on the third aspect of this alteration, Wastewater, and more specifically how Septic Systems and Municipal Sewer System Infiltration and Inflow (I/I) can impact sub-watersheds within the project area. In addition to on-site Septic systems and Municipal Centralized Sewer systems a third type of wastewater treatment, localized treatment facilities with groundwater discharges, can be a substantial part of the wastewater industry. Localized treatment facilities provide an opportunity to capture treat and recharge within discrete sub-watersheds. Although discussed in the conclusions, the focus of this chapter is on the existing conditions and future recommendations for on-site Septic systems and Municipal Sewer Systems within the project area.

Available wastewater flow and infrastructure data was collected from each of the subject municipalities and/or the MWRA. The Project Team (NepRWA, MAPC and W&S) worked with each municipality to collect all available local data and supplement it with information that each organization had previously obtained through past work/studies. GIS based maps were developed in order to depict wastewater collection and discharge, potential future wastewater (I/I) improvements, and estimate future wastewater flows. For each subwatershed, the project team estimated the volume of wastewater recharge through onsite septic systems under existing conditions, and the potential for I/I reduction in existing systems.

Using information collected from the participating towns, the project team estimated the volume of I/I reduction which has occurred in participating towns over the last five years at a subwatershed scale, and estimated the volume of potentially removable I/I at the same scale. Utilizing known I/I sewer repair projects within the watershed the project team developed a coefficient for I/I reduction per linear foot of pipe inspected. These coefficients were based on previous work conducted within the project site and are designed to be used at the planning level stage.

Included is an evaluation of the cost and value effectiveness of I/I programs as a means for reducing water loss in the context of the SWMI Framework and strategies, recommendations and, where available, examples for innovative approaches to encouraging I/I reduction.

3.2 GIS Mapping and Data Analysis

3.2.1 Mapping of Parcels Serviced by Municipal Sewer Systems

Mapping sewered parcels was conducted in various ways, depending on the most accurate, available data per community. In general, three methods were used to develop GIS maps of parcels serviced by municipal sewers. The communities investigated include: **Canton, Dedham, Foxborough, Norwood, Sharon, Stoughton, Walpole** and **Westwood**, all within the Neponset River Watershed.

For **Canton, Dedham, Norwood** and **Walpole**, an existing GIS sewer main layer was used to estimate parcels serviced by municipal sewer systems. Previous experience with similar studies (conducted in Truro, Taunton River Watershed and Sharon) has shown that applying a 50-foot buffer around the sewer main layer is an effective way to identify potentially sewered parcels. Using the computer mapping software, ArcView v. 10.1, a 50-foot buffer was placed around the sewer main layer. Using ArcView, all parcels for the communities, as obtained from MassGIS's "ASSESSPARNC_POLY_PUBLIC_SHP" data layer, were mapped. Any parcels intersecting the 50-foot buffer were then investigated for the presence of buildings. The buildings data layer were obtained from the MassGIS geodatabase "Buildings.gdb". Parcels within 50 feet of the sewer main, and containing a building, were assumed to be sewered.

Sewered parcels were developed differently for **Foxborough** as an existing sewer main layer was not available. In **Foxborough**, an electronic spreadsheet containing the addresses of sewered parcels was the only data available. The list of addresses was then geo-coded (mapped electronically) using ArcView to generate a sewered parcel map for the Town.

For **Sharon, Stoughton** and **Westwood**, GIS data was made available by the Town for all parcels serviced by a municipal sewer system

Utilizing these different approaches resulted in a Town by Town map of all of the estimated sewered parcels within the Towns. These parcels were then combined into one layer, which gave us a "Sewered Parcel Layer" for the entire study area. In addition to this layer, data stored in the sewer main layer from each town also allowed the development of a table which identified the age, diameter and type (where available) of sewer main by Town.

3.2.2 Mapping of Septic Parcels

Electronic mapping information was not available for septic systems for the communities of interest; therefore, a "Septic Parcel Layer" was generated by utilizing the Sewered Parcel Layer generated in 3.2.1.

The project team isolated all parcels not included in the Sewered Parcel layer and then using the "Buildings.gdb" geodatabase, identified all of the unsewered parcels, which also contain buildings. These parcels were assumed to contain septic systems.

Utilizing this approach the Project Team was able to develop a parcel level map on a Town by Town basis for lots containing septic systems. These parcels were then combined into one layer, producing a "Septic Parcel Layer" for this study.

3.2.3 Mapping of Water Supply Parcels

Parcels that are serviced by community water systems, and with septic systems, were further investigated since these parcels provide the most net recharge back into a watershed or sub-watershed. To determine which parcels were on community water and septic systems, water parcel mapping was required. Similar to the sewer parcel mapping effort noted above, mapping water service parcels was conducted using more than one method, depending on the most accurate, available data. For **Canton, Dedham, Sharon, Westwood, and Walpole**, a 50-foot buffer around electronically mapped water mains was used to identify all parcels within 50 feet of the water main. Once those parcels within 50 feet of the water main were identified, only those parcels with buildings on them were considered parcels being serviced by community water services. Although some error exists, this methodology, applied in the Taunton River Watershed Management Plan (Horsley Witten Group, Inc., 2008) generally provided between 85 to 95% accuracy.

For **Stoughton**, water service parcels were available in GIS electronic mapping format.

For **Norwood**, no water main/parcel data was available in electronic format. Per conversations with Fay, Spofford & Thorndike, who house Norwood's infrastructure information, it was noted that all of Norwood is serviced by MWRA water and sewer. Furthermore, it can reasonably be assumed that parcels serviced by sewer are also serviced by water. Because sewer parcel mapping for Norwood had already been created, these same parcels were assumed to be served by municipal water

.

In **Foxborough**, an electronic spreadsheet containing the addresses of parcels connected to the municipal system was the only data available. The list was geo-coded using ArcGIS and mapped electronically.

Utilizing this approach the Project Team was able to develop a parcel level map on a Town by Town basis for lots that are supplied with water through a municipally owned public water supply system. These parcels were then combined into one layer, which gave us a "Watered Parcel Layer" for this study.

Overlaying the Watered Parcel Layer with the Septic Parcel Layer identifies the parcels that are serviced by municipal water systems but return flow to the subsurface via a septic system. This combined data set was then turned into a new layer; "Watered/Septic Parcels"

3.3 Septic System Return Flows (Recharge)

3.3.1 Existing Conditions Calculation of Septic System Flows

For water/septic parcels, septic recharge per parcel was calculated by assigning zoning information to each parcel. The zoning information was obtained from MassGIS's "ZONING_POLY" data layer. Each parcel was designated as being one of the following:

- Residential
- Commercial
- Industrial
-

Water use was estimated for each zoning category by using the last 3 years (2010 – 2012) Annual Statistical Reports (ASRs) for each town (uploaded by each Town). Total connections and total annual water use for zoning categories are provided in the ASRs. With these data, average water use for each zoning category was calculated. These values were then multiplied by 0.85, to allow for 15% of consumptive losses, which is generally an industry accepted number for consumptive loss for residential, commercial, and industrial uses. The resulting values gave us the amount of septic recharge for each parcel, based on zoning category.

3.3.1.1 Town-wide Estimated Septic Return Flows

Once annual septic recharge per water and septic parcel was calculated, community-wide septic recharge for these parcels was then determined. The results are provided in Table 3-1, below:

Table 3-1:
Estimated Annual Septic Recharge by Town

Community	Zone Category	Septic Flow (GPY)
CANTON	Residential	44,008,107
	Commercial	473,314
	Industrial	3,386,872
	Total	**47,868,293**
DEDHAM	Residential	1,624,084
	Commercial	401,416
	Industrial	4,505,823
	Total	**6,531,323**
FOXBOROUGH	Residential	327,821,490
	Commercial	19,256,120
	Industrial	57,169,875
	Total	**404,247,485**
SHARON	Residential	277,477,248
	Commercial	5,490,432
	Industrial	4,439,970
	Total	**287,407,650**
STOUGHTON	Residential	78,034,950
	Commercial	10,597,730
	Industrial	6,633,900
	Total	**95,266,580**
WALPOLE	Residential	121,256,593
	Commercial	1,954,150
	Industrial	25,265,094
	Total	**148,475,837**
WESTWOOD	Residential	9,744,504
	Commercial	1,404,956
	Industrial	1,501,941
	Total	**12,651,401**
	Watershed Total	**1,002,448,569**

Although these numbers give a good indication of Septic Return Flows by Town and by Use category, it must be noted that these are estimated numbers and are intended for a planning level study only. In order to accurately calculate recharge by parcel use a much more in depth study would be needed on a Town by Town; Parcel by Parcel level. Instead these numbers should be used to provide an estimate, and a way to compare recharge numbers from Septic Return Flows throughout the Study Area.

3.3.1.2 SWMI Sub-watershed Estimated Septic Return Flows

Within the communities numerous sub-watersheds exist. Based on withdrawals and return flows, each sub-watershed has its own water balance and is categorized under the SWMI process. As part of this study the project team looked at the estimated return flows from septic systems in each sub-watershed, which can be used as part of the categorization.

To estimate available septic system recharge water by sub-watershed, the septic recharge parcel data was grouped by sub-watershed. A total of 80 different sub-watersheds were identified for the 8 communities of this study. Electronic sub-watershed mapping was provided through the USGS "Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Watersheds"_Report (USGS, 2012) and are the same sub-watershed delineations utilized through the SWMI process. It should be noted that in many cases, sub-watersheds were divided at Town Borders where they were located in more than one community. The sub-watersheds that were divided within two study communities were then designated by the sub-watershed ID followed by initials for each Town. If the portion of the sub-watershed crossed a town border of a non-study community then that portion of the sub-watershed was not included in this study. Figure 3.1 demonstrates which sub-watersheds can provide the highest septic recharge, while Table 3-2 gives the annual volumetric recharge for each sub-watershed. The sub-watersheds are listed by Average Annual Septic Recharge by Town, by sub-watershed, in the table below.

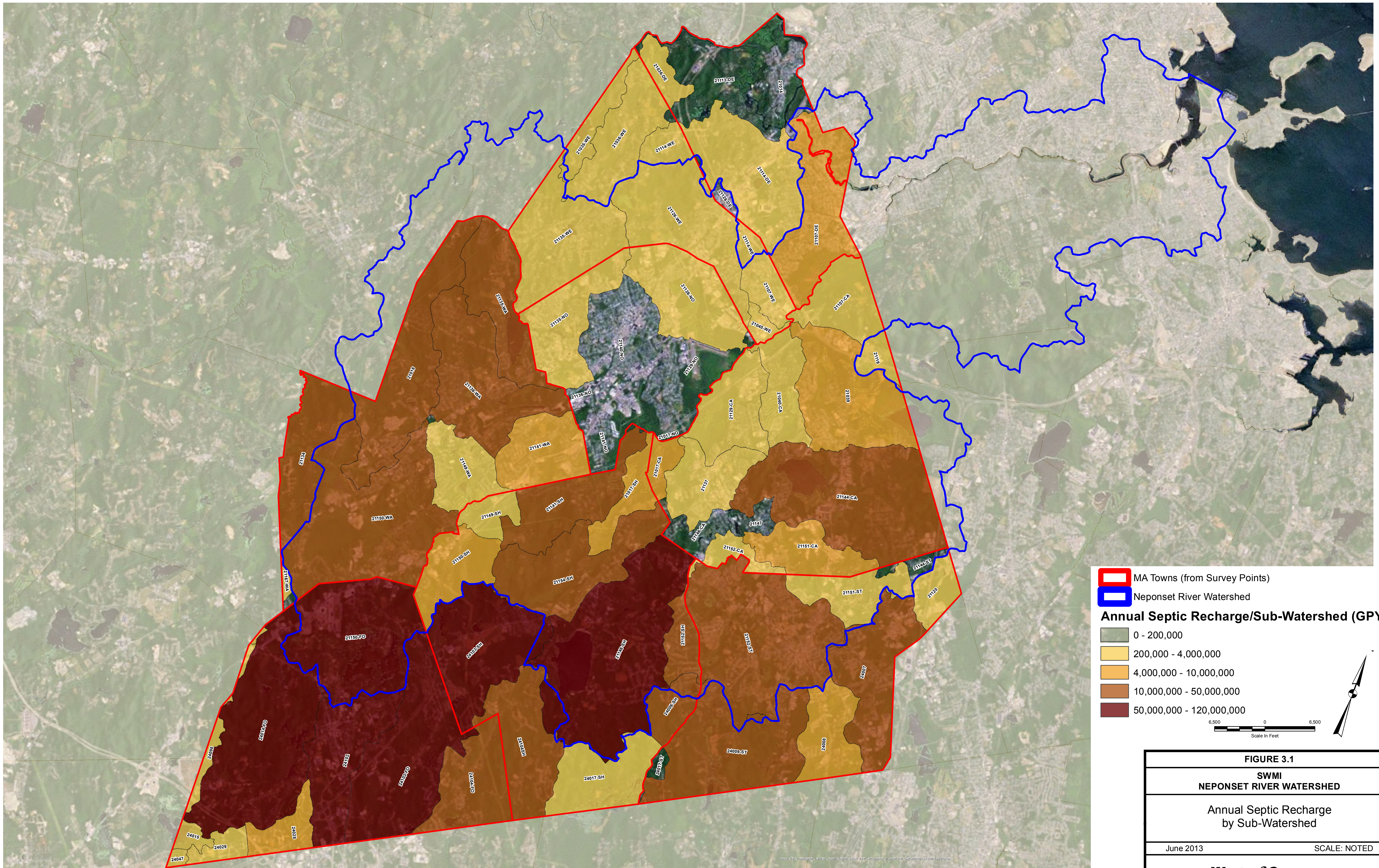


FIGURE 3.1

SWMI
NEPONSET RIVER WATERSHED

Annual Septic Recharge
by Sub-Watershed

June 2013 SCALE: NOTED

Weston&Sampson

Table 3-2
Average Annual Septic Recharge per Sub-Watershed

TOWN	BasinID	Average Annual Septic Recharge by Sub-Watershed	TOWN	BasinID	Average Annual Septic Recharge by Sub-Watershed
CANTON	21144-CA	19,781,126	SHARON	21146-SH	112,216,304
CANTON	21017-CA	4,655,874	SHARON	24103-SH	51,054,912
CANTON	21151-CA	4,643,022	SHARON	21154-SH	34,888,608
CANTON	21039-CA	4,640,064	SHARON	24104-SH	31,106,304
CANTON	21107-CA	3,924,366	SHARON	21152-SH	19,248,968
CANTON	21137-CA	3,915,054	SHARON	21141-SH	11,268,301
CANTON	21040-CA	2,900,040	SHARON	24009-SH	10,030,656
CANTON	21152-CA	2,083,210	SHARON	21150-SH	8,662,511
CANTON	21129-CA	1,632,582	SHARON	21017-SH	7,438,464
CANTON	21119-CA	435,006	SHARON	24017-SH	1,915,968
CANTON	21146-CA	72,501	SHARON	21149-SH	586,833
CANTON	21145-CA	0	SHARON	21140-SH	0
CANTON	21147-CA	0			
CANTON	21154-CA	0	STOUGHTON	21152-ST	46,387,188
			STOUGHTON	24009-ST	18,481,268
DEDHAM	21107-DE	5,358,419	STOUGHTON	24007-ST	17,960,098
DEDHAM	21036-DE	928,048	STOUGHTON	24008-ST	7,431,900
DEDHAM	21114-DE	865,440	STOUGHTON	21151-ST	1,777,322
DEDHAM	21035-DE	116,006	STOUGHTON	21146-ST	807,140
DEDHAM	21113-DE	116,006	STOUGHTON	21120-ST	631,800
DEDHAM	21014-DE	0	STOUGHTON	21144-ST	154,846
DEDHAM	21027-DE	0	STOUGHTON	24017-ST	0
DEDHAM	21126-DE	0			
			WALPOLE	21150-WA	38,210,754
FOXBOROUGH	24103-FO	101,584,496	WALPOLE	21016-WA	28,930,826
FOXBOROUGH	24102-FO	91,497,135	WALPOLE	21135-WA	28,353,719
FOXBOROUGH	21150-FO	88,510,357	WALPOLE	21134-WA	21,288,836
FOXBOROUGH	24014-FO	71,830,103	WALPOLE	21136-WA	19,242,992
FOXBOROUGH	24104-FO	37,028,932	WALPOLE	21141-WA	5,012,947
FOXBOROUGH	24028-FO	9,566,775	WALPOLE	21149-WA	1,538,952
FOXBOROUGH	24029-FO	3,684,980	WALPOLE	21167-WA	512,984
FOXBOROUGH	24015-FO	3,259,790	WALPOLE	24014-WA	0
FOXBOROUGH	24098-FO	1,346,435	WALPOLE	21148-WA	0
FOXBOROUGH	24047-FO	708,650			
FOXBOROUGH	21167-FO	283,460	WESTWOOD	21126-WE	3,787,684
			WESTWOOD	21135-WE	1,972,102
NORWOOD	21126-NO	401,416	WESTWOOD	21036-WE	1,856,096
NORWOOD	21135-NO	308,375	WESTWOOD	21107-WE	1,107,713
NORWOOD	21141-NO	64,123	WESTWOOD	21035-WE	1,044,054
NORWOOD	21017-NO	0	WESTWOOD	21040-WE	701,692
NORWOOD	21040-NO	0	WESTWOOD	21114-WE	696,036
NORWOOD	21129-NO	0	WESTWOOD	21113-WE	0
NORWOOD	21136-NO	0			
NORWOOD	21140-NO	0			

Notes:

These numbers are based on general planning level numbers and are not meant to indicate 100% accuracy. Recharge values of 0 is indicative of heavily sewered basins.

3.3.2 Results of Analysis

Average Annual Recharge by Septic system varies from Town to Town depending on the area of Town that is not sewered. The larger the non-sewered area, the more septic systems required to handle wastewater and therefore the larger recharge volume. By reviewing Table 3-1 and 3-2 it can be seen that Town's such as Foxborough or Sharon have a tremendous amount of recharge that is generated by septic systems, while towns like Dedham and Westwood (with large areas already sewered) do not. Sewered communities capture this "potential recharge" and generally transfer it out of town and out of their sub-watersheds through sewer infrastructure.

When compared to the SWMI Biological Category and Ground Water Withdrawal Level maps, Figure 3.1 should act as a tool for each town to identify high recharge sub-watersheds within town that are located within poor quality sub-watersheds. On a strictly flow based analysis (ignoring water quality concerns) if high recharge volumes are located in impacted sub-watersheds than an emphasis should be made to maintain the septic systems and discourage expansion of wastewater infrastructure that will transfer the recharge away. If high recharge volumes are located in sub-watersheds that are not impacted, then wastewater options are varied and would include localized treatment and recharge or possibly even some transfer to other sub-watersheds.

3.4 Infiltration and Inflow

Infiltration and inflow (I/I) is extraneous flow that enters the sewer system through either direct illicit discharges to the sewer system and/or imperfections in the sewer infrastructure. Infiltration comes in the form of groundwater, while inflow is considered to be stormwater entering the sewer system. Many towns conduct I/I studies and rehabilitation plans as part of cost saving measures. I/I increases the cost to treat wastewater by increasing the volume of wastewater that is transported and treated at the wastewater treatment facility.

In order to estimate I/I flow, many Towns that are part of the MWRA system utilize statistics generated by MWRA. MWRA meters flows from their communities and estimates how much of that flow is sewage, inflow and infiltration. This results in a community wide number for these three categories in both Million Gallons per Day (MGD) and Gallons per Day per inch diameter mile (GPD/IDM). Although these numbers are useful in understanding I/I in each community they do not identify specifically where the I/I is being generated. This report looks to identify the potential sources of I/I on a sub-watershed level, in order to give the towns a working map/tool for future planning. The work associated with determining I/I impacts on a sub-watershed level takes into account the actual sewer length within each Watershed. It would be up to each town to determine whether past I/I work has previously targeted these areas.

From the view point of the SWMI framework, I/I is an important factor to understand when trying to minimize or mitigate impacts to the hydrologic cycle and water balance within a watershed. Both groundwater and stormwater recharge to groundwater systems are essential in maintaining baseflow within a watershed. When both groundwater and stormwater enter into a municipal sewer system, that recharge is typically transferred away from where it would naturally recharge and is in some cases, transferred into another sub-watershed. The loss of recharge essentially depletes available water resources within each sub-watershed. This can have an effect on both drinking water supplies (if one is located in the sub-watershed) and ecological resources (stream health).

By conducting investigations into I/I, the potential to not only remove volumes of wastewater from treatment but also increase recharge to streamflow can be identified. As part of this study I/I in the project area was investigated and estimates were completed to determine I/I at both the Town and Sub-Watershed level.

It should be noted that not all sewer systems are built identically and therefore, there can be a large variability in conditions (age, type, diameter, maintenance) of each system. When estimating I/I reduction flows, any of these variables can alter the actual reduction realized. In order to fully understand each system a thorough analysis would need to be completed on a system by system basis. This Chapter represents planning level numbers and coefficients that have been calculated based on previous work in Towns within the project area. The calculated I/I flow volumes are eventually based on reduction by linear foot inspected/rehabilitated and not on per inch diameter/mile. Although calculations based on inch diameter/mile metrics is typically seen in engineering studies, pipe diameter was not immediately available for all Towns.

3.4.1 Existing Conditions Calculation of Sewer I/I Flows

Each year, the Massachusetts Water Resources Authority (MWRA) quantifies the amount of I/I that each MWRA sewered community is contributing to the regional sewer system. The latest analysis was performed in the MWRA Annual I/I Reduction Report for Fiscal Year 2012 (Annual Report). The report is drafted each year for the Environmental Protection Agency (EPA) and Department of Environmental Protection (DEP) to satisfy the requirements of the MWRA's National Pollutant Discharge Elimination System (NPDES) permit.

Canton, Dedham, Norwood, Stoughton, Walpole and **Westwood** are all MWRA communities and are represented in MWRA's Annual Report. **Sharon** and **Foxborough** have limited sewer within each town and therefore, have been omitted from the I/I portion of this analysis, as the amount of area with sewer in each town would produce minimal I/I improvements.

The estimated I/I quantified, from MWRA's annual report, for each community in the study area is shown in Table 3-3, below.

Table 3-3
CY11 MWRA Community Wastewater Flow Component Estimates (CY11-12 Months)

Town	Average Sanitary Flow (mgd)	Average Infiltration (mgd)	Average Inflow (mgd)	Average Daily Flow (mgd)
Canton	1.20	1.19	0.28	2.67
Dedham	1.80	1.88	0.54	4.22
Norwood	2.40	2.42	0.65	5.47
Stoughton	1.50	1.76	0.33	3.59
Walpole	1.20	0.80	0.17	2.17
Westwood	0.80	0.63	0.14	1.57
TOTAL	**8.90**	**8.68**	**2.11**	**19.69**

As shown above, estimated average I/I, according to the MWRA, makes up approximately 55% of the sewer flow from these communities. An average of 10.8 million gallons per day (MGD) enters the regional system as I/I and is treated by the MWRA.

3.4.1.1 Methodology Used

According to MassDEP "Guidelines for Performing I/I Analysis and Sewer System Evaluation Survey" (1993) peak infiltration consists of selecting the lowest flow reading that occurs during dry weather conditions between the hours of 12:00 a.m. and 6:00 a.m. Nighttime flow represents a period of minimum sanitary flow, and therefore, has the highest percentage of flow attributed to infiltration. Almost all data from I/I studies look at Peak Infiltration as they are conducted during the Spring season.

Peak infiltration is defined as the average of the minimum flow rates (nighttime flow as described above) observed over a period of several dry days, during a period of high groundwater (i.e., during springtime). A "dry day" is defined as at least three days after a rain event.

The DEP Guidelines suggest that the annual average infiltration rate (as seen in the tables below) can be calculated directly by analyzing metered flow data for an entire year.

However, if metered flow data exists for only a portion of the year, MWRA data can be used instead. MWRA reports both Peak Month and Annual Average I/I for each community. By comparing peak flows vs. average flows over the last three years of record (2009, 2010 and 2011) a ratio can be calculated for each community that can be used to calculate annual flows from collected peak data. This is useful when trying to estimate annual average when only peak data is available. The tables provided below show both peak infiltration as well as average annual infiltration values, which were calculated this way.

3.4.2 Past I/I Work Completed by Town

Many communities have aggressively pursued the identification and removal of I/I throughout the past few years. Figure 3.2 shows the known I/I target areas for each Town. According to MassDEP's "Guidelines for Performing Infiltration and Inflow Analysis and Sewer System Evaluation Survey" (1993) I/I studies generally require a two part approach. First, the I/I analysis, which requires towns to monitor flows within sewer collection areas in order to identify Excessive Flows (those greater than 4,000 GPD/IDM) is conducted. This is followed by a Sewer System Evaluation Survey, which is a much more thorough investigation into the actual sewer infrastructure. The SSES may include TV inspections of pipes, flow isolation investigations, manhole inspections, residential sump pump inspections, or any other way to identify potential infiltration or inflow into the municipal sewer system (DEP, 1993).

In 2011, the Town of Canton performed a comprehensive 5 Year I/I Management Plan. The plan established a 5-year program of investigation and rehabilitation which includes planning, identification and removal beginning in 2012. In January 2013, Canton developed the Year One Implementation, which provided a summary of the investigation performed in year one of the five-year program and what rehabilitation/repairs will be performed in 2013.

The Town of Dedham has been identifying and removing I/I through a yearly program since 2008. Below is a summary of their annual program that began in 2008.

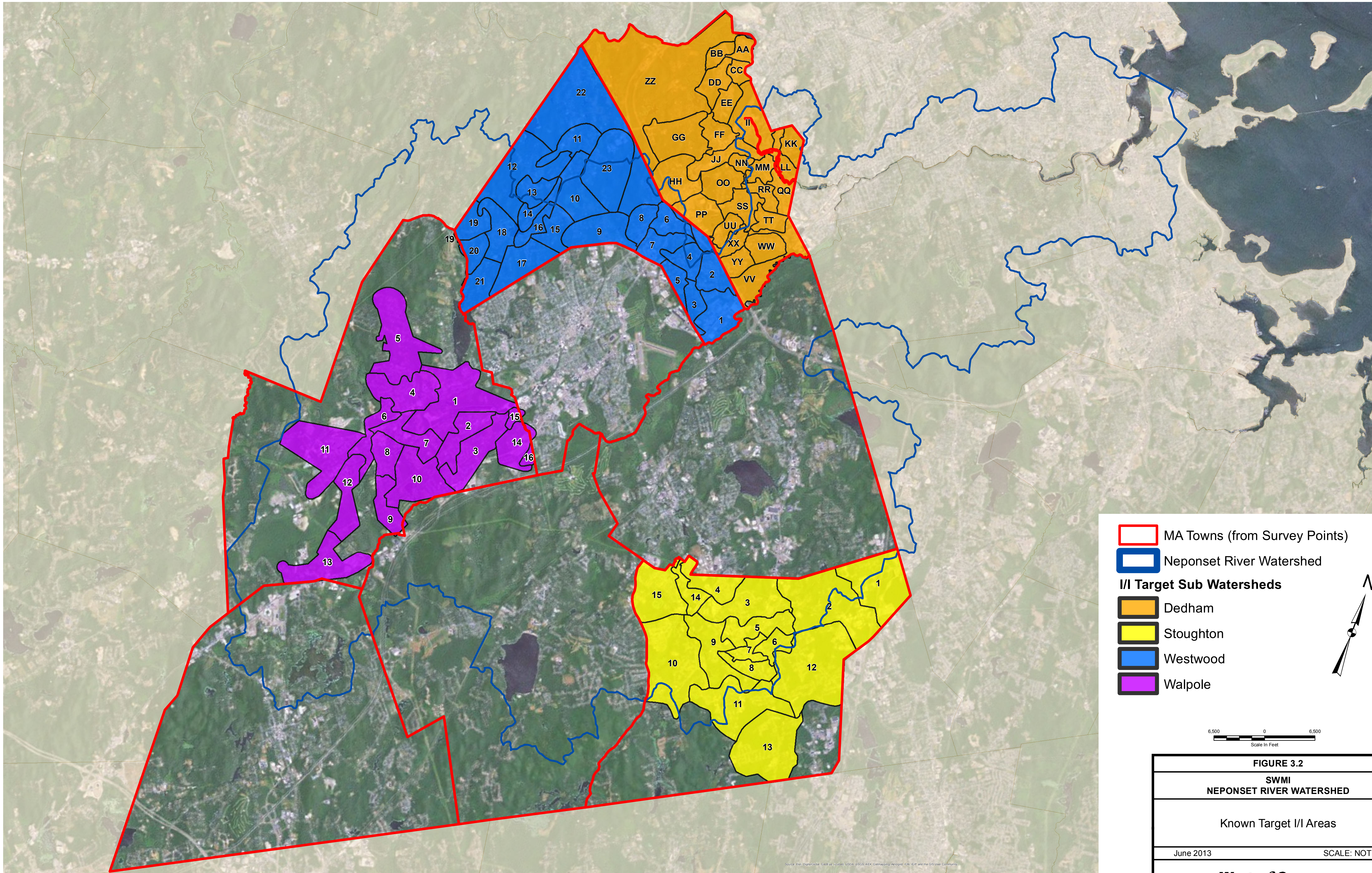


FIGURE 3.2

SWMI
NEPONSET RIVER WATERSHED

Known Target I/I Areas

June 2013 SCALE: NOTED

Weston&Sampson

Table 3-4
I/I Reduction, Town of Dedham

Calendar Year	Sewers Inspected (LF)	Sewers Rehabilitated (LF)	Estimated Peak Infiltration Removed (GPD)	Estimated Average Infiltration Removed (GPD)
2008	151,315	70,223	1,400,000	658,000
2009	110,000	15,768	340,000	159,800
2010	255,000	21,424	1,035,931	486,888
2011	99,900	19,971	646,199	303,714
2012	43,560	8,200	57,130	26,851
TOTAL	**659,775**	**135,586**	**3,479,260**	**1,635,252**

Within each Town estimated peak infiltration removed is calculated a few different ways. Some towns conduct post-rehabilitation metering or flow isolation, others base it on observed flow, while others claim a percentage (usually 50%) of the pre-rehabilitation I/I flow that was estimated. Differences in estimating I/I reduction by Town just adds another level of variability to any I/I calculations.

The Town of Stoughton has been identifying and removing I/I through a yearly program since 2006 when they embarked on a ten-year program. To date, the Town has completed eight years of the ten-year program. Below is a summary of their annual program that began in 2006.

Table 3-5
I/I Reduction, Town of Stoughton

Calendar Year	Sewers Inspected (LF)	Sewers Rehabilitated (LF)	Estimated Peak Infiltration Removed (GPD)	Estimated Average Infiltration Removed (GPD)
2006	26,141	4,364	89,784	48,483
2007	23,246	6,109	29,088	15,708
2008	29,992	3,417	87,683	47,349
2009	55,283	11,088	22,680	12,247
2010	20,105	7,249	8,280	4,471
2011	51,914	3,193	32,112	17,340
2012	63,293	10,501	39,240	21,190
2013	29,046	9,214	21,024	11,353
TOTAL	**299,020**	**55,135**	**329,891**	**178,141**

The Town of Walpole has been identifying and removing I/I through a yearly program since 2007 when they embarked on an seven-year program. To date, the town has completed six years of the seven-year program. Below is a summary of their annual program that began in 2006. Note that construction of year four through six (2010-2012) has not begun.

Table 3-6
I/I Reduction, Town of Walpole

Calendar Year	Sewers Inspected (LF)	Sewers Rehabilitated (LF)	Estimated Peak Infiltration Removed (GPD)	Estimated Average Infiltration Removed (GPD)
2007	24,500	14,625	296,000	150,960
2008	63,850	14,400	65,150	33,227
2009	58,225	8,465	39,195	19,989
2010	42,302	2,600	1,700	867
2011	26,900	13,516	104,218	53,151
2012	61,632	19,613	19,957	10,178
TOTAL	**277,409**	**73,219**	**526,220**	**268,372**

Since 1993, Norwood and Westwood have used a combined $4.8 million of the MWRA I/I Local Financial Assistance Program funds. These funds are used solely to assist MWRA communities in identifying and removing I/I from the regional system. Therefore, it can be concluded that both municipalities have been active in removing I/I from their sewer systems in the past. In fact, the Town of Westwood conducted a town wide I/I study in 2010/2011. The study looked at 1,880 residences and TV inspected 117,000 linear feet of sewer pipe. The Town is currently in the design phase for lining portions of this sewer main (Tighe & Bond, 2012). Information on past I/I programs for Norwood was not available at the time this report was drafted.

The Town of Foxborough has very limited sewer infrastructure, however, in 1999 ADS Services, Inc. under contract through Earth Tech, Inc. conducted an I/I investigation of the system. The investigation identified approximately 135,000 gpd of infiltration into the system, which approximated to roughly 1/3 of the average flow during the reporting period. The study also identified 90,000 gpd of direct inflow and 65,000 gpd of indirect inflow, all a result of the downtown collection system (ADS, 1999). The study identified a number of recommendations in order to reduce flow, however, at the time of this report there was no indication that any work was completed.

The three tables above show “Estimated Infiltration Removed” and do not take into account additional Inflow removed as well. The data was collected from Town files, and while Inflow is a concern, Infiltration makes up the bulk of the I/I flows, therefore, many towns target infiltration rather than inflow during these studies. It is estimated that only 8% of the total flow reaching Deer Island Treatment Facility is inflow, while 44% is a direct result of infiltration (NepRWA, 2007).

Inflow is often difficult for a municipality to target. Many sources of inflow come directly from private properties through illegal connections, sump pumps, cellar drains, yard drains, roof leaders, etc. and are difficult for towns to regulate or even identify. Furthermore, measuring inflow can also present another set of problems. Wet weather metering can be done prior to I/I rehabilitation, but evaluating improvements is often difficult, as the same type and frequency of storm that was metered pre-rehabilitation, cannot be directly duplicated post-rehabilitation.

3.4.3 Future I/I Work Planned by Town

The Town of Canton, will begin Year One of their five-year program in 2012. Construction of identified cost-effective repairs that will remove excessive I/I from the sewer system will begin in 2013. Canton is on pace to remain proactive with their I/I identification and removal by continuing with years two through five which are summarized in their 5 Year I/I Management Plan (Stantec, 2011).

The Town of Dedham, began Year One of a new ten-year program in 2013. The ten-year program is summarized in the 2012 I/I Investigation and Rehabilitation Annual Report. This program constitutes the inspection of the entire sewer system for excessive I/I each spring season with construction of the cost-effective repairs to remove the excessive I/I to follow in the summer and fall seasons over the course of ten years. The ten-year program may remove an estimated 1.0 mgd of peak I/I from the sewer system over the life of the program (Weston & Sampson, 2013).

The Town of Stoughton has two years remaining in their ten-year program that began in 2006. During these two years of the program the town plans to investigate approximately 60,000 LF of sewers for excessive I/I. Based on past years of the program, it is estimated that the construction of cost-effective repairs could remove approximately 77,000 gpd of peak I/I. The town plans to be proactive and reevaluate the sewer system and embark on a new annual program once the original program is complete.

The Town of Walpole has one year remaining in their seven-year program that began in 2007. During the final year of the program the town plans to investigate approximately 75,000 LF of sewers for excessive I/I. Based on past years of the program, it is estimated that the construction of cost-effective repairs could remove approximately 89,000 gpd of peak I/I. The town plans to be proactive and reevaluate the sewer system and embark on a new annual program once the original program is complete.

As previously mentioned, I/I program information was not available for the Town of Norwood at the time this report was drafted.

3.4.4 Potential for I/I Reduction by Town

The towns of Canton, Dedham, Stoughton and Walpole have existing annual I/I identification and removal programs in place and ongoing. Annual programs are a practical and effective approach to identify and remove I/I in a community while maintaining a budget that is viable for the municipality.

Based on the information that was gathered from the estimated I/I removed in Stoughton and Walpole through their annual programs, a conservative approach to predicting I/I can be developed. Coefficients for Average Infiltration removed per foot inspected and per foot rehabilitated are summarized below in Table 3-7.

Table 3-7
Average GPD I/I Removed per Linear Foot of Sewer Investigated and Rehabilitated

Town	Calendar Year	Sewers Inspected (LF)	Sewers Rehabilitated (LF)	Estimated Average Infiltration Removed (GPD)	GPD Removed/LF Inspected	GPD Removed/LF Rehabilitated
Stoughton	2006	26,141	4,364	48,483	1.85	11.11
Stoughton	2007	23,246	6,109	15,708	0.68	2.57
Stoughton	2008	29,992	3,417	47,349	1.58	13.86
Stoughton	2009	55,283	11,088	12,247	0.22	1.10
Stoughton	2010	20,105	7,249	4,471	0.22	0.62
Stoughton	2011	51,914	3,193	17,340	0.33	5.43
Stoughton	2012	63,293	10,501	21,190	0.33	2.02
Stoughton	2013	29,046	9,214	11,353	0.39	1.23
Walpole	2007	24,500	14,625	150,960	6.16	10.32
Walpole	2008	63,850	14,400	33,227	0.52	2.31
Walpole	2009	58,225	8,465	19,989	0.34	2.36
Walpole	2010	42,302	2,600	867	0.02	0.33
Walpole	2011	26,900	13,516	53,151	1.98	3.93
Walpole	2012	61,632	19,613	10,178	0.17	0.52
AVERAGE		**41,174**	**9,168**	**31,894**	**1.06**	**4.12**

In order to quantify the total I/I that could be removed from the sewer system of each community over the next five years, if they each embark on an annual program, the table above can be used to determine an average volume removed per linear foot either investigated or repaired. Data from Stoughton and Walpole indicate that for each linear foot of sewer investigated a total of 1.06 gpd of infiltration may be removed. Assuming that if a sewer is investigated, then a certain percentage of that pipe will require rehabilitation and will be systematically repaired, then a valid removal coefficient can be used for predictive purposes. In Stoughton and Walpole, 22% of the sewer that was investigated required some type of rehabilitation. Actual rehabilitation provided 4.12 gpd of infiltration removed per linear foot of sewer.

Table 3-8 takes both removal coefficients into account and applies them to the remaining towns in the study area in order to provide a predictive look at each community. Again, Sharon and Foxboro were not included in this table due to the limited amount of sewer in each town and the fact that imminent future growth or expansion of the existing sewer system is not anticipated in either town.

Table 3-8
Potential Average I/I Removed Over the Next Five Year Period by Town

Town	Year	Sewer Subareas	Potential Sewer Inspection (LF)[1]	Potential Sewer Rehabilitation (LF)[2]	Estimated Average Infiltration Removal (GPD) per LF Inspected	Estimated Average Infiltration Removal (GPD) per LF Rehabilitated[3]
Canton[4]	1	1, 3, 4, 5, 11	42,500	9,350	45,050	38,522
Canton	2	10, 14, 17, 19	42,500	9,350	45,050	38,522
Canton	3	2, 6, 8, 9, 15	42,500	9,350	45,050	38,522
Canton	4	12, 16	42,500	9,350	45,050	38,522
Canton	5		42,500	9,350	45,050	38,522
Dedham	1	TT, VV, OO	57,658	12,685	123,662	123,662
Dedham	2	LL, II, CC	57,742	12,703	78,937	78,937
Dedham	3	SS, RR	50,847	11,186	74,651	74,651
Dedham	4	EE, KK, UU	47,042	10,349	60,885	60,885
Dedham	5	WW, FF, BB	52,432	11,535	39,524	39,524
Norwood	1		42,500	9,350	45,050	38,522
Norwood	2		42,500	9,350	45,050	38,522
Norwood	3		42,500	9,350	45,050	38,522
Norwood	4		42,500	9,350	45,050	38,522
Norwood	5		42,500	9,350	45,050	38,522
Stoughton	9	3	35,000	7,700	37,100	31,724
Stoughton	10	10	25,000	5,500	26,500	22,660
Stoughton	1	6, 8	33,000	7,260	34,980	29,911
Stoughton	2	5	32,000	7,040	33,920	29,005
Stoughton	3	4, 9	43,600	9,592	46,216	39,519
Walpole	7	4, 6	75,000	16,500	79,500	67,980
Walpole	1	8, 15	27,400	6,028	29,044	24,835
Walpole	2	1, 2	63,700	14,014	67,522	57,738
Walpole	3	7, 9, 14	62,500	13,750	66,250	56,650
Walpole	4	5,13	83,600	18,392	88,616	75,775
Westwood	1		42,500	9,350	45,050	38,522
Westwood	2		42,500	9,350	45,050	38,522
Westwood	3		42,500	9,350	45,050	38,522
Westwood	4		42,500	9,350	45,050	38,522
Westwood	5		42,500	9,350	45,050	38,522
TOTAL			**1,384,021**	**304,485**	**1,563,057**	**1,391,286**

Notes:

1) Sewer Inspection (LF) Estimated for each Town were developed as listed below:
Dedham, Stoughton, Walpole estimates from Town I/I Investigation and Rehabilitation Annual Program.
Canton, Norwood and Westwood estimates are assumed, based on similar work in other towns.

2) Sewer Rehabilitation (LF) is based on an average of 22% of sewers inspected were rehabiliated (Stoughton & Walpole work).

3) Estimated Infiltration Removal takes LF of sewers rehabilitated and multiplied by I/I coefficent of 4.12 gpd/lf rehabiliated, with the exception of Dedham. Dedham data taken from Town I/I report per LF inspected.

4) The Town of Canton is performing rehabilitations of known I/I defects in the subareas listed. However, exact linear footage and estimated infiltration is not known at this time and is estimated.

Using the calculated coefficients for I/I removed for the linear footage of sewers inspected or rehabilitated, Table 3-8 allows the prediction of total I/I for the six communities. Under the assumption of a proactive annual I/I identification and removal process, between 1.3 and 1.5 MGD of I/I could be removed over the course of five years. According to the MWRA approximately 10.8 MGD of I/I is estimated from these six communities. Removing 1.5 MGD of I/I the towns would result in approximately 14% of the average I/I that they contribute to the MWRA sewer system.

3.4.5 Potential for I/I Reduction by Sub-Watershed

On a sub-watershed approach the coefficient for I/I generated above can be applied to length of sewer main within each sub-watershed to identify the sub-watersheds with highest potential for I/I reduction. The Table below ranks each sub-watershed by the highest potential flow. Just like in the Septic study, the sub-watersheds were divided at Town Borders where they were located in more than one community. The sub-watershed was then designated by the sub-watershed ID followed by initials for each Town.

Table 3-9
Potential I/I Removal per Sub-watershed

Town	BasinID	Sewer Length (LF)	Estimated Infiltration Removal (GPD) per LF Inspected[1]	Estimated Infiltration Removal (GPD) per LF Rehabilitated[2]	Town	BasinID	Sewer Length (LF)	Estimated Infiltration Removal (GPD) per LF Inspected[1]	Estimated Infiltration Removal (GPD) per LF Rehabilitated[2]
CANTON	21129-CA	122,002	129,322	110,583	SHARON	21152-SH	200	212	181
CANTON	21039-CA	115,712	122,655	104,881	SHARON	24009-SH	0	0	0
CANTON	21144-CA	108,760	115,286	98,580	SHARON	24017-SH	0	0	0
CANTON	21137-CA	95,830	101,580	86,860	SHARON	24103-SH	0	0	0
CANTON	21040-CA	54,731	58,015	49,608	SHARON	24104-SH	0	0	0
CANTON	21146-CA	48,782	51,709	44,216	SHARON	21017-SH	0	0	0
CANTON	21107-CA	41,617	44,114	37,722	SHARON	21140-SH	0	0	0
CANTON	21147-CA	38,527	40,839	34,921	SHARON	21141-SH	0	0	0
CANTON	21151-CA	32,645	34,604	29,589	SHARON	21146-SH	0	0	0
CANTON	21152-CA	27,391	29,034	24,827	SHARON	21149-SH	0	0	0
CANTON	21154-CA	1,149	1,218	1,041	SHARON	21150-SH	0	0	0
CANTON	21119-CA	143	152	130	SHARON	21154-SH	0	0	0
CANTON	21017-CA	0	0	0					
CANTON	21145-CA	0	0	0	STOUGHTON	21152-ST	262,228	277,962	237,683
					STOUGHTON	24007-ST	80,465	85,293	72,933
DEDHAM	21107-DE	223,773	237,199	202,828	STOUGHTON	21151-ST	54,226	57,480	49,150
DEDHAM	21114-DE	192,017	203,538	174,044	STOUGHTON	24008-ST	52,133	55,261	47,253
DEDHAM	21014-DE	64,154	68,003	58,149	STOUGHTON	24009-ST	18,075	19,160	16,383
DEDHAM	21113-DE	40,978	43,437	37,142	STOUGHTON	21120-ST	11,636	12,334	10,547
DEDHAM	21126-DE	7,371	7,813	6,681	STOUGHTON	21144-ST	10,059	10,663	9,117
DEDHAM	21027-DE	0	0	0	STOUGHTON	21146-ST	713	756	646
DEDHAM	21035-DE	0	0	0	STOUGHTON	24017-ST	0	0	0
DEDHAM	21036-DE	0	0	0					
					WALPOLE	21136-WA	148,779	157,706	134,853
FOXBORO	24014-FO	0	0	0	WALPOLE	21150-WA	125,008	132,508	113,307
FOXBORO	24015-FO	0	0	0	WALPOLE	21149-WA	88,141	93,429	79,891
FOXBORO	24028-FO	0	0	0	WALPOLE	21141-WA	86,582	91,777	78,478
FOXBORO	24029-FO	0	0	0	WALPOLE	21016-WA	41,578	44,073	37,686
FOXBORO	24047-FO	0	0	0	WALPOLE	21135-WA	6,694	7,096	6,067
FOXBORO	24098-FO	0	0	0	WALPOLE	21148-WA	1,663	1,763	1,507
FOXBORO	24102-FO	0	0	0	WALPOLE	24014-WA	0	0	0
FOXBORO	24103-FO	0	0	0	WALPOLE	21134-WA	0	0	0
FOXBORO	24104-FO	0	0	0	WALPOLE	21167-WA	0	0	0
FOXBORO	21150-FO	0	0	0					
FOXBORO	21167-FO	0	0	0	WESTWOOD	21126-WE	145,026	153,728	131,452
					WESTWOOD	21135-WE	140,377	148,800	127,238
NORWOOD	21140-NO	283,709	300,732	257,154	WESTWOOD	21036-WE	68,620	72,737	62,197
NORWOOD	21135-NO	159,467	169,035	144,541	WESTWOOD	21107-WE	67,211	71,244	60,920
NORWOOD	21126-NO	87,971	93,249	79,737	WESTWOOD	21114-WE	19,275	20,432	17,471
NORWOOD	21129-NO	42,293	44,831	38,334	WESTWOOD	21035-WE	14,009	14,850	12,698
NORWOOD	21141-NO	36,561	38,755	33,139	WESTWOOD	21040-WE	11,530	12,222	10,451
NORWOOD	21136-NO	7,678	8,139	6,959	WESTWOOD	21113-WE	0	0	0
NORWOOD	21017-NO	2,749	2,914	2,492					
NORWOOD	21040-NO	0	0	0					

1) Estimated Infiltration Removal per Inspected takes LF of sewers inspected and multiplies by the I/I coefficent of 1.04 gpd/lf inspected.

2) Estimated Infiltration Removal per Rehabilitated takes LF of sewers inspected or and multiplies by inspected:rehabiliated ratio of 22% and then multiplies that number by the I/I coefficent of 4.12 gpd/lf rehabiliated.

3) Estimated Infiltration Removal = 0: A value of 0 is indicative of a parcel with little to no sewer.

FIGURE 3.3

SWMI
NEPONSET RIVER WATERSHED

Sewer Lengths by
Sub-Watershed

June 2013 SCALE: NOTED

Weston&Sampson

3.5 Innovative Strategies & Recommendations

3.5.1 I/I Cost Effectiveness

Typical I/I studies are conducted by municipalities on a cost-effective approach. Historically, the cost effectiveness of any I/I improvement has been based on the cost of the improvement over the cost to transport and treat the flows generated by the I/I. These Transportation and Treatment (T&T) costs not only factor in the costs to transport and treat but also consist of capital costs to expand and upgrade the wastewater system, and annual operation and maintenance costs. Operation and maintenance (O&M) costs are directly related to the quantity of flow being discharged to pump stations and treatment facilities, therefore the higher the flow the higher the O&M costs. Increased usage will be reflected by increased operation and maintenance costs for electricity, cleaning, equipment repair, etc.

Calculating accurate T&T costs for a particular I/I source must be based on the portion of I/I that can be eliminated through rehabilitation. The percentage of I/I that can be removed depends upon the individual sources and rehabilitation method. Infiltration removal is typically limited to 50% due to the potential for migration of the flow from one repaired defect to a nearby defect that may not have been identified. Although a much smaller value or percentage of the problem, Inflow is usually considered 100 percent removable as the source can be permanently eliminated from the sewer.

Under the current process, Cost Effective Analysis (CEA), based on removal effectiveness and subsequent volume reduction makes perfect sense. Current DEP Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation Survey results in classification of each I/I project into the following categories:

- ***Excessive*** means the cost to rehabilitate the source is **less** than the T&T cost.

- ***Non-Excessive*** is the opposite, where the cost to rehabilitate the source is **more** than the T&T cost.

- ***Value-Effective*** means the cost to rehabilitate the source is more than the T&T cost, but rehabilitation is recommended because of the relative value of external benefits of the repair.

- ***Necessary*** means the cost to rehabilitate the source is more than the T&T cost, but rehabilitation is still recommended for structural repairs that are a priority.

These categories are all financially driven, however, and do not take into account monetary values for additional external benefits. Improvements to watershed health remain poorly quantified but readily acknowledged in the literature. If conducting I/I has a financial benefit to the Town, then perhaps it is one of the most logical places for a town to also increase the values of these external benefits, such as improving watershed health, essentially accomplishing two goals at one time.

By promoting the third category listed above, Value Effectiveness, the SWMI framework can begin to be incorporated into any I/I project. Although projects may not be cost efficient they will result in a greater value to the overall area, either through technical, health or in SWMI's case, environmental improvements. By focusing on the Value Effectiveness of particular I/I projects and the implications of what environmental improvements can be realized, sustainable water management practices can be implemented on a sub-watershed or town wide basis.

The benefits to streamflow or watershed health through I/I reductions requires quantification if offsets to withdrawals under the Water Management Act are to be offered. While a gallon for gallon offset for I/I reductions may not be possible, developing a metric for conducting I/I on a per linear foot basis in an impacted sub-watershed should incentivize towns to undertake I/I in the "Value-Effective" category.

Using this approach an integrated Water Management Plan would need to be created by both the Water and Sewer divisions in each Town. Working together, these often separate divisions would need to identify and select the best I/I projects for the Town from both the Water Supply and Wastewater perspective. If new water withdrawals are needed, then the Water department would have a much larger interest in promoting I/I projects in general, and advocating for sub-watershed benefits. Additionally, multi-Town coordination could also be realized for sub-watersheds that cross Town lines.

3.5.2 Quantifying I/I Credits under the SWMI Process

Our study looks at each sub-watershed and determines length of sewer pipe within each. By using coefficients developed from previous work within Towns within the study area we were able to estimate anticipated I/I reduction volumes for each of these sub-watersheds on a linear foot basis. This approach is based on a planning level scale and not intended to be an absolute metric for I/I removal that would direct individual improvement projects. Instead it provides a tool to evaluate relative improvements and emphasize areas where their highest reduction volumes can be realized. By comparing these sub-watersheds with the sub-watershed categorization supplied by SWMI a path to increase water recharge in sub-watersheds that are currently impacted, can be developed.

Although this process gives the Towns the tools to locate potential I/I projects, the question now becomes how each town can take credit for any improvements in the future. As was previously stated in this chapter there are many variables when it comes to estimating existing I/I flows and quantifying I/I reductions post rehabilitation. Moving towards establishing a credit will require further work to normalize these variables in order to develop an annual credit. This will require a plan to both quantify flows before and after any I/I work is completed.

Current I/I programs meter flows within sewer mains as part of their initial investigation but most do not require any post rehabilitation metering or monitoring. In order to accurately quantify improvements, and therefore credits, post rehabilitation metering/monitoring should be considered after rehabilitation but prior to the issuance of a value for that water offset.

3.5.3 Post-Rehabilitation Monitoring, in Practice

Although most towns do not conduct post-rehabilitation monitoring we are familiar with several towns that have conducted post-rehabilitation in the last few years. Arlington, Woburn and

Newton have all conducted “Post Rehabilitation Flow Evaluation Projects” utilizing flow isolation techniques.

Flow isolation consists of investigating manhole to manhole sewer segments by isolating each segment by plugging flows at the upstream manhole. Utilizing weirs, measurements are taken at the downstream manhole. Work is generally performed during the hours of midnight to 6 a.m. and during a high groundwater and dry weather period. The goal is to eliminate any use of the sewer system (hence the overnight hours when sewers are typically not being used) so that all flow that is recorded is theoretically from I/I.

In order to calculate actual peak infiltration removal estimations a direct comparison between pre-rehabilitation flow isolation values and post-rehabilitation flow isolation values can be conducted. However, variables must be accounted for, since these readings are typically taken in different years, and therefore, under different conditions.

Variations in precipitation amounts and groundwater levels during data collection can significantly affect infiltration quantities. To determine if a direct comparison is appropriate, precipitation and groundwater conditions are compared from the pre-rehabilitation investigation to the post rehabilitation investigation, to make a general assumption about the similarity of the conditions. If the conditions are similar then a direct comparison between pre-rehabilitation flow isolation values and post-rehabilitation flow isolation values is used to estimate peak infiltration removal. If conditions are different than the variation must be accounted for during the comparison.

The comparison from pre-rehabilitation flows to post-rehabilitation flows does provide an accurate estimate of how much flow was actually reduced within each segment of pipe. However, some of these flows will travel to other defects and enter the pipes in those locations. So although hard flow numbers are calculated from this technique, 100% of the flow reductions are not actually realized as the I/I may enter in other areas. Sound engineering practices have shown that proper rehabilitation techniques (i.e. extending rehabilitation work down gradient beyond where I/I was observed) can reduce the amount of flow entering into the pipe at other locations.

3.5.4 Assigning Direct I/I Credits

As anyone familiar with I/I will tell you there are a magnitude of different variables when conducting I/I studies that will change the estimate of I/I reduction realized. These variables include changes in site conditions (groundwater levels, precipitation, etc.), sewer system (condition, age, etc.) rehabilitation techniques, flow estimation techniques (pre and post rehabilitation) as well as a number of other minor variables.

Although “indirect credits” can be established through the SWMI process for I/I programs, moving towards establishing a “direct credit” will require further work to normalize these variables. A starting point may be for towns, who are applying for a “direct credit” for I/I returns, be required to conduct a post-rehabilitation metering project. Post-Rehabilitation Projects should be a well-defined process that would apply to all I/I projects and require towns to meter their flows exactly the same way. This will require some additional work and costs for the Town, however those costs are minimal ($0.30-$0.50 a foot) and the benefits of receiving more water through the SWMI process will typically outweigh the costs of post-rehabilitation monitoring.

A typical rehabilitation program under SWMI could require a town to conduct the following:

- Pre-rehabilitation monitoring – Flow Isolation
    - Monitor Groundwater
    - Monitor Precipitation
- Implement a well-defined Rehabilitation Program
    - Although actual techniques do not need to be defined how the project is completed could be (i.e. extending work 3 segments past observed I/I flows)
- Post-rehabilitation monitoring – Flow Isolation
    - Monitor Groundwater
    - Monitor Precipitation
- Comparison of Pre and Post Flows
    - Develop Report
    - Calculate value reduced
    - Apply a safety factor to that Value for flows returned to pipes in other areas (it can be assumed 80% removal, 20% returns as I/I)
- Apply to SWMI for Direct Credit of 80% of measured Flows

Although the 80% removal can be debated for its accuracy, up or down, it does supply a safety factor when applying direct credits for water withdrawal offsets.

3.5.4 Other Recommendations

Our study has shown that there is a tremendous amount of opportunity to capture recharge through the maintenance of existing wastewater systems or the design of new wastewater infrastructure. A few additional recommendations are provided below:

3.5.4.1 Indirect Credit using the 10/20/30 Year Programs

Utilize an Indirect Credit approach for I/I Programs, but apply a larger credit for a program that occurs over a 10 year program rather than a 20 or 30 year program. By incentivizing towns to conduct their I/I projects on a faster schedule more I/I will be reduced on a quicker timeframe. Assuming 10% of the system is completed every year in a 10 year program, 5% in a 20 year program, and 3.3% in a 30 year program SWMI credits should be applied accordingly.

3.5.4.2 Septic System Improvements and Local Package Plants

Septic systems provide a source of recharge within each sub-watershed. Based on which sub-watershed they are located in they could be contributing to an impacted sub-watershed or a non-impacted sub-watershed. Within impacted sub-watersheds septic systems should be maintained and encouraged to promote recharge. However, when septic systems are within non-impacted sub-watersheds the potential is there to capture that recharge in the form of localized collection systems and package plants. These localized collection systems can transport septic flows to net negative Watersheds where small package plants can be located and provide recharge to these areas.

3.5.4.3 New Sewer Connection Fees

In areas where known I/I is an issue, Towns could charge a fee for new sewer hookups or expansions to existing systems. The money collected through this fee could be utilized to repair existing I/I within that sub-watershed or within targeted sub-watersheds that were shown to have a net negative water balance.

3.5.4.4 Changes to Local Wastewater Regulations

Many towns focus on improving the public infrastructure by repairing sewer pipes on public property, and for a number of reasons, do not try to resolve I/I issues that occur within a private parcel. Private I/I can come in a number of forms from illegal sump pump hook up to leaking sewer connections. Addressing this source of I/I through local wastewater regulatory changes is one possible solution. In order to target private I/I, towns could require a full inspection of sewer infrastructure as part of a transfer of property requirement. This inspection would identify any I/I issues and require either the current or new owner to repair any deficiencies.

Other similar local regulatory requirements could be implemented as well, however the ultimate cost and benefit of addressing I/I that occurs on or within a private parcel needs further assessment.

4.0 OPTIMIZATION, ALTERNATIVE SUPPLIES, AND SURFACE WATER RELEASES

4.1 Background

Under the November 2012 SWMI Framework, all permit applicants with sources in Ground Water Category (GWC) 4 or 5 Sub-basins—which includes all the communities in the study area—are required to "minimize existing impacts to the maximum extent feasible." Toward that end, applicants are required to develop a plan that addresses (among other things):

- Optimization of existing resources
- Use of Alternative Sources, including sources available to meet seasonal needs
- Interconnections with other communities or suppliers, and
- Releases from surface water impoundments.

In addition, where a Coldwater Fishery Resource (CFR) or Biological Category (BC) 1-3 Sub-basin is present, applicants are required to prepare a "desktop pumping analysis" and to minimize impacts on these resources. Several of the communities in the study area have CFRs and thus must address these issues.

This chapter evaluates these questions for each community in the study area, bearing in mind that the Commonwealth has yet to issue definitive guidance on how these issues should be assessed.

4.2 Overview of Analytical Approach

4.2.1 Optimization of Existing Resources

The focus of "Optimization" is to better coordinate the use of existing sources of supply throughout the year so as to minimize environmental impacts. In general, this means identifying opportunities to reduce the overall groundwater depletion levels of the Sub-basins where a community's supplies are found by shifting the location and timing of withdrawals.

Personal communication with MassDEP staff indicates that MassDEP is expecting that Water Management Act (WMA) permits issued under SWMI will contain a Baseline volume and permit limits calculated at the major basin scale (i.e. Charles, Neponset, etc) rather than at a Sub-basin scale. As such, MassDEP is not planning to issue permittees with specific withdrawal limits for each of the potentially many Sub-Basins in which the permittee has sources.

However, where a Minimization plan is required, MassDEP will require applicants to evaluate opportunities to mare carefully manage their withdrawals at the Sub-basin scale, and this is the essence of Optimization. Thus, while the SWMI Tiers Table requirements are not technically being applied at a Sub-basin scale, the Optimization process applies the principles outlined in the Tiers Table at a Sub-basin scale in an effort to find cost effective options for reducing environmental impacts. Some of the key ideas from the Tiers Table that are applied during the Optimization process include efforts to:

- avoid Backsliding at a Sub-basin level,
- return flow to GWC 4-5 Sub-basins to the point where they would effectively be restored to GWC 3, and to
- remove additional flow from GWC 4 Sub-basins only as a last resort and only up to 5% of unaffected August median flow.

It appears that MassDEP will likely treat a community's Optimization plan as a condition of their WMA permit under SWMI, but it does not appear to be MassDEP's intention to rigidly enforce the Optimization plan as if it were an additional set of permit limits. Rather it appears that the plan would serve as a guideline that communities would be expected to adhere to as changing operating conditions allow. Lastly, many of the Optimization opportunities identified below are contingent upon completion of upgrades or renovations of existing sources. Given that Minimization generally and Optimization specifically are ongoing requirements that span the 20 year life of the permit, an Optimization plan can help to guide a community's ongoing investments in system maintenance and upgrades over time, thus creating environmental benefits with little additional cost.

In order to asses Optimization opportunities, a relational database that combined information from the USGS SYE Database, the USGS Indicators Project, additional water use point location data, and monthly pumping data provided by MassDEP was developed. Using this data, a variety of metrics and indicators were developed to assist in identifying Optimization opportunities. A report format was developed to summarize the information needed to evaluate Optimization options. In addition a number of maps were produced using some of the resulting metrics. Copies of the Optimization Data Reports for each community are included in the Appendix and are discussed below.

The Optimization Data Report is designed to organize and present these pieces of data for each community in a way that makes it much easier and faster to answer the basic questions inherent in the Optimization process. In their simplest terms, these questions are:

- Where would it be desirable to reduce withdrawals and by how much would they ideally be reduced, and
- Where is additional water available that could be used to reduce withdrawals in these other areas without unduly impacting the donor Sub-basin.

One final and very important point is that the discussion below speaks in terms of additional volumes which can be withdrawn to meet Optimization goals. It is important to understand that while it may be possible to justify an additional withdrawal in the context of alleviating impacts to other streams and Sub-basins, that same withdrawal may not be available under the SWMI Framework to satisfy additional water demands outside the context of Optimization planning. In a heavily depleted region like the study area, the process of Optimization planning often involves trading off one poor environmental option against another poor environmental option, and leads to considering increased withdrawals in areas where an increase would not normally be entertained under the SWMI Framework.

Building on the work done for the SWMI Pilot Project, the following procedure for evaluating Optimization opportunities was developed:

1. Evaluate Optimization objectives within each community. Identify priority Sub-basins where pumping would ideally be reduced. Priority areas for reductions include: CFR's, BC 1-3, and GWC 4-5 Sub-basins. Also consider what if any other priorities may exist such as high quality streams not designated as CFR's, or areas where site specific conditions suggest that stream flow impacts may be more severe than indicated by the SWMI GWC.

   To the extent feasible, identify the volume that would ideally not be withdrawn from each priority Sub-basin considering groundwater withdrawals only (GW Depletion), as well as the combination of groundwater withdrawals and wastewater returns (Net Depletion), and with the goal of reducing GW and/or Net Depletion to the GWC 3 or GWC 4 percentages (i.e. 25% and 55%). In CFR or BC 1-3 Sub-basins, reduce withdrawals as much as possible. To help evaluate these volumes, the volume of reduced pumping needed to restore GWC 4 Sub-basins to GWC 3, and the volume required to restore GWG 5 Sub-basins to GWC 4 or GWC 3, have been calculated using data from the USGS Indicators project. Using the same source information, the volumes needed to restore Sub-basins with Net Depletion Categories of 4 or 5 back to a Net Depletion Category of 3 or 4 have also been calculated.

2. Evaluate opportunities to utilize surface storage. Surface supplies with substantial storage can be used seasonally to reduce pressure on groundwater sources, so long as the surface sources also allow for appropriate seasonal flow releases downstream.

3. Evaluate opportunities to utilize Sub-basins with higher base flows. Specifically:
   a. Shifting pumping from a smaller child Sub-basin to a larger parent Sub-basin directly downstream, can restore the child Sub-basin while producing no net increase in GW Depletion to the parent Sub-basin.
   b. Shifting pumping from a smaller Sub-basin to a larger, unrelated Sub-basin will produce an increased GW Depletion in the larger Sub-basin, but the system as a whole may be better off because the gain to the smaller basin will be proportionately greater than the impact to the larger Sub-basin.

4. Sub-basins with remaining GWC capacity. Most Sub-basins can yield some level of additional water without Backsliding. For example a GWC 3 Sub-basin at 12% depletion can yield an additional 13% of Unaffected August median flow before it Backslides, thus potentially providing additional water that can be used to reduce impacts on other priority resources. To help quantify these opportunities, the volume of additional flow which can be withdrawn from GWC 1-3 Sub-basins without causing Backsliding has been calculated. These volumes are referred to throughout the text as a Sub-basin's "Backslide Volume." Backslide Volume has also been calculated for GWC 4 Sub-basins, but is further limited to a maximum of 5% of Unaffected August median flow. In practice there is a strong preference not to remove additional flow from GWC 4 Sub-basins except under unusual circumstances. It is assumed that no additional withdrawals should be made in GWC 5 Sub-basins for Optimization purposes except in extreme cases where no other Minimization alternatives are available. Specific opportunities for this type of Optimization include:

a. Increasing pumping in GWC 1-3 Sub-basins in order to reduce demands on other priority Sub-basins, without causing Backsliding in the donor basin.
b. While the general preference is to reduce, rather than increase, pumping in GWC 4 Sub-basins, in some situations, it may be desirable to increase pumping in GWC 4 Sub-basins by up to 5% of Unaffected August median flow in order to better protect higher priority resource.

5. Evaluate Sub-basins with wastewater returns. The SWMI GWCs do not take into account wastewater returns. In some Sub-basins, conditions may look more favorable when one considers the Net Depletion (i.e. withdrawals minus returns as a percentage of Unaffected August median flows) rather than looking at withdrawals in isolation. To assist in evaluating such opportunities "Net Depletion" was calculated for each Sub-basin, as was a "Net Depletion Category" based on data developed for the USGS Indicators Project. The Net Depletion Category is analogous to GWC and uses the depletion percentage thresholds. The volume of additional flow that can be withdrawn from a Sub-basin without Net Backsliding was also calculated to produce a Net Backslide Volume metric which is analogous to the Backslide volume discussed above. In most cases, this makes more water available to provide relief to priority resources than would be possible when considering GWC alone. However, when dealing with Sub-basins have large returns of wastewater effluent, removing additional stream base flow may produce unacceptable water quality impacts. With this in mind the Net Backslide Volume has been reduced in particular circumstances as described further below. Several types of Optimization opportunities were evaluated based on concept of Net Depletion:

   a. The possibility of increasing withdrawals in "surcharged" Sub-basins where flows are higher than natural in order to relieve pressure on other priority Sub-basins, subject to the caveat that it must be possible to increase withdrawals without causing or contributing to a violation of surface water quality standards.

      Surcharged Sub-basins which also have significant withdrawals are, by definition, effluent-dominated. It is presumed that wastewater surcharged Sub-basins in GWC 4 or 5 are "effluent dominated" and in recognition of the unique water quality challenges facing such streams, the calculation of Net Backslide Volume for such Sub-basins is limited to the amount of additional withdrawal that would effectively return a Sub-basin to its Unaffected flow (i.e. 0% Net Depletion). For example in a Sub-basin with a GW Depletion of 50% and a Net Depletion of -14% (i.e. surcharged) the Net Backslide Volume is set to 14% of Unaffected August median flow.

      It is further presumed that surcharged Sub-basins with a GWC of 1-3, are not effluent dominated. Therefore, the Net Backslide Volume is the sum of the GW Backslide Volume, plus the surcharge volume. For example, in a Sub-basin with GW Depletion of 8% (GWC 2) and Net Depletion of -9% (i.e. surcharged) the Net Depletion volume would be 18.99% (i.e. 9.99% of Unaffected August flow as the limit of GW Backsliding plus 9% of Unaffected flow representing the surcharge amount)

It is important to note that these calculations are designed to draw attention to areas where it might make sense to divert additional water to alleviate stream depletion in another Sub-basin, but they should always be subjected to further evaluation based on more site specific information.

b. The possibility of increasing withdrawals in GWC 1-3 Sub-basins which have wastewater returns but which are not surcharged. Where GWC and Net Depletion Category are the same, Net Backslide Volume is the additional withdrawal amount that does not produce Net Backsliding. For example, if a stream has a GW Depletion of 8% (GWC 2) and a Net Depletion of 4% (Net Depletion Category 2), then the Net Backslide Volume is 5.99% of Unaffected August median flow which produces Net Depletion of 9.99% after the additional withdrawal. Where Net Depletion Category is healthier than the GWC (i.e. Net Depletion Category of 3 but GWC 5) Net Backslide Volume is the volume equal to one Net Depletion Category worse, but no higher than Net Depletion Category 3 (in other words there is an attempt to preserve some of the benefit of wastewater returns for the donor Sub-basin). For example, if a Sub-basin has a GW Depletion of 67%, and a Net Depletion of 8%, the Net Backslide Volume is 17% of Unaffected August flow which results in an overall Net Depletion of 24.99% (i.e the threshold between Net Depletion Categories 3 and 4).

c. Where a Sub-basin falls in a Net Depletion Category 4 (by definition such a Sub-basin will have a GWC of 4-5), the Net Backslide Volume is an amount equal to 5% of natural August median flow or 55% Net Depletion (i.e. Net Backsliding) whichever is less. However, in general it is preferable not to increase withdrawals at all in a Sub-basin in GWC 4 or Net Depletion Category 4, unless needed to provide relief to a high priority resource.

d. Where a Sub-basin is in Net Depletion Category 5, the net Backsliding volume is zero.

6. Stream Proximity and Connectivity. The SWMI framework assumes that all streams are equally connected to water bodies. In practice, site-specific hydrogeologic factors determine how long it takes for pumping at a given source to be expressed as reduced stream flow and where in the watershed that reduction will be observed. A complete review of the hydrogeology of every existing source in the study area was beyond the scope of this project. However, a preliminary analysis of stream connectivity issues has been performed based on the distance between each well and the nearest water body (as shown in the MassGIS 25k hydrography), and the relative position of wells within their Sub-basin from upstream to downstream. Recommendations for this type of Optimization should be further evaluated based on more detailed site specific hydrogeologic information. The following opportunities were included:
   a. Shifting peak summer pumping to wells located farther from streams at a town-wide scale.
   b. Shifting peak summer pumping to wells located farther from streams within a given hydrologic unit.

c. Shifting pumping from wells at the upstream end of a given Hydrologic Unit toward wells at the downstream end of the same hydrologic unit.
d. Shifting pumping towards sources adjacent to a pond, when doing so does not jeopardize the ability to maintain releases from the pond that equal or exceed Unaffected August base flow for the pour point of the pond.

7. Summary of potential opportunities. Taking all of the opportunities described above into consideration a single prioritized list of Optimization opportunities is presented. To the extent they have not already been covered, this discussion also addresses any potential impacts to downstream Sub-basins outside the community and any site specific or anecdotal concerns that are not accounted for in the GWC or Net Depletion Category model which may bear further investigation such as I/I losses or surface withdrawals which have not been considered.

8. Discussion of constraints. Even where Optimization opportunities may exist, they may be subject to numerous potential constraints. These constraints are briefly discussed, though the communities themselves are generally in the best position to assess these constraints. The discussion considers pumping limits for individual sources, major basin Baseline volumes, water treatment and conveyance capacity, the current functionality of individual wells, and other permitting and regulatory constraints peculiar to individual sources.

In addition, this information has been checked using more recent monthly pumping data for the period 2009 through 2011 to ensure that the Optimization recommendations reflect current seasonal pumping patterns and Optimization opportunities.

4.2.2 Alternative Sources

For purposes of this analysis, the term “Alternative Sources” has been interpreted as meaning new sources of supply within an applicant’s geographic jurisdiction. Thus, Alternative Source opportunities are those situations where a Sub-basin would be identified as an Optimization opportunity but for the lack of an existing source.

The Alternative Source analysis is quite similar to the Optimization analysis described above, and essentially follows the same steps. One important difference from the Optimization analysis is that where an Alternate Source with a large volume is available, it may be desirable to reallocate more water than was discussed in the priorities section of the Optimization discussion. Copies of the Alternate Source Data Reports for each community are included in the Appendix and are discussed below.

The Alternative Source analysis also considers where areas of high yield aquifer exist, to provide at least a basic test of new source development potential. A full review of all the past investigations of potential Alternate Sources for each community was beyond the scope of the current project. However, the recommendations presented here may provide guidance on how communities might use a streamflow protection lens as an additional criterion to guide new source development efforts.

The same type of tabular database output and GIS maps were used to guide the discussion of Alternate Sources as was used for the discussion of Optimization. To summarize and present the relevant data for each community, an Alternate Sources Data Report format was developed. The data have been used to identify any Sub-basins within the boundaries of each town, which do not have existing sources, and which could yield increased volumes without Backsliding when considering both GW Depletion and Net Depletion using the same procedures and metrics described above for Optimization.

For purposes of evaluating potential Alternative Sources, an arbitrary threshold of 0.1 MGD has been established as a conservative estimate of the minimum volume that would justify developing an Alternative Source. Sub-basins which cannot yield at least this minimum volume without Backsliding or Net Backsliding have been excluded from the discussion.

Even more so than with Optimization, there are numerous potential constraints and barriers to development of a new source, not the least of which is the existence of appropriate aquifer material. These are discussed briefly for each identified opportunity.

Based on its recent experience, Weston and Sampson estimate the cost of developing a new source to be on the order of $2 million including costs for land acquisition, construction and permitting. They estimate the cost of an advanced treatment plant, adequate for the treatment of groundwater under the influence of surface water, at approximately $7 million per million gallons, with the potential for lower costs where less sophisticated treatment is required.

The cost of new transmission lines is estimated at $1 million per mile. To the extent that water is transmitted via existing pipe networks through another community, interconnections and or booster pumps will be needed rather than (or in addition to) new transmission lines. In 2007 GeoSyntec estimated the cost of constructing gravity-fed interconnection for 6” to 12” lines at $39,000-$84,000. Based on more recent experience, Weston and Sampson estimate the cost of constructing a simple interconnection with a small electric booster pump at $250,000. They estimate the cost of an interconnection with more robust booster pumps, backup power, and land acquisition at $500,000 to $750,000. Where water is to be transmitted through existing pipe networks from one community, across a second, and into a third in an uphill direction, it is likely that two pump stations will be required, one at each side of the intermediate community. In addition, whenever water from two different sources is comingled, there can be water compatibility issues that need to be addressed, though these costs are generally smaller than the other elements of developing a new source.

4.2.3 Interconnections

In examining the potential for Interconnections with other suppliers, the following scenarios have been examined:

- The potential for Interconnections with neighboring communities that would utilize local sources in those neighboring communities, and
- The potential for interconnection with larger regional sources of supply

This discussion focuses on Interconnections primarily in the context of the SWMI Minimization requirements, but MassDEP has not yet issued definitive guidance on the scope of evaluation that would be required for Interconnections under Minimization. For purposes of the discussion below though it is presumed that communities would only be required to evaluate the use of existing Interconnections under Minimization.

Communities that decide to request a volume greater than Baseline, will also be required to examine the use of Interconnections in the context of Mitigation and potentially in the context of demonstrating that there is “no alternative less environmentally harmful source.” In the Mitigation context, it appears very likely that MassDEP will require evaluation of the potential for establishing new Interconnections. Thus information on potential new Interconnections has been briefly summarized below as well.

The following process has been utilized to evaluate opportunities to minimize environmental impacts using water imported through Interconnections:

1. Discuss existing or potential Interconnection infrastructure and the volumes of water potentially available through Interconnections.

2. Discuss the volumes of water that would be required to minimize depletion levels in local Sub-basins. MassDEP has not yet provided guidance on “how much Minimization is enough.” For discussion purposes, the volume required to restore all depleted Sub-basins to GWC 4 or GWC 3 status (i.e. 55% or 25% GW Depletion) during the 90 day peak summer season has been calculated. This volume is referred to below as the Seasonal Minimization Volume and its calculation is predicated on the level of depletion that occurred due to pumping during the SWMI base period (i.e. 2000-2004), and further assumes that the volume needed to offset August depletion levels is required for 90 days. In Sub-basins where there are withdrawals by multiple permittees, each community’s “share” of this 90 day Minimization volume has been prorated in proportion to their share of total withdrawals in the Sub-basin during the SWMI base period.

   This approach provides a general sense of how much water might be needed to Minimize impacts for all depleted Sub-basins for each community during the peak summer months. Actual Minimization proposals to MassDEP by individual communities should also consider current and forward looking expectations of pumping by Sub-basin, Minimization of impacts in seasons other than the summer period, and the impact of other Minimization measures such as Optimization and water conservation that a community decides to propose.

3. Discuss order of magnitude cost and other constraints to implementing potential Interconnections, such as pipe networks, elevation, water chemistry, regulatory barriers, and economic arrangements between parties. Discuss the cost of importing water through Interconnections and the savings associated with not using local sources to produce an equivalent volume. These savings include electricity and treatment chemicals, as well as some level of wear and tear on local infrastructure. Detailed information on these costs for every community in the study area was not available, however several communities indicated that electricity and chemical costs are in the

range of $500-$600 per MG so a default value of $500/MG has been used in all cost calculations and the cost savings associated with decreased wear and tear have been ignored.

The calculations of volumes for Minimization scenarios and associated costs are detailed in the Appendix and summarized in the narrative below.

Information on existing and potential interconnections was taken from interviews with communities, examination of water distribution system GIS data, and from the final report of the "Neponset Emergency Water Sharing Project" which was completed in 2007 by GeoSyntec Consultants and the Neponset River Watershed Association with funding from a MassDEP source water protection grant.

Overview of Potential for Interconnections within the Study Area

One potential source of additional water that could be used to minimize the impact of existing withdrawals in depleted Sub-basins, would be to import water to targeted areas via Interconnections that draw on existing or Alternative Sources within the study area communities themselves.

However, as discussed at length below, the options for Minimizing impacts through Optimization or Alternate Sources within each of the study area communities are very limited. So limited, that there would appear to be no opportunities to Minimize the impact of existing or increased withdrawals through Interconnections fed by sources local to the study area communities.

Overview of Potential for Interconnections to Regional Sources

A number of regional sources of supply exist or could potentially be developed outside the study area. These include:

- Existing or potential sources in the Taunton River Basin.
- The Aquaria Taunton River Desalination plant.
- Supplemental water taken from the Mass Water Resources Authority via existing or new Interconnections.

One of the unresolved SWMI policy questions is how much communities will be expected to do in order to "Minimize" impacts to the "maximum extent feasible." With this in mind, the discussion below attempts to explore a range of potential volumes and associated costs for water imported from regional sources.

Background on Existing or Potential Taunton Basin Sources

As indicated in the Backslide Volume map, the nearest Sub-basins which have significant capacity to provide additional water without Backsliding are located to the south and east of the study area in the Taunton River Watershed. These sources are closest to Foxborough, Sharon and Stoughton, but are still located at least five miles away from the study area, which limits the feasibility of these sources. Based on its recent experience, Weston and Sampson estimate the cost of developing a new source to be on the order of two million dollars over a period of three years, which reflects roughly one million dollars for land acquisition and one million for permitting and construction. Such a project would likely be more complex and potentially more expensive if undertaken at a remote site as would be the case here. In addition, the cost of constructing transmission lines is on the order of one million dollars per mile, with in this case a distance of at least five miles involved. Alternatively it might be possible to convey the water through existing pipe networks, but given that the target communities would be uphill of a new source in the Taunton River, one, or more likely, two pump stations would likely be required at a combined cost of 1 to 1.5 million dollars. In addition to this would potentially be the cost of a treatment plant on the order of five to seven million dollars. Given the total potential cost of 4 to 9 million dollars or more, and the uncertainties inherent in such an effort, it is likely that other interconnection options would be more appealing for all communities in the study area.

Background on the Aquaria Desalination Plant

The Aquaria Taunton River Desalination plant is an existing regional source which is presently underutilized. The Town of Norton has an option to import water from the Taunton Desalination plant and reportedly it is feasible to deliver water from the plant to the Town of Norton through existing pipe networks. However, the Town of Norton is not currently actively using its option for water from the Plant, and is located some distance from the towns in the study area which could potentially benefit from such an Interconnection. The costs of delivering water from Norton into the study area are similar to those associated with potential new sources in the Taunton Basin discussed above. Use of water from the Taunton Desal Plant would have the advantage of not requiring a new treatment plant, although there might well be water chemistry compatibility issues that would have to be addressed, particularly if the water were conveyed through existing pipe networks across several town water systems. The details of the cost to purchase a share of the water available from the Taunton Plant are unknown, as are the specific costs per unit of water consumed. Also of significant concern is the uncertainty regarding the long term economic viability of the plant given that the Plant's primary customer (Brockton) has indicated a desire to end its relationship with the Plant when its existing contract ends in 15 years. While in some respects, the Taunton plant may be more appealing than the development of new sources downstream in the Taunton River Watershed, the MWRA likely represents a more appealing regional Interconnection option for most if not all the communities in the study area.

Background on MWRA Supply

The MWRA system is based on very large surface storage supplies, which allow for downstream releases below the MWRA reservoirs, as well as reliable supply for seasonal needs including during extended periods of drought.

The MWRA functions as a wholesaler for water and currently delivers water to its wholesale customers as a usage cost of roughly $3,000 per million gallons. The MWRA estimates that this cost will increase at an average rate of less than 5-7% per year for the next decade, after which rates are projected to fall.

For communities who are not already members, or who are partial members and wish to increase their average annual daily allotment from the MWRA, there is an additional one time connection fee. The connection fee varies over time but presently stands at approximately $5 million for one million gallons of water per day. The MWRA Board of Directors has recently set out a policy which allows new entrants the option of paying the entrance fee in 25 equal annual payments without interest beginning three years after connection. In effect, this adds $550 to the usage fee for each million gallons of water purchased from the fourth to 27th year of a new connection. Additional costs of joining the MWRA include submission of an IBTA approval request and related permits. These costs have been dropping and are expected to drop further as the SWMI process brings further clarity to the process of judging the impacts of local supply alternatives. Recent admittees to the MRWA have reported permitting costs of $100,000 to $200,000. Lastly, new entrants to the MWRA system face the cost of constructing physical interconnection infrastructure and issues related to local pumping and/or water quality compatibility issues, all of which are highly site specific but are discussed briefly below.

The Cost of Constructing Interconnections

In 2007 GeoSyntec estimated the cost of constructing gravity-fed interconnection for 6" to 12" lines at $39,000-$84,000. Based on more recent experience, Weston and Sampson estimate the cost of constructing a simple interconnection with a small electric booster pump at $250,000. They estimate the cost of an interconnection with more robust booster pumps, backup power, and land acquisition at $500,000 to $750,000. The cost of new transmission lines is estimated at $1 million per mile. In addition, whenever water from two different sources is comingled, there can be water compatibility issues that need to be addressed, though these costs are generally smaller than the other elements of developing a new interconnection.

4.2.4 Surface Water Releases

The inclusion of surface water releases in the SWMI framework's list of Minimization planning requirements is directed primarily at water supply reservoir systems. There are no surface drinking water sources in the study area, and relatively few large surface water bodies of any kind. For most of these surface water bodies, ownership and existing recreational/aesthetic uses will be at least a partial constraint on their potential use in augmenting seasonal streamflows. Nonetheless, the few opportunities which may exist have been briefly discussed.

4.3 Discussion and Recommendations

4.3.1 Canton Discussion and Recommendations

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.1.1 Optimization for Town of Canton

Canton Priority Sub-Basins for Optimization

Canton has no existing sources in CFR areas, or BC 1-3 areas. Canton has several sources listed in DEP records which appear to be inactive and located in the Town of Stoughton along the Beaver Meadow Brook (21151) which is GWC 1. Canton's remaining sources are spread across four other Sub-basins, most of which are fairly large Sub-basins, and all of which are GWC 4 or 5, in part because of withdrawals upstream.

The Neponset River to Ponkapoag (21040) is unusual in that it is Canton's largest Sub-basin with the highest Unaffected August flows, but Canton's sources in this Sub-basin are located at the headwaters of a small stream (Pecunit Brook) rather than on the main stem of the Neponset. These sources are also in an aquifer which is somewhat separate from the major Fowl Meadow aquifer. As a result, this Sub-basin is prioritized for seasonal pumping reductions, ahead of Canton's other GWC 4-5 Sub-basins. Because Pecunit Brook is a small part of a much larger Sub-basin, the statistics developed for this project do not directly indicate by what volume pumping should be reduced in the Sub-basin, but given the small size of the brook, a seasonal reduction of up to 100% would be ideal, which amounts to about 0.4 to 0.5 MGD relative to both historical and recent pumping.

The next, albeit somewhat lower priority for reduced pumping is the Neponset River to East Branch Confluence (21017 including Wells 5, 6, 9, 10, 13, and 16) which has higher GW Depletion and Net Depletion levels (59% and 45%) than Canton's other GWC 4-5 Sub-basins, even before the major infrastructure improvements which Canton has implemented to increase pumping here. During the SWMI base period estimated August pumping in the Sub-basin was less that 0.2 MGD. More recent average August pumping has been in the range of 0.95 MGD, increasing GW Depletion for the Sub-basin as a while by about 8.5% and bringing total GW Depletion to roughly 67%.

<u>Canton Surface Supplies for Optimization</u>
All of the existing public water supply sources in Canton are groundwater sources and thus there are no surface storage Optimization opportunities.

<u>Canton Sub-Basins with Higher Base Flows</u>
The Beaver Meadow Sub-basin (21151) is Canton's smallest, with minimal base flow. The East Branch Sub-basin (21137) is Canton's next smallest Sub-basin which includes Well 7. Even though Well 7 was not in use during the SWMI base period, this Sub-basin was already in GWC 4. The Town has nearly completed a renovation of this well and is preparing to reactivate it.

Canton's sources in the Neponset River to East Branch Sub-basin (21017) include Wells 5, 6, 9, 10, 13 and 16. As discussed above, this basin is the second priority for withdrawal reduction.

Canton's largest base flow Sub-basin is 20140 which includes Wells 4, 11, 12 and 14 along Pecunit Brook. As discussed above, this Sub-basin is the first priority for flow reduction.

Sub-basin 21129 is home to Wells 2 and 3 and is in GWC4. These wells have been inactive for some time, and the Town indicates they have no plans to reactivate them. This Sub-basin has the second highest base flows in town. If these sources were reactivated, pumping could be shifted from the Neponset River to East Branch Confluence (21017) with no net increase in depletion. Canton should consider reactivating these wells and that as much water as possible be produced at Wells 3 and 4 and be dedicated to providing relief to wells in the Neponset River to East Branch Sub-basin.

<u>Canton Sub-Basins With Remaining GWC Capacity Or Wastewater Returns</u>
Sub-basin 21151, Beaver Meadow Brook, is Canton's surcharged Sub-basin which also has existing sources. However, Canton's sources here are inactive and the Sub-basin is GWC1. Therefore it is not recommended that withdrawals in the Sub-basin be increased.

The East Branch Sub-Basin (21127, Well 7) is a GWC 4 and has a Net Depletion Category of 3. It is notable that during the SWMI base period, Canton had no withdrawals from Well 7 yet the Sub-basin was still in GWC 4 due to upstream influences. Well 7 has recently been renovated with an eye toward increasing withdrawals at this location. Using the standard Net Backsliding volume formula, only 0.08 MGD of additional withdrawal is recommended. However, given that this is Canton's only immediately viable Optimization opportunity, Canton should follow the GW Backslide Volume rather than the Net Backslide Volume, which would make just under 0.3 MGD of additional supply available from Well 7 to relieve the Pequit Brook wells during the summer months. During the winter months, this volume should be used to relieve the Neponset River to East Branch Sub-basin (21017).

As discussed above Wells 3 and 4 in Sub-basin 21129 are currently inactive. This Sub-basin is in GWC 4 so normally increased withdrawals would not be recommended. However in light of the need in the Pequit Brook area, if these wells are redeveloped, they should be used to further relieve the Pequit Brook Wells. Five percent of Unaffected August median flow amounts to almost 0.8 MGD in Sub-basin 21129.

<u>Canton Stream Connectivity</u>
The wells along Pequit Brook (21040), at roughly 200' or less from the stream, are the closest and thus most problematic from a stream connectivity perspective. They are also least advantageous from a distance from headwaters perspective.

The inactive wells (Wells 2 and 3) in Sub-basin (21129) at more than 800 feet away from their respective streams are the most favorable from both a distance from stream and a distance from headwaters perspective by a wide margin.

Within the Neponset River to East Branch Sub-basin (21017), Wells 6 and 9 are both just under 700 feet from waterways, while Wells 5 and 10 are significantly closer. Thus Canton should consider Optimizing the use of sources within this Sub-basin by resting Wells 6 and 9 in the winter and spring, and then using them to relieve wells 5 and 10 in the summer.

<u>Canton Summary of Optimization Opportunities</u>
Based on the above canton should consider the following:

- Leave the inactive sources in Beaver Meadow Brook (21151) fallow.
- Investigate the possibility of renovating Wells 3 and 4 in Sub-basin 21129. These wells should be redeveloped for the maximum possible volume and used to relieve the Pequit Brook wells and then the Neponset River to East Branch Sub-basin (21017) particularly in the spring and summer months. This is Canton's most significant Optimization opportunity, but would require significant investment on the town's part.
- Increase pumping at the newly renovated Well 7 to roughly 0.3 MGD and use it to relieve Pequit Brook and then the Neponset River to East Branch Confluence Sub-basin.
- Within the Neponset River to East Branch Sub-basin (21017) rest wells 6 and 9 in the winter and spring and use them to relieve the other wells in this Sub-basin in the summer.

<u>Canton Discussion Of Constraints</u>
Optimization constraints for Canton have been discussed in the narrative above.

4.3.1.2 Canton Water Department Alternative Sources
There are three Sub-basins within the Town of Canton which have a Backslide Volume or Net Backslide Volume of more than 0.1 MGD.

The largest of these is the Neponset River to Pine Tree Brook Sub-basin (21107) along the Neponset River main stem. This is a GWC 5 Sub-basin, but has a Net Backslide Volume of 0.5 MGD. Because it has a relatively large natural base flow, stream depletion levels would be reduced by shifting withdrawals to this Sub-basin. This Sub-basin also has significant high-yield aquifer material. However, most if not all of the appropriate sites for new source development are located on land owned by DCR, and Canton could achieve similar benefits, potentially at less cost, by redeveloping its existing Wells 2 and 3 instead. Therefore no action is recommended in this Sub-basin.

The next Sub-basin is the East Branch to Pequit Brook (21145). This is an abnormally small hydrologic unit with no potential for new source development based on existing land uses.

The final Sub-basin is Pequit Brook to the East Branch Confluence (21144). This Sub-basin includes Reservoir Pond and is in GWC 1. This Sub-basin is characterized by small natural base flows and extremely high water temperatures due to long retention times in Reservoir Pond. Additional withdrawals in this system would tend to exacerbate the temperature problems. Because stream baseflow volumes here are small, the potential for additional ground water withdrawals is limited. While a surface withdrawal from the pond is hypothetically possible, no action is recommended in this Sub-basin because there is a well-organized constituency of recreational lake users, because maintaining adequate downstream flows in conjunction with a surface withdrawal would require aggressive drawdown of the pond, and because of the likely high cost to develop and treat a surface source at this location.

Canton summary of Alternative Source recommendations

Based on the discussion above there are no Alternative Sources within the boundaries of the Town of Canton which are recommended for further consideration.

4.3.1.3 Canton Water Department Regional Interconnections

The Town of Canton is already a full member of the MWRA system and already has in place all the infrastructure and authority needed to draw as much water from the MWRA as it desires. Thus it is not recommended that the Town of Canton consider establishing Interconnections with any other regional supplies.

During the SWMI base period, Canton operated withdrawals in two Sub-basins, with one being the parent of the other. Canton’s share of the pumping reduction needed to restore both these Sub-basins to GWC 4 or GWC 3 over the 90 day summer period is summarized in the table below. However, as discussed above under Optimization, the GWC for the Pecunit Brook wells does not fully reflect the level of depletion that exists along the brook. Thus a scenario where pumping of the Pecunit Brook wells was reduced 100% during the summer period was evaluated. It is important to note that all these figures are based on Canton’s pumping during the SWMI base period. Since that time, Canton’s pumping of local sources has increased from these levels up to and beyond Baseline. Increased pumping above Baseline will have to be addressed under SWMI’s Mitigation provisions. Increased pumping above levels in the SWMI base period but below Baseline is not reflected in the figures presented below.

Goal	Required MGY	$/Yr	$/Yr/Connection
Restore GWC4 (standard approach)	1	2,500	0.36
Restore GWC3 (standard approach)	20	50,000	7.16
Restore GWC3 (alternative approach)	46	115,000	16.47

4.3.1.4 Canton Surface Supplies

There are two sizeable bodies of water in Canton which could potentially generate seasonal water releases that might be useful in the context of Minimization: Ponkapoag Pond and Reservoir Pond.

Ponkapoag Pond is owned and operated by DCR. This dam was recently rebuilt and has in place mechanisms and procedures to provide continuous water releases during the summer based on a pond and stream management considerations as they relate to water withdrawals at the Ponkapoag Golf Course. Ponkapoag Pond is also effectively downstream of all of Canton's water supply sources. There is no opportunity to arrange further water releases for Minimization purposes at Ponkapoag Pond.

Reservoir Pond, located along Pequit Brook, was constructed to provide streamflow control for the benefit of a now defunct downstream industry and has not been actively used as an industrial surface water supply for many years. It was recently acquired by the Town of Canton and the dam was rebuilt. Reservoir Pond is located upstream of all of Canton's water supply sources. As such, the Pond has the potential to provide seasonal water releases to augment impacted Sub-basins downstream, however the Pond's ability to provide such releases is at least partially limited by its shallow average depth, the limited stream baseflows in the area, and the significant volume of evaporation that results from the Pond's wide and shallow configuration. As part of the dam reconstruction process a Pond operation and maintenance plan was developed. Reportedly this plan does not address the issue of seasonal water releases or maintenance of releases that at least equal natural base flow. The O&M plan should be reviewed to determine whether it addresses the issues of base flow or augmented seasonal releases. If it does not, Canton should consider amending the O&M plan to address these issues.

4.3.2 Dedham Westwood Water District Discussion and Recommendations

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.2.1 Optimization for the Dedham Westwood Water District

<u>DWWD Priority Sub-Basins</u>

DWWD has no existing sources in CFR areas, or BC 1-3 areas. DWWD has several sources in the Rock Meadow Brook Subwatershed (21036). This is a smaller headwater Sub-basins with low natural base flows and a GWC of 3. These sources, which are in a child basin of DWWD's Charles River sources downstream, were in active use during the SWMI base period, but are now inactive and would reportedly require a substantial water treatment plant investment in order to be reactivated. Because of the small base flows in the Sub-basin it is recommend that DWWD not reactivate these sources if possible.

The bulk of DWWD's supply, roughly 70%, is drawn from two large (83 and 100 sq mi) Sub-basins along the Neponset main stem (21040 and 21107). One of these Sub-basins is the parent of the other. In spite of the fact that they fall in two different Sub-basins, DWWD's Neponset wells are concentrated in a relatively compact area along the river. The more upstream of the two Sub-basins is a GWC 5 with GW Depletion of 59% and a Net Depletion Category of 4 with Net Depletion of 43%. The more downstream of these Sub-basins is also in GWC 5 with a GW Depletion of 66%, a Net Depletion Category of 4 and Net Depletion of 52%.

The remaining 30% of DWWD's supply is located in a single large (194 sq mi) Sub-basin along the Charles River (21113). This Sub-basin is in GWC 4 with 54% depletion and a Net Depletion Category of 3 with Net Depletion of 21%.

Since the SWMI Base Period, DWWD has reduced pumping of all its sources, with the bulk of that reduction occurring in the Rock Meadow and Charles River sources which has significantly reduced DWWD's contribution to depletion levels in the Charles. DWWD staff indicated that withdrawals from their Charles sources are currently limited by iron clogged wells, however they are in the process of pursuing renovation and/or replacement wells to increase their effective capacity on the Charles. Existing treatment capacity for the Charles River sources is reportedly currently underutilized.

Given the high depletion and Net Depletion levels in the Neponset Sub-basins, the first Optimization priority would be to provide relief to these Sub-basins. It would take an addition of 2.1 MGD to restore the more downstream of the two Neponset Sub-basins (21107) to a GWC 4 depletion level and 7.3 MGD to restore it to a GWC 3. Conditions are somewhat more favorable when wastewater returns are included, with the basin already meeting a Net Depletion Category of 4 and requiring only an additional 5.0 MGD to achieve a Net Depletion Category of 3. It is notable that these are the most downstream basins on the Neponset and reflect the cumulative impacts of numerous other water withdrawals upstream. During the SWMI base period, DWWD's withdrawals represented approximately 28% of total August withdrawals by all permittees in the Sub-basin. With this in mind it would be reasonable for DWWD to be held responsible for only 28% of the potential restoration volume. Therefore it is recommended that DWWD ideally seek to reduce withdrawals from its Neponset wells, at least on a seasonal basis, by 1.4 to 2.0 MGD as its allocated "share" of achieving Net Depletion Category 3 or GWC 3 respectively.

<u>DWWD Surface Supplies</u>
All of the existing public water supply sources in the DWWD system are groundwater sources and thus there are no surface storage Optimization opportunities.

<u>DWWD Sub-Basins With Higher Base Flows</u>
As discussed above the Rock Meadow Brook Sub-basin (21036) has very small base flows and is a child basin of DWWD's Charles River sources (21113). Up to 100% of pumping in Rock Meadow Brook could be shifted to DWWD's Charles River sources, without any increase in the depletion level of the Charles Sub-basin.

The DWWD's Neponset sources are in two Sub-basins, one of which (21040) is a child of the other (21107). However, because of land use and geology, the unaffected August base flow is only incrementally larger in the downstream Sub-basin as compared to the more upstream Sub-basin. Thus there are not meaningful improvements to be achieved by shifting between Sub-basins on the Neponset.

<u>DWWD Sub-Basins With Remaining GWC Capacity Or Wastewater Returns</u>

DWWD's Charles Sub-basin (21113) has natural base flows which are almost two and a third times higher than the base flows in the Neponset. As discussed above, the Charles Sub-basin also has both substantially lower GW Depletion levels and substantially higher wastewater returns than the Neponset Sub-basins. The volume available without Net Backsliding in the Charles (21113) is 1.75 MGD and the volume available without backsliding is approximately 0.5 MGD, however given decreases in pumping of DWWD's Charles sources since the SWMI base period (approximately 1.3 MGD) these numbers are now significantly higher. Based on the pumping levels during the SWMI base period, withdrawals from the Charles sources could be increased 1.75 MGD without Net Backsliding. Reallocating up to 1.5 MGD of pumping from the Neponset sources to the Charles sources would represent DWWD's 28% "fair share" of restoring the Neponset from Net Depletion Category 4 to Net Depletion Category 3 while producing no change in Net Depletion Category on the Charles.

A reallocation of this magnitude (1.5 MGD) would represent only 3.7% of Unaffected August flow for the Charles, but a restoration of 8.5% of Unaffected August flow for the Neponset. It is also notable that the above figures are based on pumping levels during the 2000-2004 SWMI Base period. Since that time, DWWD's pumping of Charles sources has dropped by roughly 1.3 MGD whereas pumping of their Neponset sources has remained essentially constant (note that the accuracy of the pumping volumes at the Rock Meadow Wells during the SWMI base period should be verified). Thus a shift of 1.5 MGD from the Neponset to the Charles would actually represent an increase of only 0.2 MGD above the depletion level that existed during the SWMI base period or less than one half of one percent of Unaffected August median for that portion of the Charles. Given DWWD's Charles Basin Baseline of 1.91 MGD and their recent pumping of their Charles sources at a rate of 1.4 MGD, DWWD can only increase pumping on the Charles by roughly 0.5 MGD without triggering a Mitigation requirement. An decrease of 0.5 MGD on the Neponset would still be beneficial and an increase of 0.5 on the Charles would have less impact that a larger increase.

<u>DWWD Stream Connectivity</u>

The Rock Meadow Brook wells are both the closest to the stream of all DWWD's wells and the nearest to the headwaters of their stream. This adds further impetus to the recommendation to discontinue these sources.

All of DWWD's Charles River wells are located a similar distance from the stream, generally between 160 and 210 feet. The one exception is well A2 which is 600 feet away but appears to be inactive. As DWWD continues its effort to rehabilitate its Charles River wells, they should consider opportunities to locate wells further from the stream.

DWWD's Neponset wells are reported at various distances from the river. White Lodge Well #5 is shown as only 139' from a stream but the stream in question is a mosquito ditch. In fact, at roughly 870' from the river, it is the most distant of all the Neponset wells. The other White Lodge Wells are on the order of 600' from the river with the exception of #3 and 3A which are significantly closer at roughly 200'. With the above in mind, it is recommended that when choosing among the White Lodge Wells in the summer they rest White Lodge #5 in the winter and spring and maximize its use in the summer, while also minimizing the use of #3 and #3Ain the late spring and summer. There is some information in the pump test report which suggests that #5 may also be better separated from the river than the other wells by the configuration of an aquatard. This issue deserves more careful scrutiny. One barrier to reducing the use of Well 3 and 3A and increasing the use of Well 5, is the operational conditions applied to Well 5 by its IBTA permit, which require this well to be shut off when the river meets a minimum flow threshold. When Well 5 is forced to shut down, DWWD relies more heavily on the other White Lodge Wells including the problematic #3/3A, and begins drawing on their MWRA connection as conditions worsen. It appears that an unintended consequence of the IBTA condition may be to worsen stream flow depletion.

DWWD Summary of Opportunities

Based on the above DWWD should consider the following:

- Do not invest in reactivating the Rock Meadow Brook Wells.
- Continue and/or accelerate efforts to renovate and/or replace pumping capacity for the Charles River sources and seek to locate replacement wells as far from the river as feasible, all with the ultimate goal of redirecting 0.5 to 1.5 MGD of current pumping from Neponset sources to Charles sources.
- Further evaluate the concept of minimizing the use of White Lodge Wells 3 and 3A during the summer months while resting White Lodge #5 in the winter and spring, and maximizing its use in the summer.
- Seek an amendment to the IBTA permit conditions for White Lodge #5 that would emphasize shutting down Well 3 instead of Well 5 when the stream flow threshold is reached.

DWWD Discussion of Constraints

As discussed above, the primary constraints to be addressed are enhancing pumping capacity of DWWD's Charles River sources, the Charles River Basin Baseline and amending IBTA permit conditions for White Lodge Well #5.

4.3.2.2 Dedham Westwood Water District Alternative Sources

DWWD hypothetically has access to six additional Sub-basins in which it does not presently have sources. Four of these could potentially provide more than 0.1 MGD to provide relief for more highly depleted Sub-basins.

The largest of these is the Charles River to Rock Meadow Brook Sub-basin (21035). This is a GWC4 Sub-basin which includes portions of the Charles River main stem as well as a CFR, with significant wastewater returns. However, the portion of the Sub-basin within DWWD district boundaries is along a headwater stream and is largely inside Hale Reservation. Given that DWWD already has existing sources in a larger main stem Sub-basin downstream it would be preferable to redevelop those existing sources rather than to pursue new ones in this Sub-basin.

The next largest is the Charles River to Rosemary Brook Sub-basin (21014). This Sub-basin is immediately downstream of DWWD's existing sources on the Charles River and there appears to be a substantial area of high yield aquifer in the Sub-basin. Much of the land in this area is owned by DCR. It is unlikely that the effective impact of a new source developed in this Sub-basin would be very different from the impact of DWWD's existing Charles River sources. However, as discussed above under Optimization, there would be significant overall benefits to reallocating some withdrawals from the Neponset to the Charles, a change which is currently limited by inadequate pumping (though not treatment) capacity at the Charles River Wells. If DWWD's current efforts to renovate the pumping capacity of their existing sources on the Charles are unsuccessful, it would be worthwhile to investigate the possibility of developing a new source in this Sub-basin.

The next Sub-basin is the "Most of the City of Boston" Sub-basin (21027). It is presumed that existing land use would make it impossible to develop a new source in this Sub-basin.

The final available Sub-basin is the Hawes, Germany and Mill Brook Sub-basin (21027). This is a GWC 2 Sub-basin. The Sub-basin has moderate wastewater returns and thus a Net Backslide Volume of 0.3 MGD. However, this Sub-basin includes a CFR in its upper reaches which covers much of the area inside the DWWD district boundary, making it difficult to develop a new groundwater source here. The Town of Norwood recently conducted a pump test at its inactive Buckmaster Pond Well in this Sub-basin in hopes of reactivating it with a withdrawal rate approaching 1 MGD, however the Town ultimately abandoned this effort and there do not appear to be any further efforts to redevelop this source in light of the limitations mentioned above. In addition, this Sub-basin is a child of DWWD's downstream sources on the Neponset and shifting demand from downstream sources on the Neponset to a new upstream source would result in no net reduction of depletion in the parent Sub-basin.

One interesting, albeit unlikely, alternative in this Sub-basin would be the development of a new surface water supply in Willett Pond. Surface water sources are regulated differently than groundwater sources under SWMI and are not directly limited by GWC thresholds on the theory that surface water sources incorporate substantial storage and thus, when managed well, can decouple withdrawals from water releases. The entirety of Willett Pond is owned by a subsidiary of the Neponset River Watershed Association. The Association currently maintains a program of minimum summer water releases from the pond based on 0.5 CFSM. This generally produces seasonal water fluctuations of up to 2.5 feet below "normal" pool during drought years. Operating a sizeable water withdrawal at Willett Pond, while maintaining adequate summer releases, would likely require more aggressive drawdowns during dry years, which would undoubtedly raise objections from recreational users. However, because of the ownership by the Watershed Association, such objections would not necessarily be an insurmountable barrier to establishing a surface water withdrawal.

Development of such a project could be undertaken individually by Norwood, Walpole, or Dedham-Westwood, or alternately through a combined effort of more than one of these entities. However, it would be quite difficult to develop a surface water source in this area. Weston and Sampson reports that it has been 20 years since a new surface source were permitted in Eastern Massachusetts. Creating a surface source at Willett Pond would involve construction of an advanced treatment plant, with an estimated cost of at least $7 million for a capacity of 1 MGD. Pumping and transmission capacity would also be required at an additional cost of $2 million or more. Given the high cost of and regulatory uncertainty associated with developing a new surface source at Willett Pond, and the availability of water at lower cost through interconnections, it is not recommended that DWWD pursue this possibility.

<u>DWWD Summary of Alternative Source Recommendations</u>
Based on the above DWWD should consider the following:

- If efforts to increase pumping capacity at DWWD's existing Charles River sources are unsuccessful, explore the possibility of new sources in Sub-basin 21014.

4.3.2.3 DWWD Regional Interconnections
DWWD is a partial member of the MWRA, and already has in place the physical infrastructure to draw large volumes from the MWRA system. However, the DWWD has only joined the MWRA for 0.1 MGD or 36.5 MGY. If DWWD were to increase use of the MWRA system above these levels on a regular (i.e. non-emergency) basis, additional permitting work and the payment of additional entrance fees would be required.

DWWD's current practice is to utilize their MWRA allocation primarily when low river levels trigger the condition in the IBTA permit for White Lodge Well #5 which requires shutting down that well. This results in significant variation in how much MWRA is utilized from year to year. DWWD's MWRA consumption has varied from 0.25 MGY to 39.84 MGY over the last five years with an average of 13.9 MGY. One potential approach to minimizing impacts would be to maximize the use of DWWD's limited MWRA allocation during the summer months irrespective of the river's trigger level, or using a trigger level which is more protective of the environment that that contained in the permit. On average, this would enable DWWD to reduce pumping of their local sources, by 0.25 MGD for a period of 90 days. This scenario was evaluated in addition to the standard scenarios which were evaluated for all the towns. These calculations are detailed in the Appendix.

Goal	**Required MGY**	**$/yr**	**$/yr/ connection**
Maximize use of existing MWRA allocation	22.6	56,500	4
Restore GWC4 all sources	52	145,348	11
Restore GWC3 all sources	263	733,453	56

4.3.2.4 DWWD Surface Water Releases
There are no large surface water bodies within the DWWD's boundaries that would potentially be able to provide surface water releases for Minimization purposes. The one exception in Willett Pond, which as discussed above, already has a program of seasonal surface releases in place.

4.3.3 Foxborough Water Department Discussion and Results

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.3.1 Optimization for the Foxborough Water Department

Foxborough Priority Sub-Basins

Foxborough is unique in that it sits at the headwaters of four major basins and has existing sources in three major basins. Almost by definition, all of Foxborough's sources are in relatively small headwater Sub-basins.

Foxborough has sources in one Sub-basin (24103, Rumford River) which hosts a CFR. However, hydrologically speaking, Foxborough's sources are "downstream" of the CFR stream (Henke's Brook) and it does not appear that the sources have any impact on the CFR brook. Foxborough has no existing sources in BC 1-3 areas.

Foxborough's existing sources are located in four Sub-basins. In the Neponset, this includes the Neponset River Headwaters Sub-basin (21150) which is GWC 5 with 144% groundwater depletion and 123% Net Depletion.

In the Taunton are the Upper Wading River Sub-basin (24014) which is GWC 4 with GW Depletion of 50% and Net Depletion of 39%, and the Rumford River Sub-basin (24103) is GWC 5 with 81% GW Depletion and 59% Net Depletion.

Foxborough's newest sources, Wells #14 and #15 (the Witch Pond Wells) are located in the Ten Mile Basin in the Bungay River Sub-basin (24047). The SWMI base period predates the operation of these wells, and even at that time, the Sub-basin was GWC 5 with GW Depletion of 133% and Net Depletion of 77%. If Wells #14 and #15 are both operated at only half their daily pumping limits, GW Depletion in this Sub-basin will rise to 179%. Because these wells are located in the Ten-Mile Basin they are subject to an IBTA permit which includes provisions designed to protect nearby endangered species habitat among other considerations.

Foxborough's lack of Sub-basins with higher base flows combined with very high existing stream depletion levels leaves the town with no good Optimization options.

Given the presence of rare wildlife and very high existing depletion levels, the top priority for Optimization would appear to be to minimize withdrawals from the Bungay River Sub-basin (24047).

Foxborough also has one unique source at its disposal which is not reflected in in the normal SWMI materials, a wastewater reuse system that allows for delivery of reclaimed wastewater for non-potable uses in the area in the north end of town around Gillette Stadium. Reportedly this source is under-subscribed.

Foxborough Surface Supplies

All of the existing public water supply sources in Foxborough are groundwater sources and thus there are no surface storage Optimization opportunities. However, Foxborough's Neponset sources are immediately adjacent to the Neponset Reservoir. The Reservoir is the source of the Neponset River and was historically used by downstream industries to augment summer stream flows in the river. However, because the Reservoir sits at the headwaters, it would contribute relatively little natural base flow to the stream, and so the expectation for "natural" downstream water releases at this location is minimal. In effect, the Reservoir may be providing surface storage that helps prevent the nearby wells from depleting natural base flows further downstream.

While it is difficult to recommend increasing pumping in a Sub-basin which is already at 144% depletion, increasing withdrawals at the Neponset wells on a seasonal basis may be the best of the bad options available for providing relief to the Bungay River Sub-basin (24047). Current use of the Neponset sources is well below daily pumping limits, and based on conversations with Foxborough, it appears the existing infrastructure has at least some ability to deliver additional water. One limitation of this approach is that the Neponset Reservoir is highly eutrophic and has a well-organized constituency of abutting homeowners. To the extent that changes to pumping and reservoir releases at this location result in reduced surface releases, reduced seasonal reservoir levels, or reduced clean groundwater flow entering the Reservoir, abutter objections would likely result. It is also important to note that recent pumping of Foxborough's Neponset sources is somewhat over the Neponset Basin Baseline, potentially imposing a Mitigation requirement. Increasing pumping of the Neponset sources will exacerbate the required volume of Mitigation.

Foxborough Sub-Basins With Higher Base Flows

Because all of the Sub-basins in Foxborough are headwater Sub-basins, all of which have minimal natural base flow, there are no opportunities for Optimization in this area.

Foxborough Sub-Basins With Remaining GWC Capacity Or Wastewater Returns

All the Sub-basins with existing supplies in Foxborough are so small and so heavily depleted both in terms of GW Depletion and Net Depletion that there are no opportunities for Optimization in this area.

Foxborough Stream Connectivity

Foxborough's Neponset sources are significantly farther away from their stream, 4,000 feet or more, than any of Foxborough's other sources because they sit on the opposite side of the Neponset Reservoir from the outlet. Of the sources near the Reservoir, Well #13 is somewhat farther from the Reservoir than the others and its use should be emphasized in the summer.

Well 12, located on the boundary of the Neponset Headwater Sub-basin and the Upper Wading River Sub-basin, is also much further removed from water bodies than Foxborough's other sources and should also be emphasized in the summer. Reportedly, under existing conditions this well can supply water only to the northern end of the town near the Stadium and that its use is limited by iron clogging and lack of sufficient treatment capacity.

Well 10 in the Rumford River Sub-basin (24103) is also somewhat further removed from the stream than its neighbors, and consequently should be rested in the off season and emphasized in the summer.

Foxborough Summary Of Opportunities

Based on the above Foxborough should consider the following:

- Maximize the utilization of the reclaimed water to provide relief to the Bungay and Neponset Sub-basins.

- Increase the utilization of sources adjoining the Neponset Reservoir on a seasonal basis in order to provide relief to sources in the Bungay River Sub-basin (24047).
- Evaluate the potential to increase seasonal pumping at Well 12 which will require upgrades to pumping and treatment infrastructure.
- Rest Well 10 in the winter months and use it to relieve pumping on other sources in the Rumford River Sub-basin (24103) during the summer.

Foxborough Discussion Of Constraints

Optimization constraints have been discussed in the narrative above.

4.3.3.2 Foxborough Water Department Alternative Sources

Foxborough hypothetically has access to seven additional Sub-basins in which it does not presently have sources. Five of these could potentially provide more than 0.1 MGD to relieve more highly depleted Sub-basins.

The largest of these is the Wading River to Hodges Brook Sub-basin (24029) which is GWC 4 but has moderate wastewater returns which might enable it to provide 0.25 MGD without net Backsliding. This Sub-basin is in the corner of town at the headwaters of the Taunton River Watershed, next to Foxborough's Witch Pond Wells. It appears that the parent Sub-basins downstream also have additional capacity. This Sub-basin actually contains a significant area of high yield aquifer, though this aquifer at least partially spans watershed boundaries to connect with the area around the Witch Pond Wells. Given the proximity of the existing treatment plant and conveyance capacity, development of a new source in this Sub-basin might be a cost effective way to relieve the pressure on the Witch Pond site with its associated endangered species concerns. One limitation is that the more favorable location based on existing land use would be just over the town line into Mansfield.

The Stop River to Stony Brook Sub-basin (21167) has a small amount of capacity but no appropriate aquifer material is indicated in or near the town boundaries.

The Hodges Brook to Wading River Sub-Basin (24028) has a very small amount of capacity available when counting wastewater returns. There appears to be a small aquifer in this Sub-basin just over the town line in Mansfield, however the volume is too small to justify pursuing a new source here.

Lastly in the Lake Miramichi Sub-basin (24015) there is a small amount of capacity available and seemingly appropriate aquifer material in a narrow band along the lake shore. Again because of the proximity of the Witch Pond treatment and conveyance capacity, it might be possible to develop a source in this Sub-basin to help relieve demands at the Witch Pond Site. Proximity to the Lake in conjunction with appropriate water releases from the lake would make it possible to withdraw water at this location with less impact on surface flows than would otherwise be expected. Although immediately adjacent to the Sub-basin that contains Witch Pond, this area is in a completely unrelated Sub-basin. As a practical matter however, there are almost certain to be discrepancies between surface and groundwater boundaries in this area. Reportedly, Lake Miramichi is operated as a source of surface water storage by a downstream community which would further complicate development of a new source in this area.

Foxborough Summary Of Alternative Source Recommendations

Based on the above Foxborough should consider the following:

- Explore the possibility of establishing a new source in the Wading River to Hodges Brook Sub-basin (24029) and/or the Lake Miramichi Sub-basin (24015) that would utilize the existing treatment and conveyance capacity at Witch Pond and alleviate pressure on those sources.

4.3.3.3 Foxborough Water Department Regional Interconnections

Foxborough has existing Interconnections with Mansfield, Sharon, Walpole, Wrentham, and Plainville. However, because Foxborough sits at the top of four major basins, these existing Interconnections all flow out rather than in, unless there is active pumping. It appears that none of the communities with which Foxborough has existing Interconnections can provide substantial additional volumes of water from their own sources without Backsliding. Thus in the short term, there would seem to be few opportunities for Minimization using existing Interconnections.

Over the longer term, Foxborough may wish to investigate creating new Interconnections in the context of Mitigation. North Attleboro is nearby, and while there is no existing interconnection, Foxborough and North Attleboro have existing pipe networks in relatively close proximity. North Attleboro has some surface supplies and supplies of this type are generally treated more favorably under the SWMI framework.

In the larger region, there are some Sub-basins, generally south and east of Foxborough which could provide significant additional volumes without Backsliding. The nearest of these is Sub-basin 24030 in Easton, though this Sub-basin is approximately 3.5 miles away and contains a surface supply and thus its effective Depletion level may be understated. Slightly further south into the Taunton River Watershed, there are a number of Sub-basins which could yield more than 1 MGD without Backsliding, however these Sub-basins are at least six miles away from the Foxborough town boundary. As discussed in the overview on Interconnections at the beginning of this Chapter, the costs and uncertainties of developing these distant sources are high and unlikely to be attractive, even in the long term.

The Town of Norton, located 3.5 miles from the Foxborough town line on the far side of Mansfield (with which Foxborough has an existing interconnection) has access to water from the Aquaria Taunton Desalination Plant. However as discussed in the overview on Interconnections above, the costs and uncertainties of importing water from the Taunton Plant are high, and while potentially more attractive than the idea of developing new sources in the Taunton Basin, this option presents significant challenges, even in the long term.

The other long term possibility for Interconnections for Foxborough would to access MWRA water through Walpole or Sharon. Neither Walpole nor Sharon are currently MWRA member communities, but as discussed below, both are in close proximity to the MWRA system. If one or both of these communities were to connect to the MWRA, it might open up possibilities for Foxborough as well, or Foxborough could potentially pursue a joint MWRA connection in partnership with one of these communities.

Creation of a new MWRA Interconnection for Foxborough is beyond the scope of what would be required for Minimization. However, Foxborough will also likely face Mitigation requirements at least in the Ten Mile Basin and possibly in the Neponset Basin and will likely need to demonstrate that it has no feasible alternative sources with less environmental impact. To assist Foxborough with that analysis, the volume of water needed to reduce Foxborough's share of depletion in all its Sub-basins to GWC 4 or 3 on a seasonal basis was calculated, and a preliminary estimate of the cost of importing this volume from the MWRA was prepared, as summarized in the table below.

Goal	**MGY**	**$/yr**	**$/yr/ connection**
Restore GWC4 for all Sub-basins seasonally	137	541,470	98.25
Restore GWC3 for all Sub-basins seasonally	202	739,720	134.23

4.3.3.4 Foxborough Surface Water Releases

The only large body of water in Foxborough which could potentially provide significant Minimization through Surface Water Releases is the Neponset Reservoir. The Reservoir was developed more than 100 years ago by downstream industries on the Neponset River as a way to augment in-stream flows that were ultimately diverted from the river into factories in Walpole and other communities. Until very recently (<10 years) the successors of those industries continued to manage the Neponset Reservoir in this manner, to the benefit of downstream flow levels on the Neponset. More recently, ownership of the Neponset Reservoir has been transferred to the Town of Foxborough and the dam has been rebuilt. As mentioned above the Reservoir faces many competing demands in terms of water releases including maintenance of water levels for recreation, the desire by some constituencies for seasonal water releases in an effort to redistribute high concentrations of industrial phosphorous accumulation out of the Reservoir, ongoing water supply operations, and continued downstream industrial uses. It is unknown whether Foxborough has adopted a formal water release program for the Neponset Reservoir and what the implications of that program are for Minimization of water supply impacts downstream. However, if such a program does not exist, or does not take into consideration downstream baseflow issues, it would likely be worth addressing these issues.

4.3.4 Medfield Water Department Discussion and Recommendations

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.4.1 Optimization for the Medfield Water Department<u>***Medfield Priority Sub-Basins***</u>

Medfield straddles the Charles and Neponset Basins. It has no sources in BC 1-3 areas, but in the Neponset Basin, the Mill-Mine Brook Sub-basin (21016) includes a CFR. Only the headwaters of this system, in the area known at Tubwreck Brook, which is upstream of Medfield's sources, is still listed as a cold water fishery but past assessments by MassDEP have indicated that cold water species were formerly found throughout this system. The Mill-Mine Sub-basin is in GWC 5 with GW Depletion of 101% and Net Depletion of 84%. Intermittent stream gauging conducted by USGS has also indicates that this stream experiences extended periods of zero flow during dry weather.

Medfield also has sources along the Charles River main stem. These include the Charles River to Vine Brook Sub-basin (21127) which is GWC 5 with 56% GW Depletion. However this Sub-basin has large surface and groundwater returns such that the Net Depletion in the Sub-basin is negative 2% (i.e. surcharged). Medfield has an additional source in the Charles River to Indian Brook Sub-basin (21116) which is GWC 4 with 52% GW Depletion and 6% Net Depletion.

Reportedly, Medfield has recently acquired the Medfield State Hospital well site located in the Mill Brook Sub-basin (21125) which is a GWC 2 with 4% GW Depletion, but is surcharged with a Net Depletion of negative 14%.

Based on the above, the primary Optimization goal for Medfield is to reduce its use of the Mill-Mine Brook Sub-basin in order to protect or restore CFR resources. For the reasons discussed further below, it is recommended that seasonal pumping of these sources be reduced by 100% which amounts to a reduction of 0.4 to 0.6 MGD.

In addition, it is recommended that Medfield take steps to reduce its impacts to its Charles River sources and minimize increases in pumping at the State Hospital site.

<u>Medfield Surface Supplies</u>
All of the existing public water supply sources in Medfield are groundwater sources and thus there are no surface storage Optimization opportunities.

<u>Medfield Sub-Basins With Higher Base Flows</u>
The Mill Brook Sub-basin (21125, State Hospital) is a small headwater Sub-basin with natural August flows of just over 0.5 MGD, Medfield's smallest. The Mill-Mine Brook Sub-basin has the next lowest base flows at 1.5 MGD.

Base flows for the two Charles River Sub-basins along the main stem are considerably higher, at 19.9 and 27.3 MGD respectively. The wells in the more upstream of these two Sub-basins (Charles to Vine Brook 21127) are located a short distance upstream of the surface water discharge associated with the Medfield WWTP. Conditions in this upper Sub-basin could be improved by shifting as much pumping as possible to the lower Sub-basin (Charles to Indian Brook 21116). This change would not increase depletion of the downstream Sub-basin and would take maximum advantage of wastewater return flows. It appears that more than 100% of the recent pumping volumes at the upstream sources could be shifted to the downstream Sub-basin within the daily pumping limit of the downstream source. However, no information was available on the feasibility of implementing such a change from a pumping and treatment capacity standpoint.

Among its Charles River sources, Medfield also appears to have adequate daily pumping limits to allow for shifting 100% of its Mill-Mine Brook pumping to its Charles sources. During the SWMI base period, this amounted to 0.6 MGD, though recent pumping has been somewhat less. Assuming pumping were increased at the more upstream Charles Sub-basin (21127) this would amount to an additional withdrawal of only 3% of Unaffected August median flow for the donor Sub-basin, but the restoration of 40% of Unaffected August median for the recipient.

Taking into account the wastewater returns in the Charles Sub-basin, the donor would end up at a Net Depletion of 1%.

However, it appears that Medfield's recent pumping of its Charles River sources (at least during August, though perhaps not on an annual daily average which is what ultimately matters for Mitigation requirements) already exceeds its Charles Basin Baseline, and thus Mitigation may be required. Increasing use of the Charles River sources further in order to better protect the potential CFR in Mill-Mine Brook would increase the amount of required mitigation.

Lastly, this recommendation for Medfield should also be considered in light of the recommendation that DWWD increase pumping on the Charles. If one must choose between shifting pumping in Medfield and shifting pumping in DWWD, the higher priority is to make the change in Medfield. This is because the opportunity to protect or restore the potential CFR on Mill-Mine Brook is uniquely valuable. It is also notable that because Mill-Mine is a child of the Sub-basin where DWWD's withdrawals occur, the reduction in the Mill-Mine system will also benefit the sub-basin where DWWD's withdrawals occur (though the reduction will not be part of DWWD's "fair share" as discussed above).

<u>Medfield Sub-Basins With Remaining GWC Capacity Or Wastewater Returns</u>
As discussed above, Medfield's two Sub-basins along the Charles River main stem receive large wastewater returns which could be used to relieve pressure on the Mill-Mine Sub-basin.

The small Mill Brook Sub-basin which includes the Medfield State Hospital Well is surcharged. However, the additional volume available in this Sub-basin without Backsliding, even when wastewater returns are included, is very small. Thus it is recommended that Medfield avoid using the State Hospital Well to any significant degree as part of its normal operations.

<u>Medfield Stream Connectivity</u>
Comparing Well 3 and Well 4 on Mill-Mine Brook, Well 3 is almost four times further from the stream and should be used preferentially when choosing between the two during the summer months.

Of the Charles main stem sources, Well 1 is approximately five times further from the river than either of the two other sources, and should be used preferentially on a seasonal basis, subject to the discussion above regarding the desirability of shifting pumping to a point downstream of the wastewater discharge point. Conversely the use of Well 2 should be minimized in the summer when choosing among these three sources.

<u>Medfield Summary Of Opportunities</u>
Based on the above Medfield should consider the following:

- Shift pumping downstream from Wells 1 and 2 toward Well 6 on the Charles main stem.
- Shift pumping away from the Mill-Mine Brook wells at least in the summer months with the goal of reducing seasonal pumping of Mill Mine by 100%.
- During the summer months, utilize Well 1 rather than Well 2 on the Charles main stem.

- Also during the summer months, if the Mill-Mine Brook sources must be used at all, use Well 3 rather than 4.
- Avoid using the State Hospital well as much as possible.

Medfield Discussion Of Constraints

Because Medfield declined to participate in the project, there is little information available regarding the constraints which may apply to the recommendations laid out above. The known constraints are discussed above.

4.3.4.2 Medfield Water Department Alternative Sources

Medfield hypothetically has access to five additional Sub-basins in which it does not presently have sources. All five of these could potentially provide more than 0.1 MGD to relieve more highly depleted Sub-basins.

One of these, the Mill Brook Sub-basin (21125) contains the Medfield State Hospital site which was recently acquired by the Town of Medfield and which is discussed above under Optimization.

The other four Sub-basins are upstream children of one or more of the Sub-basins containing Medfield's existing sources along the Charles River. As such, there would be no net benefit to developing sources in these areas in an attempt to offset demand from the existing sources downstream unless those sources could be located further from the stream than Medfield's existing sources. However, such an analysis is beyond the scope of this review.

Medfield Summary Of Alternative Source Recommendations

Based on the discussion above, Medfield has no opportunities to reduce the impact of existing supplies through the development of Alternative Sources within town boundaries.

4.3.4.3 Medfield Water Department Regional Interconnections

Medfield has no existing Interconnections with other communities, though they do have established hydrant to hydrant Interconnections with Millis and Norfolk. The Sub-basins where Millis and Norfolk have their sources are all in the Charles River Basin, are generally upstream of Medfield's sources on the Charles, and are all in GWC 5.

While not interconnected, Medfield appears to have 8"-12" lines in four locations near their boundary with Walpole in areas where Walpole has similarly sized lines in close proximity. One of these is within one mile of an interconnection between the Walpole and DWWD systems. As discussed previously, neither Walpole nor DWWD has existing or potential local supplies that could be used to provide relief to depleted Sub-basins in Medfield. However, DWWD, is interconnected with the MWRA system, and establishing a new connection to the MWRA may be feasible in the context of mitigating volumes in excess of Baseline.

Based on Medfield's lack of short term Interconnection options available to assist with Minimization, a table of volumes and costs has not been presented. However a spreadsheet is included in the Appendix in the event that Medfield needs to evaluate Mitigation options. As detailed in this spreadsheet, the cost to import enough water from the MWRA to restore

Medfield's share of depletion for all its sources to GWC 3 on a seasonal basis is approximately $100 per account per year.

4.3.4.4 Medfield Surface Water Releases

Medfield has no large surface water bodies that could potentially be useful in augmenting downstream water levels on a seasonal basis.

4.3.5 Sharon Water Department Discussion and Recommendations

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.5.1 Optimization for the Sharon Water Department

<u>Sharon Priority Sub-Basins</u>

Sharon sits at the headwaters of two major basins—the Neponset and Taunton—and has sources in each. Sharon has sources in two Sub-basins which contain CFR resources.

The first of these CFRs is the Rumford River Sub-basin (24103) in the Taunton River Watershed. Foxborough also has sources in this Sub-basin and, as is the case with Foxborough, Sharon's sources appear to be hydrologically "downstream" of the CFR tributary. This Sub-basin is a GWC 5 with GW Depletion of 81% and Net Depletion of 59%.

The other Sub-basin which contains a CFR is the Beaver Brook Sub-basin (21154). This CFR is listed on the Mass DFG website, but is not included on the MassDEP SWMI Interactive Map. The authors understand that the CFR designated area is upstream of Sharon's sources in the Sub-basin. However, past studies by MassDEP have indicated that high quality habitat also exists downstream and suggest that a CFR would likely also exist downstream but for the presence of the water withdrawals. This Sub-basin is a GWC 5 with 204% GW Depletion and Net Depletion of 178%.

Sharon's only other sources are located in the Upper Canoe River Sub-basin (24104). This Sub-basin does not include CFR resources and is GWC 5 with 81% GW Depletion and Net Depletion of 63%.

None of Sharon's sources are located in BC 1-3 Sub-basins.

The overall objective of Optimization in Sharon would be to reduce the very high Net Depletion levels in all of its Sub-basins, particularly including the Beaver Brook Sub-basin.

<u>Sharon Surface Supplies</u>

All of the existing public water supply sources in Sharon are groundwater sources and thus there are no surface storage Optimization opportunities.

<u>Sharon Sub-Basins with Higher Base Flows</u>

The smallest Unaffected August flows in the three Sub-basins in which Sharon's sources are located are found in the Beaver Brook Sub-basin (21154). The highest Unaffected August flows are found in the Rumford River Sub-basin (24103), with the Upper Canoe River (24104) coming in slightly lower. However, these are all headwater streams with low natural base flows ranging from just 0.5 MGD to 1.6 MGD. Given these uniformly low base flows, and high depletion levels, Sharon has no meaningful opportunities for Optimization based on Sub-basins with higher base flows.

Sharon Sub-Basins with Remaining GWC Capacity or Wastewater Returns

All of the Sub-basins in which Sharon has existing sources have very high GW Depletion levels ranging from 81% to 204%. Net depletion levels, which integrate wastewater returns, are also similarly high, ranging from 59% to 178%. As a result, Sharon has no opportunities for Optimization based on remaining GWC capacity or wastewater returns.

Sharon Stream Connectivity

All of Sharon's sources are located at or near the headwaters of their respective Sub-basins and close to a stream, generally within 150' and in some cases within 50'. The exceptions are Well #3 in the Beaver Brook Sub-basin which is almost 300' from the stream. However Well #3 is also located closest to the section of stream in this Sub-basin which is designated as a CFR, and thus the option of relying more heavily of Well #3 during the summer months is not very appealing. The other relatively distant well is #5 which is 430' removed from its stream in the Upper Canoe River Sub-basin (24103). When choosing between Wells #5 and #7 in the Upper Canoe River Sub-basin, it would make sense to rely more heavily on #5 during the summer months. Well 4 in the Beaver Brook Sub-basin is set the closest to the stream at 46' but is also twice as deep as any of Sharon's other sources at 85'. This may indicate that Well #4 is less closely connected to the stream than it would first appear.

Sharon Summary of Opportunities

Based on the above Sharon should consider the following:

- Sharon has no meaningful Optimization opportunities
- When choosing between Wells #5 and #7, rely more heavily on #5

Sharon Discussion of Constraints

The primary constraint on Sharon's ability to optimize the use of its existing sources is Sharon's lack of sources in Sub-basins with substantial natural August base flows. Sharon's current lack to treatment capacity (beyond basic chlorination) also limits Sharon's ability to shift pumping among sources because of high levels of iron and manganese found in some sources. It was not possible to interview Sharon regarding the status of its individual sources, but it appears that Sharon's current pumping patterns are a function of drinking water quality constraints. However, even if these constraints were lifted through the addition of more advanced water treatment capacity, it would not open up further Optimization opportunities.

4.3.5.2 Sharon Water Department Alternative Sources

Sharon hypothetically has access to eight additional Sub-basins in which it does not presently have sources. Only three of these could potentially provide more than 0.1 MGD to relieve more highly depleted Sub-basins.

The largest of these is the Neponset River to East Branch Confluence Sub-basin (21017) which is categorized as GWC 5. The Net Depletion Category for this Sub-basin is 4, and the Net Backslide Volume is approximately 0.4 MGD. Sharon has already given some consideration to development of a new source in this area which would give Sharon access to the larger aquifers and higher natural base flows of the Fowl Meadow area. Normally an increase in withdrawals from such a depleted Sub-basin would not be recommended, and it is notable that Canton has already very substantially increased withdrawals from this Sub-basin since the SWMI Base period and these additional impacts are not reflected in the figures above. Nonetheless, Sharon's Beaver Brook Sub-basin (21154) is even more severely depleted than the Neponset River to East Branch (21017). In addition the Beaver Brook Sub-basin contains existing and potential CFR's which could be protected or potentially restored with a substantial reduction in pumping in Beaver Brook. The Neponset to East Branch Sub-basin and the Beaver Brook Sub-basin are hyrdologically unrelated, so a shift from one to the other would result in an increase in the depletion level of the donor Sub-basin. However these two share several downstream parents, which would experience no net increase in depletion as a result of such a shift.

Lastly, the Neponset River to East Branch (21017) Sub-basin has significantly higher Unaffected August flows than Beaver Brook (8.8 MGD vs 0.5 MGD). In an extreme scenario where Sharon transferred 100% of its Beaver Brook pumping to a new source in 21017, Beaver Brook would experience a 204% reduction in GW Depletion while the downstream basin would experience only an 11% increase in GW Depletion. Although it may not be feasible to shift Sharon's Beaver Brook withdrawals so dramatically, the development of a new source in Sub-basin 21017 that could be used to relieve Beaver Brook would be quite desirable from a minimization perspective. Also because both sources are in the Neponset Major Basin, such a shift could be undertaken without any further Mitigation requirement.

The two other potential Sub-basins in Sharon are the Neponset River to Traphole Brook (21140) and Poquanticut Brook (24017). Both of these are geographically isolated and their development potential is further limited by the presence of extensive wetlands or state park ownership which would be a hindrance to infrastructure access.

<u>Sharon Summary of Alternative Source Recommendations</u>

Based on the discussion above, Sharon should consider pursuing an alternate supply in the Neponset River to East Branch Confluence Sub-basin (21017).

4.3.5.3 Sharon Water Department Regional Interconnections

Sharon reportedly has two existing Interconnections with Foxborough and one with Canton, although the Canton connection has not actually been utilized for many years. In addition there are numerous locations where Walpole, Norwood and Stoughton have lines in close proximity to lines in Sharon.

As discussed above, given their existing high levels of depletion, local sources in Foxborough and Canton do not have the capacity to provide relief for depleted Sub-basins in Sharon. Canton also has access to MWRA water, though Sharon's existing interconnection with Canton may require renovation before it could be put into service. It is unclear whether MassDEP would consider the Canton connection to be an "existing interconnection" for purposes of Minimization or not.

If Sharon requests a withdrawal volume over Baseline, it would likely also need to evaluate potential Interconnections in the context of Mitigation. While potential exists to establish new Interconnections with Walpole, Norwood or Stoughton, the local sources in these communities will be unable provide relief to Sub-basins in Sharon given the high levels of depletion in these potential donor communities. Norwood and Stoughton however offer additional options for connecting with the MWRA system in addition to the existing connection to Canton. Sharon has already discussed the possibility of establishing an emergency connection to the MWRA system through Norwood.

In the context of Mitigation, Sharon, like Foxborough, may have opportunities to consider importing water from further south in the Taunton River Watershed or from the Taunton River Desalination plant. However given the length of supply mains needed to access these potential sources, and the proximity of the MWRA supply, these options are unlikely to be desirable.

Thus, a connection to the MWRA would appear to be the most attractive and feasible Interconnection option for Sharon. The approximate cost of using MWRA water for several scenarios is estimated below. These figures include a large pump station, permitting, MWRA admission fees, and MWRA usage fees as detailed in the spreadsheet in the Appendix.

Goal	Required MGY	$/yr	$/yr/ connection
Vol to restore GWC4 for all sources seasonally	92	349,681	61.14
Vol to restore GWC3 for all sources seasonally	129	462,531	80.88

4.3.5.4 Sharon Surface Water Releases

The only body of water which could potentially provide meaningful water releases in Sharon is Lake Massapoag, which is owned by the Town. Releases from Lake Massapoag would not directly benefit depletion in the Beaver Brook Sub-basin because, hydrologically speaking, the lake is downstream of Sharon's Beaver Brook sources. Such releases would, however benefit the Sub-basins further downstream that are impacted by the Beaver Brook withdrawals. There reportedly is an existing program of water releases at Lake Massapoag which are designed with the goal of enhancing in-lake water quality. These water releases, although under the Town's control generally, are not under the direct control of the Sharon Water Department. The details of the existing water release program were not available for review. It would likely be worthwhile to evaluate this water release program to see what if any benefit it provides for the goal of Minimizing downstream flow impacts, and to what extent it could be adapted to further enhance such benefits.

4.3.6 Stoughton Public Works Water Division Discussion and Recommendations

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.6.1 Optimization for Stoughton Water Division

<u>Stoughton Priority Sub-Basins</u>

Stoughton straddles the Neponset and Taunton basins and has sources in each.

In the Neponset, Stoughton has sources in the Steep Hill Brook Sub-basin (21152). This Sub-basin is a GWC 5, with GW Depletion of 93% and Net Depletion of 69%.

In the Taunton, the Dorchester Coweeset Brook Sub-basin (24008) is a GWC 3 with GW Depletion of 15% and Net Depletion of negative 3% (i.e. surcharged). Finally the Queset Brook Sub-basin (24009) is GWC 5 with 1.34% GW Depletion and Net Depletion of 112%.

There are no CFR's or BC 1-3 Sub-basins anywhere within the town of Stoughton.

The goal of Optimization in Stoughton should be to reduce depletion levels in the Queset Brook Sub-basin, and to a lesser degree in the Steep Hill Brook Sub-basin.

Stoughton Surface Supplies

All of the existing public water supply sources in Stoughton are groundwater sources and thus there are no surface storage Optimization opportunities.

Stoughton Sub-Basins with Higher Base Flows

All of Stoughton's sources are located in similarly sized, headwater Sub-basins with limited August natural base flows ranging from 1.2 to 1.8 MGD. As a result Stoughton has no Optimization opportunities based on Sub-basins with higher base flows.

Stoughton Sub-Basins with Remaining GWC Capacity or Wastewater Returns

Stoughton has one Sub-basin with remaining GWC capacity, that being the Dorchester Coweeset Brook Sub-basin (24008) which has a single source, the Goddard Well. This Sub-basin is also surcharged with wastewater, giving it a Net Depletion of negative 3%. Following the default rule of thumb, additional withdrawals would be recommended in this Sub-basin to a level which would bring it back to a Net Depletion level of 0%. However, this would make only 0.04 MGD available for Optimization use.

Given the severity of the depletion levels in the Queset Brook Sub-basin (24009), and the fact that these two Sub-basins flow into the same parent, thus producing no additional impact downstream, it is recommended that Stoughton consider increasing pumping in this Sub-basin by a volume equal to the limit of GWC 3 (i.e. 25% GW Depletion) plus the wastewater returns to the Sub-basin. All-together, this would make an additional 0.33 MGD available to relieve Queset Brook. A withdrawal at this level would maintain Coweeset Brook at Net Depletion level 3 and restore 18% of Queset Brook's natural August flow leaving it with a Net Depletion of 94%. Unfortunately, the Goddard Well cannot accommodate this level of total pumping (approximately 0.47 MGD) within its current daily limit (0.187 MGD). Thus it is recommended that Stoughton do what it can to maximize the use of the Goddard Well and use that volume to relieve the Queset Brook Sub-basin. According to staff, the Goddard Well is currently being impacted by plugging with iron and is scheduled for cleaning.

Stoughton Stream Connectivity

Most of Stoughton's wells are quite close to a stream, generally less than 100'. The three exceptions are the Harris Pond Gravel Packed Well, the Fennel GP Well and Fennel 3A Well.

Within the Queset Brook Sub-basin (24009) it is recommended that Stoughton rest the two Fennel Wells in the winter and spring and maximize their use in the summer relative to other sources in this Sub-basin.

In the Steep Hill Brook Sub-basin (21152) the Harris Pond GP Well is almost five times further from a water body that the other sources in this Sub-basin. In addition Harris Pond GP has the benefit of being next to the pond. Although this is not true for all ponds, in this case the configuration of the pond and the surface storage it provides will help to further limit the impact of the well on streamflows downstream. It is notable however that the pond is extremely shallow and in some respects resembles an emergent marsh rather than a pond, which has been raised as an aesthetic concern by some abutters. Nonetheless it is recommended that Stoughton rest the Harris Pond DP Well in the winter and spring, and then maximize its use in the summer, while resting other sources in this Sub-basin as much as possible during the summer.

Stoughton Summary of Opportunities

Based on the above Stoughton should consider the following:

- Increase pumping of sources in the Coweeset Brook Subbasin (24008, Goddard Well) as much as possible during the summer months and use this additional water to relieve sources in the Queset Brook Sub-basin (24009).
- In the Queset Brook Sub-basin (24009), maximize the use of the two Fennel Wells and minimize the use of other sources in this Sub-basin during the summer.
- In the steep Hill Brook Sub-basin (21152), maximize the use of the Harris Pond GP Well and minimize the use of the other sources in this Sub-basin during the summer.

Stoughton Discussion of Constraints

Overall Stoughton's opportunities to minimize environmental impacts are quite limited. The main constraint to implementing the recommendations above is the low daily pumping limit of the Goddard Well.

4.3.6.2 Stoughton PWD Water Division Alternative Sources

Stoughton hypothetically has access to six additional Sub-basins in which it does not presently have sources. Only three of these could potentially provide more than 0.1 MGD to relieve more highly depleted Sub-basins.

The largest of these is the Salsbury and Beaver Brook Sub-basin (24007) which is a GWC 2 with modest wastewater returns making for a Net Backslide Volume of 0.25 MGD. However, this does not reflect the effects of a good sized surface water withdrawal in the Sub-basin. Also there is no high yield aquifer material indicated in the Sub-basin, and the downstream parent Sub-basin is extremely surcharged, calling into question the wisdom of diverting additional clean base flows from this system.

The Poquanticut Brook Sub-basin (24017) is located in the far corner of the town and does include a small area of medium yield aquifer material. However the Backsliding volume is very small here and even the Net Backslide Volume is modest at 0.19 MGD. Nonetheless this area may be worth further consideration.

The Pequit Brook to East Branch Sub-basin (21144) has a modest net Backsliding volume available (0.13 MGD) and includes an area of high yield aquifer material. However, given the intensive existing development in this area it seems unlikely that it would be feasible to develop a new source here.

Stoughton Summary of Alternative Source Recommendations
Based on the discussion it appears that Stoughton has no compelling potential Alternative Sources to explore.

4.3.6.3 Stoughton Water Department Regional Interconnections
The Town of Stoughton is already a partial member of the MWRA system as of 2002. Stoughton has IBTA approval to withdraw up to 2.5 MGD from the MWRA system, though to date Stoughton has only joined the MWRA (i.e. paid the admission fee) for 1.15 MGD. Given, its connection to the MWRA, it is not recommended that Stoughton consider Interconnections with any other systems for Minimization under SWMI.

In 2009 Stoughton made minimal use of its MWRA connection, but from 2010 through 2012 its use was quite consistent from year to year ranging from 0.59 to 0.63 MGD on an annual basis. It is also notable that Stoughton’s use of MWRA water occurs year round, increasing by roughly 20-30% in the summer months. The table below summarizes the volume of water needed during the summer to reduce pumping of all Stoughton’s sources to GWC 3 or 4 for a 90 day period and the estimated cost of doing so.

Cost to achieve volume goal	**Required MGY**	**$/yr**	**$/yr/ connection**
Vol to restore GWC4 for all sources seasonally	89	222,500	25.98
Vol to restore GWC3 for all sources seasonally	140	350,000	40.86

Stoughton is in the process of renovating many of its local sources with the goal of increasing the volume of water that can be obtained. Once that process is complete, Stoughton could potentially adopt a strategy of increasing pumping of its local sources in the winter and spring months to reduce the volume it takes from the MWRA during those seasons, and then cutting back pumping of local sources and increasing withdrawals from the MWRA during the low streamflow season. This approach could allow Stoughton to minimize its streamflow impacts in the summer while simultaneously reducing the amount of water it takes from the MWRA system on an annual basis, thus minimizing overall costs.

It is also notable that the estimates of the volumes required to restore GWC 3 and 4 conditions is based on estimated pumping levels from the 2000-2004 period. In practice, it appears Stoughton has reduced its overall local source pumping levels since joining the MWRA system. As such it is recommended that stream depletion levels be reevaluated based on both current and forward looking pumping which may indicate that less water than indicated above is required to meet these Minimization goals.

4.3.6.4 Stoughton Surface Water Releases
There are no bodies of water in Stoughton of sufficient size to allow for Surface Water Releases that would be meaningful for Minimization purposes.

4.3.7 Walpole Water Department Discussion and Recommendations

In order to make it easier to follow the discussion below, readers may wish to review the map of Sub-basins and/or the various Data Reports all of which are included in the Appendix.

4.3.7.1 Optimization for the Walpole Water Department

Walpole Priority Sub-Basins

Walpole has numerous sources, however all of them are located in two relatively small headwater Sub-basins in the Neponset River Basin.

There are no BC 1-3 areas in the Town of Walpole. The Mill-Mine Brook Sub-basin (21016) includes a CFR. Only the headwaters of this system, in the area known as Tubwreck Brook (which is well upstream of Walpole's sources) is still listed as a cold water fishery, but past assessments by MassDEP have indicated that cold water species were formerly found throughout this system and could potentially be restored. The Mill-Mine Sub-basin is in GWC 5 with GW Depletion of 101% and Net Depletion of 84%. Intermittent stream gauging conducted by USGS indicates that this stream experiences extended periods of zero flow during dry weather.

The Neponset Headwaters Sub-basin (21150) is categorized as GWC 5 with GW Depletion of 144% and Net Depletion of 123%.

Based on the above the priority for Optimization is to reduce Net Depletion in the Mill-Mine Brook Sub-basin (21016) in an effort to better protect potential CFR habitat.

Walpole Surface Supplies

All of the existing public water supply sources in Walpole are groundwater sources and thus there are no surface storage Optimization opportunities.

Walpole Sub-Basins with Higher Base Flows

At 2.3 MGD the Unaffected August base flows in the Neponset Headwaters Sub-basin (21150) are somewhat higher than those in the Mill-Mine Sub-basin, but not by much. Given the level of existing depletion in the Neponset Headwaters Sub-basin, shifting pumping to this Sub-basin is not recommended.

Walpole Sub-Basins with Remaining GWC Capacity or Wastewater Returns

Neither of the Sub-basins where Walpole's sources are located has remaining GWC capacity because both are currently in GWC 5. This situation remains unchanged when wastewater returns are taken into account. Thus Walpole has no Optimization opportunities based on GW capacity and wastewater returns. That said, given the presence of the potential CFR on Mill Mine Brook it is recommended that Walpole favor the Upper Neponset sources to some degree, in spite of their higher level of depletion.

Walpole Stream Connectivity

Walpole is unique among the Neponset Communities in the number of different sources it has in each Sub-basin and there is substantial variation in the distance between each source and its nearest stream, as well as each source's location along the upstream-downstream axis in its Sub-basin.

Most of Walpole's wells have been developed as pairs of replacement wells in relatively close proximity to one another. The pairs generally have a shared daily pumping limit and it is understood that at any given moment only one member of a pair will be in use, and they generally alternate which member of a pair is in use on a two week cycle.

In the Mill Mine Brook Sub-basin (21016) Wells 5 and 5A are three to four times further from the stream (roughly 700') than the other sources which range from roughly 100-200'. Wells 5 and 5A also appear to be slightly deeper than the other wells in this area. It is notable that the area of potentially restorable CFR habitat in this Sub-basin is found upstream of Turner's Pond. Wells 5 and 5A are the only pair located downstream of the pond. Wells 1 and 1A are slightly further from the stream (by 50' to 100') than the other sources in this area, but are also located more or less next to Turner Pond, albeit not downstream of the pond. Thus is the case of Wells 5 and 5A, and to a lesser extent 1 and 1A, the pond will help to buffer the impact of water withdrawals on streamflow levels in the potential CFR areas upstream (though it will do little to buffer impacts downstream of the pond). Thus it is recommended that to the maximum extent feasible, Walpole should rest wells 5, 5A, 1 and 1A during the winter and spring and maximize their use during the summer. At the same time Walpole should rest wells 2, 2A, 3 and 3A during the summer as much as possible. Based on estimated pumping during the SWMI base period and reported August pumping during the 2009-2012 period it appears that Wells 5 and 5A have sufficient reserve capacity within the boundary of their daily pumping limits to accommodate such a strategy and there appears to be no water treatment capacity constraint that would impede such an approach.

Within the Neponset Headwaters Sub-basin (21150), Neponset 1 and 2 at roughly 480', along with Washington 6 at roughly 557' and the South Street Well at 574' are the most removed from their streams, and generally located three to four times further from the stream than the other sources in this Sub-basin. It is notable that some of Walpole's sources in this Sub-basin are along Steep Hill Brook while others are along the Neponset main stem. Steep hill Brook is a smaller tributary, which presumably has lower natural base flows than the Upper Neponset above Steep Hill Brook, but given the sizeable withdrawals by the Town of Foxborough on the Upper Neponset, it seems unlikely that there would be much benefit in favoring pumping on the Neponset wells. In light of the above, Walpole should consider resting Washington 6, Neponset 1 & 2, and the South Street well in the winter and spring and maximizing their use in the summer, while at the same time resting the other sources in this Sub-basin in the summer.

<u>Walpole Summary of Opportunities</u>

Given the limited natural base flows and high levels of depletion in Walpole's Sub-basins with existing supplies, its opportunities for improving existing conditions through Optimization are limited. Nevertheless, the following steps are recommended:

- Favor the Upper Neponset sources to some degree, in spite of their higher level of depletion, in order to protect the potential CFR resource on Mill-Mine Brook.
- Within Mill Mine Brook (21016), during the summer months, maximize the use of Well 5 and 5A, and to a lesser degree, Wells 1 and 1A, while cutting back the use of other sources in this Sub-basin. Reverse this pattern in the winter and spring.

- Within the Neponset Headwaters Sub-basin (21150) maximize the use of Washington 6, Neponset 1 & 2, and the South Street well within this Sub-basin during the summer months while minimizing the use of other sources in this area, and reversing this pattern in the winter and spring.

Walpole Discussion of Constraints

Walpole has an unusual number of sources from which to choose and robust water treatment capacity. The primary constraints on its ability to reduce impacts through Optimization are the low natural base flows and high depletion levels in Walpole existing source Sub-basins.

4.3.7.2 Walpole Water Department Alternative Sources

Walpole hypothetically has access to ten additional Sub-basins in which it does not presently have sources. Only three of these could potentially provide more than 0.1 MGD to relieve more highly depleted Sub-basins.

The largest of these is the Stop River Sub-basin (21134) with is a GWC 4 with significant wastewater returns and has a net Backsliding volume of 0.48 MGD. However there does not appear to be any appropriate aquifer material within the town boundaries.

Next is the Hawes, Germany and Mill Brook Sub-basin (21135) where it would be conceptually possible to develop a surface water supply at Willett Pond, as discussed in greater detail under Alternative Sources for DWWD above. However, this would be substantially more complicated and expensive that other options available to the Town.

Last is the Stop River to Stony Brook Sub-basin (21167) which is in the far corner of the town and appears to have no appropriate aquifer material within the town boundaries.

Walpole Summary of Alternative Source Recommendations

Based on the discussion, it appears that Walpole has no meaningful opportunities for Minimization through the development of Alternative Sources.

4.3.7.3 Walpole Water Department Regional Interconnections

Walpole has an existing interconnection with Foxborough (8” x 6”). However, due to the high existing depletion levels mentioned above, Foxborough’s local sources do not have the capacity to relieve Sub-basins in Walpole.

Walpole also has two existing Interconnections with the Town of Norwood, one of which is non-functional, the other of which is located on Route 1 and is functional (8” x 14”) though seldom used.

There are also numerous additional locations where Walpole has pipes in close proximity to pipes located in the towns of Westwood, Medfield, Norfolk and Sharon, all of which represent potential opportunities for new Interconnections. However, none of these communities has local sources which are able to offer relief to depleted Sub-basins in Walpole.

It appears that MassDEP will expect communities to evaluate at least the use of existing Interconnections in the context of Minimization. However for Walpole to use its existing interconnection with Norwood to draw MWRA water for Minimization purposes on a regular basis, would require Walpole to join the MWRA on at least a limited basis, and it is unclear how MassDEP would handle such a situation in the context of Minimization. In the event that Walpole were to request a withdrawal volume over Baseline, it is likely that they would need to examine the possibility of MWRA water in the context of Mitigation.

Be it for Minimization or Mitigation purposes, if Walpole were to become a partial member of the MWRA system, it is presumed for purposes of discussion that it would cost $200,000 to complete the necessary permitting and that a large booster station would have to be constructed. A detailed evaluation of interconnection infrastructure, system pressures and the like was beyond the scope of this project and thus these factors, along with the potential economic arrangements between the two towns are not reflected below. The table below summarizes the approximate cost for Walpole to import sufficient water from the MWRA during the summer to reduce its share of pumping to a level that would restore GWC or GWC 4 for all of Walpole's sources. The calculations which underlie the table are included in the Appendix.

Goal	**Required MGY**	**$/yr**	**$/yr/ connection**
Vol to restore GWC4 for all sources seasonally	155	541,831	69.01
Vol to restore GWC3 for all sources seasonally	216	727,881	92.70

4.3.7.4 Walpole Surface Water Releases

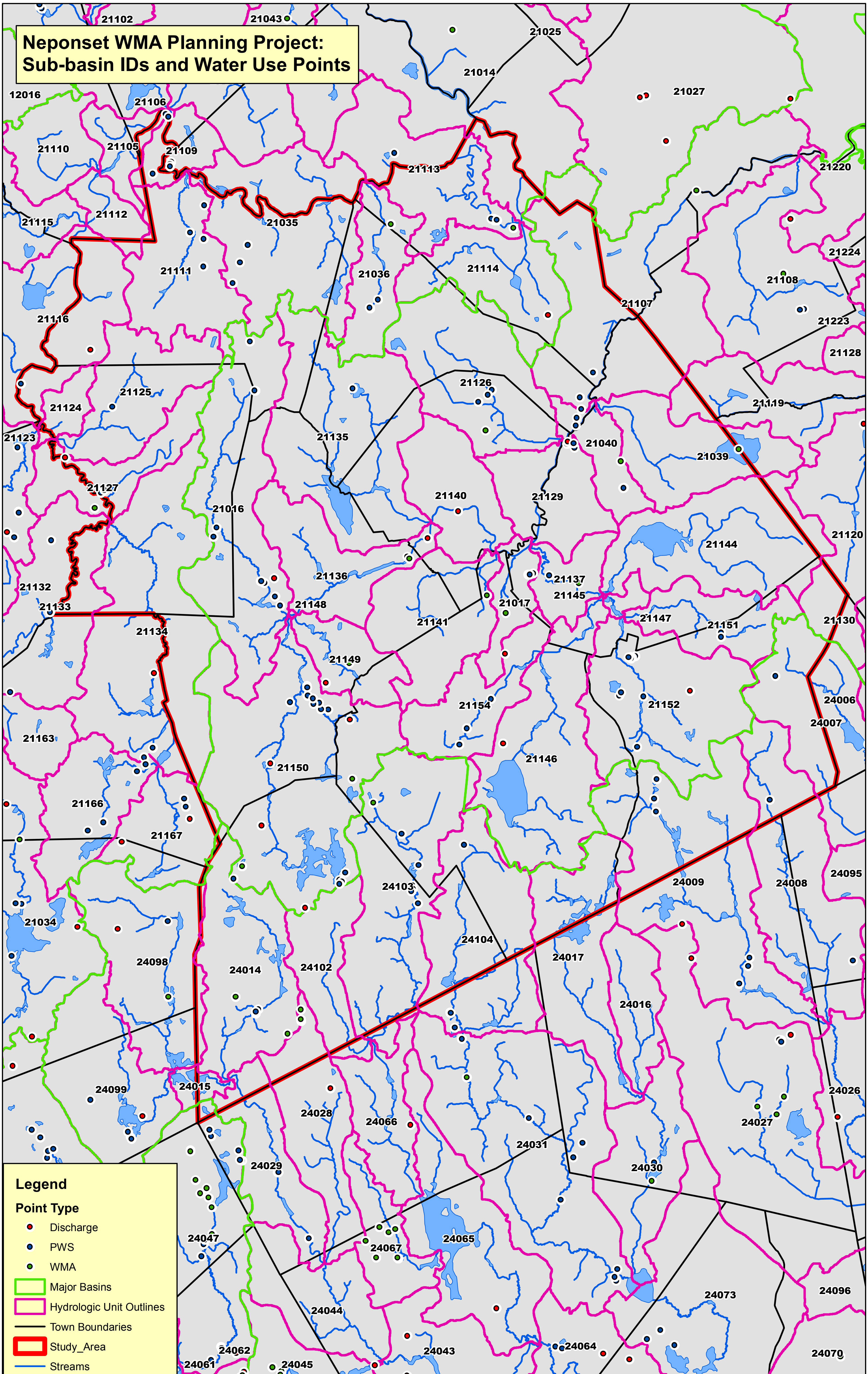
Other than Willett Pond, which is discussed above under DWWD, there are no water bodies in Walpole of sufficient size to allow for significant Minimization through Surface Water Releases.

APPENDIX 8

Summary of Optimization, Alternate Sources, Interconnections and Surface Releases

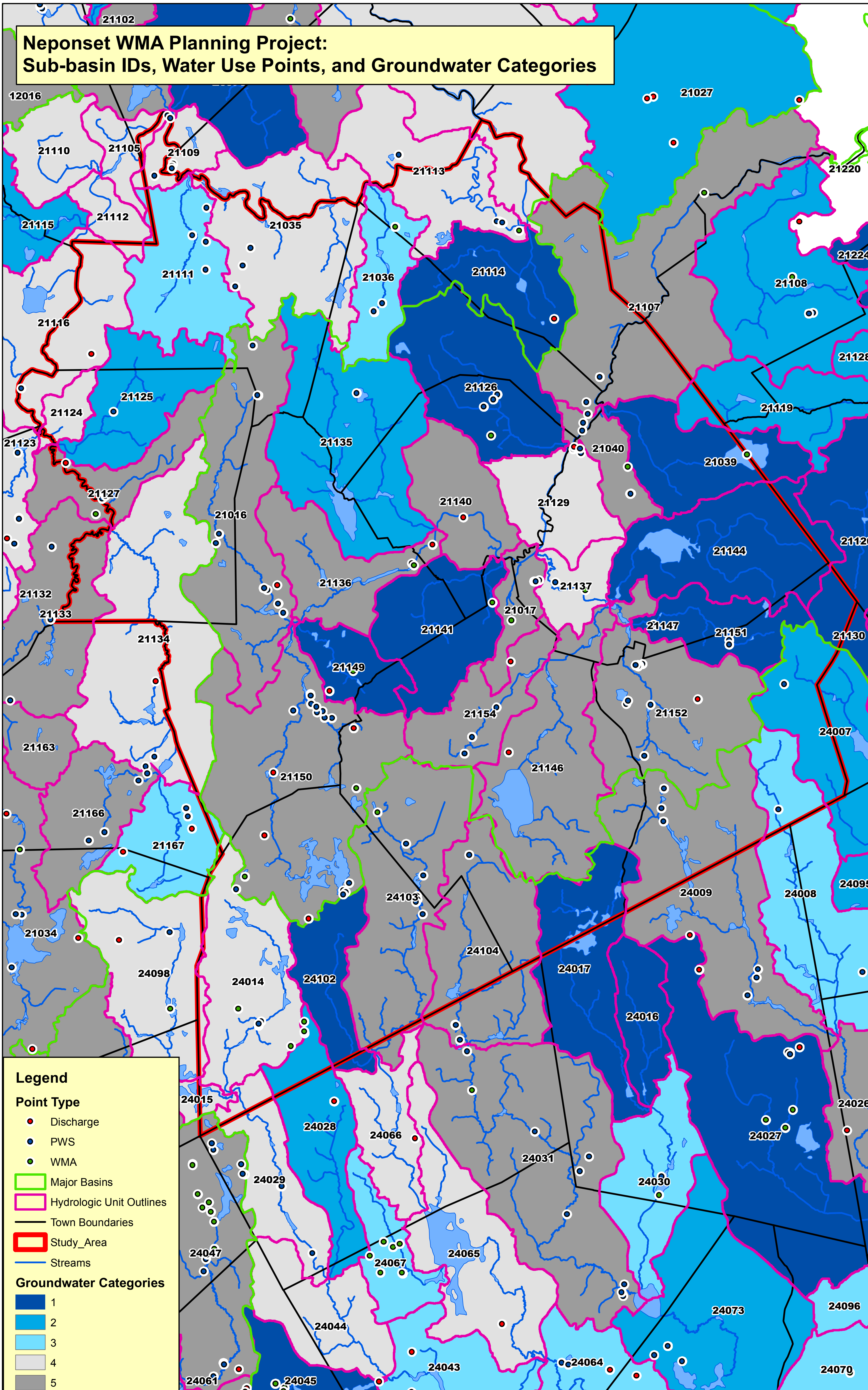
Legend
+ Some significant and potentially feasible opportunities exist
- Some minor and/or marginally feasible opportunities exist
x No potentially feasible opportunities exist

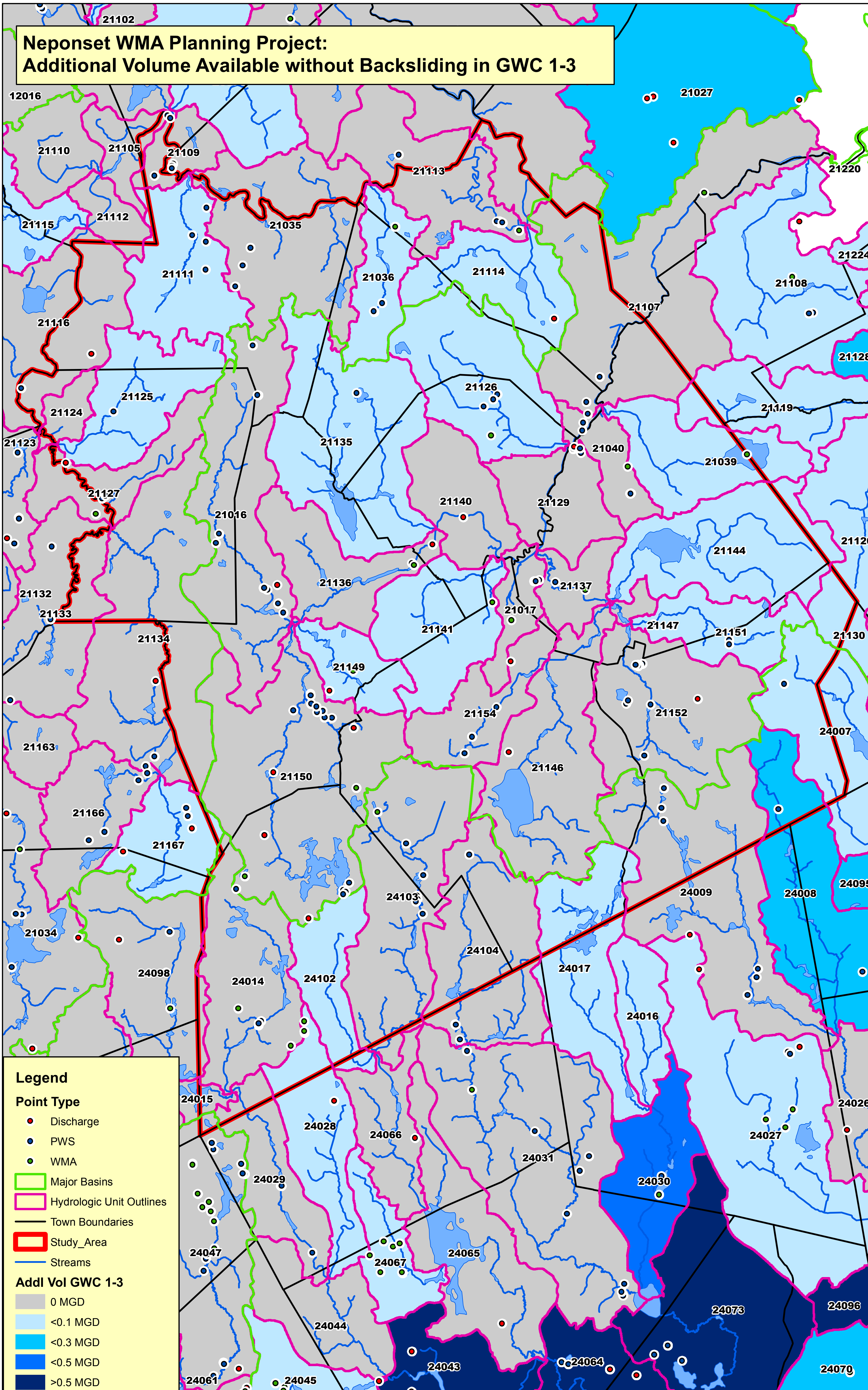
Town	Optimization	Alternative Soures	Inter-Connections
Canton	+	X	+
Dedham-Westwood	+	-	+
Foxborough	-	-	-
Medfield	+	X	-
Sharon	X	+	+
Stoughton	-	X	+
Walpole	-	-	+



Neponset WMA Planning Project:
Sub-basin IDs and Water Use Points
Legend
Point Type
Discharge
PWS
WMA
Major Basins
Hydrologic Unit Outlines
Town Boundaries
Study_Area
Streams
21102
21043
21025
21014
21027
12016
21106
21110
21105
21109
21113
21220
21115
21112
21035
21224
21111
21036
21114
21108
21107
21116
21223
21128
21125
21126
21124
21119
21123
21135
21040
21039
21127
21140
21129
21016
21120
21144
21136
21137
21132
21145
21148
21017
21133
21141
21147
21151
21130
21134
21149
21154
21152
24006
21163
24007
21150
21146
21166
21167
24009
24008
24095
24103
21034
24104
24017
24098
24014
24102
24016
24026
24015
24099
24028
24066
24027
24031
24029
24030
24047
24067
24065
24073
24096
24044
24062
24043
24064
24070
24061
24045

Neponset WMA Planning Project: Sub-basin IDs, Water Use Points, and Groundwater Categories





Neponset WMA Planning Project:
Additional Volume Available without Backsliding in GWC 1-3
Legend
Point Type
Discharge
PWS
WMA
Major Basins
Hydrologic Unit Outlines
Town Boundaries
Study_Area
Streams
Addl Vol GWC 1-3
0 MGD
<0.1 MGD
<0.3 MGD
<0.5 MGD
>0.5 MGD
21102
12016
21027
21110
21105
21109
21113
21220
21115
21112
21035
21111
21036
21114
21224
21108
21107
21116
21128
21125
21126
21124
21119
21123
21135
21040
21039
21127
21140
21129
21016
21144
21120
21136
21137
21132
21133
21017
21141
21147
21151
21130
21134
21149
21154
21152
21163
24007
21150
21146
21166
21167
24103
24009
24008
24095
21034
24104
24017
24098
24014
24102
24016
24015
24026
24028
24066
24027
24031
24030
24029
24047
24067
24065
24073
24096
24044
24043
24064
24070
24061
24045

Neponset Water Management Act Planning Project

Explanation of Chapter 4 Reports and Metrics

Background

As part of the Neponset Water Management Act Planning Project, a variety of data sources were brought together into a single relational database with the goal of creating a report format that could assist a community in performing the evaluation of Optimization and Alternative Sources required as part of a Minimization plan. Two report formats were developed.

The "Optimization Report" presents information on each of the SWMI Sub-basins where a community has local sources, and also juxtaposes selected data for each of the community's withdrawal points in the Hydrologic Unit that corresponds to each Sub-basin. When reviewing this report, it is important to understand the difference between viewing the SWMI Subwatersheds as Sub-basins vs Hydrologic Units (refer to Chapter 1 of the Neponset WMA Planning Project Final report for a discussion of this issue). This report is designed to provide the information needed to perform the Optimization of existing sources analysis presented in Chapter 4. The report is sorted by Sub-basin size from smallest to largest.

The "Alternative Sources" report presents information on each of the SWMI Sub-basins where a community does not have local sources. It presents the same Sub-basin information used for the Optimization report, but for obvious reasons no information on the community's existing local sources is provided. This report is designed to provide the information needed to perform the Alternative Sources analysis presented in Chapter 4. The report is sorted by Sub-basin Net Backslide Volume (explained below) from highest to lowest.

The intention behind the metrics presented in these reports is NOT to establish hard and fast rules for what is and is not considered an optimization opportunity. Rather the goal is to assemble information that will draw the user's attention to Sub-basins that would potentially benefit from reduced withdrawals and those that might have the capacity for increased withdrawals to provide relief to other sub-basins, so that those opportunities can be considered more carefully based on local knowledge of the conditions in both the donor and recipient Sub-basins.

Explanation of Optimization Report Data Fields

Sub-basin Name

A text name assigned to each of the USGS Indicators Sub-basins in the study area to facilitate narrative discussion.

Sub-basin Unique ID

The unique ID number assigned to each Sub-basin by the USGS Indicators Project.

Area SM

The total land area of the Sub-basin (including all upstream HU's) taken from the USGS Indicators Project.

Aug_U MGD

The estimated Unaffected August median flow for the Sub-basin taken from the USGS Indicators Project and converted to MGD. Values were calculated for the whole state.

CFR
Indicates whether a cold water fishery resource exists in the Sub-basin. A value of "1" indicates the presence of a CFR, while "0" or blank indicates no CFR. Values were manually entered for the study area from the MassDEP SWMI Interactive Map and the list of CFRs on the MassDFG website.

BC
The SWMI biological category for the Sub-basin, taken from the "solver" spreadsheet downloaded from the MassDEP SWMI page on May 13, 2013. Values are taken from the "Category" column of the Basin Data tab of the spreadsheet, and were imported for the whole state. Values were imported for the whole state.

GWC
The SWMI Ground Water Category (or Ground Water Level) for the Sub-basin. This was calculated from the "Aug GW Dplt %" field (described below) using the category thresholds described in the SWMI Framework. Values were calculated for the whole state.

Aug GW Dplt %
The August groundwater depletion for the Sub-basin as a percentage, calculated from the USGS Indicators Project. Specifically: estimated August ground water withdrawals plus estimated August private well withdrawals, then divided by estimated August unaffected flow. Values were calculated for the whole state.

Restor GWC3 MGD
The minimum volume of water, in MGD, that would have to NOT be withdrawn from the Sub-basin, in order for it to be a GWC3, as calculated from the USGS Indicators Project. Specifically: the existing August percent depletion minus 25%, then multiplied by the August unaffected flow. If the Sub-basin is GWC 1-3 the value will be "0". Values were calculated for the whole state.

Restor GWC4 MGD
The minimum volume of water, in MGD, that would have to NOT be withdrawn from the Sub-basin, in order for it to be a GWC4 as calculated from the USGS Indicators Project. Specifically: the existing August percent depletion minus 55%, then multiplied by the August unaffected flow. If the Sub-basin is GWC 1-4 the value will be "0". Values were calculated for the whole state.

Aug Net Deplt Cat
The Net Depletion Category for the Sub-basin was calculated from the "Aug Net Dplt %" field (described below) using the same category thresholds described in the SWMI Framework for the SWMI Ground Water Categories. Values were calculated for the whole state.

Aug Net Dplt %
The August Net Depletion for the Sub-basin as a percentage, calculated from the USGS Indicators Project. Specifically: estimated August ground water withdrawals plus estimated August private well withdrawals minus estimated August septic returns minus estimated August

groundwater discharges minus estimated August surface discharges, then divided by estimated August unaffected flow. Positive values indicate the % of Net Depletion, negative values indicate the % of Net Surcharge. Values were calculated for the whole state.

<u>Net Restor 3 MGD</u>
The minimum volume of water, in MGD, that would have to either be NOT be withdrawn or be returned to the Sub-basin, in order for it to be a Net Depletion Category 3 as calculated from the USGS Indicators Project. Specifically: the existing August percent Net Depletion minus 25%, then multiplied by the August unaffected flow. If the Sub-basin is GWC 1-3 or if the Sub-basin in surcharged the value will be “0”. Values were calculated for the whole state.

<u>Restor GWC4 MGD</u>
The minimum volume of water, in MGD, that would have to either be NOT be withdrawn or be returned to the Sub-basin, in order for it to be a Net Depletion Category 4. Specifically: the existing August percent net depletion minus 55%, and then multiplied by the August unaffected flow. If the Sub-basin is GWC 1-3 or if the Sub-basin is surcharged the value will be “0”. Values were calculated for the whole state.

<u>Aug GW Draw MGD</u>
Total estimated August groundwater withdrawals for the Sub-basin, in MGD, calculated from the USGS Indicators Project. Specifically: estimated August permitted withdrawals plus estimated August private well withdrawals. Values were calculated for the whole state.

<u>Aug SW Draw MGD</u>
Total estimated August surface water withdrawals for the Sub-basin, in MGD, as calculated from the USGS Indicators Project. Specifically” estimated August surface discharges. Values were calculated for the whole state.

<u>Aug WW Return MGD</u>
Total estimated August wastewater returns for the Sub-basin, in MGD, as calculated from the USGS Indicators Project. Specifically: estimated August septic returns plus estimated August groundwater discharges plus estimated August surface water discharges. Values were calculated for the whole state.

<u>BS Vol GWC 1-4 MGD</u>
Generally, the additional volume that can be withdrawn from the Sub-basin without causing backsliding. More specifically:

- For GWC 1-3 Sub-basins, the volume of water that can be withdrawn without causing backsliding in MGD calculated from the USGS Indicators Project. Specifically: the August Unaffected flow multiplied by the threshold for the GWC (i.e. for a GWC 3 Sub-basin this would be 0.24999) and then minus estimated August groundwater withdrawals and minus estimated August private well withdrawals.
- For GWC 4 Sub-basins, the value will be the lesser of the backslide volume as indicated above or 5% of Unaffected August flow.
- For GWD 5 the value of this field is zero.
- Values were calculated for the whole state.

Net BS GWC 1-4 MGD

The Net BS metric is similar to the BS metric, but is based on Net Depletion rather than Groundwater Depletion. However because of the potential for adverse water quality impacts, the Net BS metric includes some additional criteria.

- For net surcharged Sub-basins in GWC 1-3, Net BS equals the amount of the surcharge plus the limit of the Sub-basin's GWC threshold. For example, for a GWC 2 Sub-basin that is 6% surcharged, it would be 15.999% of Unaffected August flow (i.e. 6% surcharge + 9.999% GWC threshold).
- For net surcharged Sub-basins in GWC 4-5, Net BS is zero on the assumption that these streams are effluent dominated and can't spare any clean baseflow for water quality reasons.
- For Sub-basins in Net Depletion Category 1-3 which are not surcharged and which have a Net Depletion Category that is the same as the GWC, Net BS is the amount of additional withdrawal that would return the Sub-basin to the upper limit of its current Net Depletion Category. For example for a GWC 3 Sub-Basin with a GW depletion of 23% and a Net Depletion of 12%, the Net BS volume would be 12.999% of Unaffected August Median (i.e. 24.999% threshold minus 12% current Net Depletion).
- For Sub-basins in Net Depletion Category 1-3 which are not surcharged and which have a Net Depletion Category that is lower (i.e. healthier) than the GWC, Net BS is the amount of additional withdrawal that would return the Sub-basin to the upper limit of the next worse Net Depletion Category, but not worse than the original GWC. The concept is to try to preserve some benefit of the wastewater return for the donor basin. For example for a GWC 3 Sub-Basin (GW depletion of 23%) with a Net Depletion Category of 2 (Net Depletion of 5%), the Net BS volume would be 4.999% of Unaffected August Median (i.e. 9.999% threshold of the next worse Net Depletion Category, minus 5% current Net Depletion).
- For Sub-basins in Net Depletion Category 4, Net BS volume is the lesser of the amount that would cause net backsliding or 5% of Unaffected August median flow.
- For Sub-basins in Net Depletion Category 5, Net BS volume is zero.
- Values were calculated for the whole state.

Permittee_Name

The name of the permittee. These were created only for permittees in the study area.

Point Name

The name of the individual withdrawal point. Taken form the SYE Database.

Prog

The permitting program for the point, taken from the SYE Database. Note that the SYE database includes information on both withdrawal and discharge points, although only the withdrawals associated with the permittee of interest are normally displayed on the Optimization Report.

GW/SW

An indicator of whether the point is a groundwater (GW) or surface water (SW) point, taken from the SYE database. Note that only the groundwater points for the permittee if interest are normally shown on the Optimization Report.

00-04 Aug MGD
An estimate of the August volume for the point that was likely used in the USGS Indicators project. These are calculated by averaging the reported annual volumes for each point during the years 2000-2004 as provided in the SYE Database, and then multiplying the annual average use by the USGS seasonal adjustment factor. It is unclear whether the version of the SYE Database available during this project included the same data set of annual volumes that USGS used for its calculations in the Indicators Project. Because we were only able to estimate August flows for PWS sources, we were unable to confirm that our 00-04 Aug MGD estimates tie out to the overall USGS Indicators Project calculations. However they appear to be about right in most cases. In a number of cases we had to manually add additional water use points to the database for the study area that were not included in the SYE Database, and in such cases, this field will be blank.

09-12 Aug MGD
The average of reported August pumping for each source over the period 2009-2012, based on a dataset provided by Richard Friend of MassDEP which he exported from the prototype Water Management Act Database. Note this dataset had no records for a water use points during years in which they were not pumped, so in some cases, these values may reflect an average of less than four data points. These values were calculated for the entire state.

09-12 Ann MGD
The average of reported annual pumping for each source over the period 2009-2012, based on a dataset provided by Richard Friend of MassDEP which he exported from the prototype Water Management Act Database. Note this dataset had no records for a water use points during years in which they were not pumped, so in some cases, these values may reflect an average of less than four data points. Note this field gives a sense of the ratio between annual and August pumping at each water use point, which also gives a general suggestion of the degree to which the estimated August values used under the Indicator Project may have deviated from actual August values. These values were calculated only for the study area.

Day Limit MGD
The zone II daily pumping limit for the water use source taken from the SYE Database. This information is missing for water use points that were manually added. Note that the SYE Database includes some points in the study area which are inactive, as a result a total daily pumping limit for the Sub-basin cannot be calculated.

Distance Ft
The distance between the well and the nearest stream, in feet. Taken from the SYE Database and converted to feet. These values were calculated for the whole state. However, manual review indicated that they are sometimes inaccurate, and thus in some cases they have been manually corrected (or added for new water use points) in the study area.

Depth Ft
The depth of the well in feet as taken from the SYE database. No corrections were made to this data and many areas of the state have no values in the SYE database.

CANTON WATER DEPARTMENT

Optimization Report (Summary of Sub-Basins and Sources)

Beaver Meadow to Steep Hill Confluence (Sub-Basin 21151)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
2.86	0.531	0	5	1	2%	0.000	0.000	0	-10%	0	0	0.010	0.000	0.061	0.006	0.067

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
CANTON WATER	GP WELL # 1 (WASHINGTON ST.)	PWS	G	0.000				46	
CANTON WATER	HENRYS SPRING DUG WELL	WMA/PWS	G	0.000					
CANTON WATER	SPRINGDALE DUG & TUB. WELLS	WMA/PWS	G	0.000					
			Totals	0.000					

East Branch all to NR (Sub-Basin 21137)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
28.67	5.844	0	5	4	41%	0.938	0.000	3	24%	0	0	2.399	0.200	1.018	0.292	0.080

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
CANTON WATER	GP WELL # 7 (NEPONSET ST.)	PWS	G	0.000			0.000	355	
			Totals	0.000					

NR to East Branch Confluence (Sub-Basin 21017)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
43.99	8.795	0	5	5	59%	2.954	0.315	4	45%	2	0	5.152	0.061	1.224	0.000	0.440

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft

CANTON WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

CANTON WATER	GD WELL #10 (FOREST AVE.)	WMA/PWS	G	0.164			0.200	493	45
CANTON WATER	GP WELL # 5 (FOREST AVE.)	WMA/PWS	G	0.029			0.403	310	59
CANTON WATER	GP WELL # 6 (FOREST AVE.)	WMA/PWS	G	0.000				690	
CANTON WATER	GP WELL #13 (Forest Ave)	WMA/PWS	G		0.248	0.136	0.400		
CANTON WATER	GP WELL #16 (Forest Ave)	WMA/PWS	G		0.242	0.113	0.200		
CANTON WATER	GP WELL #9 (Forest Ave)	WMA/PWS	G		0.461	0.230	0.000		
			Totals	0.193	0.951	0.479			

NR to Purgatory Brook Confluence (Sub-Basin 21129)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
75.90	15.926	0	5	4	47%	3.571	0.000	4	33%	1	0	7.552	0.261	2.269	0.796	0.796

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
CANTON WATER	GP WELL # 2 (DEDHAM ST.)	WMA/PWS	G	0.000				870	
CANTON WATER	GP WELL # 3 (DEDHAM ST.)	WMA/PWS	G	0.000				908	
			Totals	0.000					

NR to Ponkapoag Confluence (Sub-Basin 21040)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
83.61	17.528	0	5	5	57%	5.551	0.293	4	43%	3	0	9.933	0.281	2.352	0.000	0.876

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
CANTON WATER	GP WELL # 4 (PECUNIT ST.)	WMA/PWS	G	0.278				200	
CANTON WATER	GP WELL #11 (PECUNIT ST.)	WMA/PWS	G	0.065	0.304	0.237	0.806	139	60
CANTON WATER	GP WELL #12 (PECUNIT ST.)	WMA/PWS	G	0.057			0.000	210	60
CANTON WATER	GP WELL #14 (Pecunit)	WMA/PWS	G		0.197	0.157	0.576		

CANTON WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Totals	0.399	0.501	0.394

Canton Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

NR to Pine Tree Brook Confluence (Sub-Basin 21107)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
100.82	17.579	0	5	5	66%	7.286	2.012	4	52%	5	0	11.681	0.569	2.523	0.000	0.511

EB to Pequit Brook Confluence (Sub-Basin 21145)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
20.40	4.165	0	5	5	57%	1.347	0.098	4	36%	0	0	2.389	0.000	0.900	0.000	0.208

Pequit Brook to East Branch Confluence (Sub-Basin 21144)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.63	1.168	0	5	1	1%	0.000	0.000	0	-8%	0	0	0.010	0.000	0.100	0.025	0.126

Steep Hill and Beaver Meadow to Massapoag Confluence (Sub-Basin 21147)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
10.01	1.994	0	5	5	63%	0.749	0.151	4	43%	0	0	1.248	0.000	0.390	0.000	0.100

Massapoag Brook to Steep Hill Confluence (Sub-Basin 21146)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
10.38	1.989	0	5	5	57%	0.644	0.047	4	32%	0	0	1.141	0.000	0.509	0.000	0.099

Canton Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Ponkapoag to NR confluence (Sub-Basin 21039)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.27	0.733	1	4	1	0%	0.000	0.000	0	-7%	0	0	0.001	0.000	0.051	0.021	0.072

Blue Hill R to Farm R Confluence (Sub-Basin 21119)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.05	0.495	0	4	2	6%	0.000	0.000	2	4%	0	0	0.031	0.000	0.011	0.019	0.029

Steep Hill to Beaver Meadow Confluence (Sub-Basin 21152)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.79	1.327	0	5	5	93%	0.906	0.508	5	69%	1	0	1.238	0.000	0.325	0.000	0.000

Beaver Brook to Massapoag Confluence (Sub-Basin 21154)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
3.14	0.548	1	5	5	204%	0.983	0.819	5	178%	1	1	1.120	0.000	0.142	0.000	0.000

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
21017	Nep	5.152	0.315	2.954		0.193	0.037	0.012	0.111
21040	Nep	9.993	0.293	5.551		0.399	0.040	0.012	0.222
Neponset Max								**0.012**	**0.222**
Alternate Treatment of Pecunit Brook									
21017	Nep	5.152	0.315	2.954		0.193	0.037	n/a	0.111
21040 (alternative estimate)	Nep	n/a	n/a	n/a		0.399	n/a	n/a	0.399
Total Alternate Treatment									**0.510**
Total MGY Standard Approach (over 90 days)								**1.062**	**19.948**
Total MGY Alternate Approach (over 90 days)								**n/a**	**45.869**

Cost of Imported Water	**$/MG**						
Net cost of imported water up to 36.5 MGY	2,500	MWRA usage fees of $3,000, less $500 treatment and electric					
Total number of service connections	6,984						
Goal	**Required MGY**	**$/Yr**	**$/Yr/ Connection**				
Restore GWC4 for all sources seasonally (standard approach)	1	2,500	0.36				
Restore GWC3 for all sources seansonally (standard approach)	20	50,000	7.16				
Restore GWC3 for all sources seasonally (alternative approach)	46	115,000	16.47				

DEDHAM WESTWOOD WATER DISTRICT
Optimization Report (Summary of Sub-Basins and Sources)

Placeholder for Water Purchases (Sub-Basin 0)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
DEDHAM WESTWOOD	Purchase MWRA	PWS	G		0.222	0.061			
DEDHAM WESTWOOD	Purchase MWRA second connection	PWS	G			0.000			
			Totals		0.222	0.061			

Rock Meadow Bk to CR Confluence (Sub-Basin 21036)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
2.68	0.408	0	5	3	24%	0.000	0.000	3	11%	0	0	0.097	0.034	0.053	0.005	0.058

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
DEDHAM WESTWOOD	DOVER ROAD WELL	PWS	G	0.375					
DEDHAM WESTWOOD	ROCK MEADOW TUBULAR WELLS	PWS	G	0.627			0.000	131	
DEDHAM WESTWOOD	ROCK MEADOW WELL # 11	WMA/PWS	G	0.037			0.883	167	
			Totals	1.039					

DEDHAM WESTWOOD WATER DISTRICT
Optimization Report (Summary of Sub-Basins and Sources)

NR to Ponkapoag Confluence (Sub-Basin 21040)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
83.61	17.528	0	5	5	57%	5.551	0.293	4	43%	3	0	9.933	0.281	2.352	0.000	0.876

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
DEDHAM WESTWOOD	WHITE LODGE WELL #2	WMA/PWS	G	0.622	0.538	0.386	0.945	720	71
DEDHAM WESTWOOD	WHITE LODGE WELL #3	WMA/PWS	G	0.370			0.945	207	63
DEDHAM WESTWOOD	White Lodge Well #3A	PWS	G		0.690	0.689	1.440		
DEDHAM WESTWOOD	WHITE LODGE WELL #4	WMA/PWS	G	0.616			0.945	581	72
DEDHAM WESTWOOD	White Lodge Well #4A	PWS	G		0.433	0.427	0.000		
			Totals	1.609	1.661	1.502			

NR to Pine Tree Brook Confluence (Sub-Basin 21107)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
100.82	17.579	0	5	5	66%	7.286	2.012	4	52%	5	0	11.681	0.569	2.523	0.000	0.511

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
DEDHAM WESTWOOD	WHITE LODGE WELL #1	WMA/PWS	G	0.732	0.653	0.450	0.945	663	73
DEDHAM WESTWOOD	WHITE LODGE WELL #5	PWS	G	0.996	0.786	0.760	1.152	870	100
			Totals	1.728	1.439	1.210			

DEDHAM WESTWOOD WATER DISTRICT
Optimization Report (Summary of Sub-Basins and Sources)

CR to Mother Bk Confluence (Sub-Basin 21113)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
194.35	40.318	0	5	4	54%	11.597	0.000	3	21%	0	0	21.677	2.101	13.350	0.498	1.752

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
DEDHAM WESTWOOD	WELL A2	WMA/PWS	G	0.009			1.901	546	
DEDHAM WESTWOOD	WELL B1	WMA/PWS	G	0.214	0.097	0.134	0.000	239	
DEDHAM WESTWOOD	WELL B2	WMA/PWS	G	0.018	0.080	0.045	0.000	200	42
DEDHAM WESTWOOD	WELL D1	WMA/PWS	G	0.295	0.294	0.231	0.000	164	
DEDHAM WESTWOOD	WELL D2	WMA/PWS	G	0.109	0.131	0.132	0.000	164	56
DEDHAM WESTWOOD	WELL E	WMA/PWS	G	0.297	0.015	0.110	0.000	177	
DEDHAM WESTWOOD	WELL E1	WMA/PWS	G	0.109	0.215	0.159	0.000	186	56
DEDHAM WESTWOOD	WELL E2	WMA/PWS	G	0.125	0.302	0.181	0.000	210	56
DEDHAM WESTWOOD	WELL F	WMA/PWS	G	0.398	0.202	0.153	0.000	164	
			Totals	1.573	1.335	1.146			

Dedham Westwood Water District Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

CR to Rock Meadow Bk Confluence (Sub-Basin 21035)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
186.51	38.525	1	5	4	52%	10.262	0.000	3	17%	0	0	19.893	2.067	13.241	1.296	2.979

CR to Rosemary Bk Confluence (Sub-Basin 21014)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
213.05	44.675	0	5	4	49%	10.642	0.000	3	19%	0	0	21.811	2.267	13.474	2.234	2.832

Most of the City of Boston (Sub-Basin 21027)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
23.98	3.325	0	5	2	4%	0.000	0.000	1	1%	0	0	0.120	0.009	0.092	0.213	0.305

Hawes, Germany and Mill to NR Confluence (Sub-Basin 21135)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.68	1.389	1	5	2	3%	0.000	0.000	0	-11%	0	0	0.042	0.000	0.193	0.097	0.289

Purgatory and Plantingfield to NR Confluence (Sub-Basin 21126)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
5.98	0.947	1	5	1	2%	0.000	0.000	0	-6%	0	0	0.016	0.020	0.069	0.012	0.081

Dedham Westwood Water District Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Lowder Bk to CR Confluence (Sub-Basin 21114)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.05	0.689	0	5	1	2%	0.000	0.000	0	-5%	0	0	0.014	0.000	0.045	0.007	0.052

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
21040	Nep	9.933	0.293	5.551		1.609	0.162	0.047	0.899
21207	Nep	11.681	2.012	7.286		3.337	0.286	0.575	2.081
Neponset Max								**0.575**	**2.081**
21113	Chas	21.677	0	11.597		1.573	0.073	0.000	0.842
Charles Max								**0.000**	**0.842**
Total								**0.575**	**2.923**
Total MGY (over 90 days)								**51.730**	**263.069**

Cost of Imported Water	**$/MG**						
Net cost of imported water up to 36.5 MGY	2,500	MWRA usage, less $500 treatment and electric					
Net cost of imported water over 36.5 MGY	3,050	MWRA usage, less $500 treatment and electric, plus $550 admission fee					
MWRA Allocation Available	**MGY**						
Average annual use of MWRA 2009-2012	13.9						
Average un-utilized MWRA allocation	22.6	Equals 0.251 MGD for 90 days or 0.24 MGD over 60 days					
Total number of service connections	13,141						
Goal	**Required Volume MGY**	**$/yr**	**$/yr/ connection**				
Maximize use of existing MWRA allocation	22.6	56,500	4				
Restore GWC4 all sources seasonally	52	145,348	11				
Restore GWC3 all sources seasonally	263	733,453	56				

FOXBOROUGH WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Upper Wading R to Unnamed Trib Confluence (Sub-Basin 24014)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
5.66	1.156	0	5	4	50%	0.289	0.000	4	39%	0	0	0.578	0.030	0.131	0.057	0.058

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
FOXBOROUGH WATER	WELL # 4 PUMPING STATION NO. 2	WMA/PWS	G	0.192	0.122	0.159	0.576	66	45
FOXBOROUGH WATER	WELL # 5 PUMPING STATION NO. 2	WMA/PWS	G	0.192	0.360	0.163	0.576	164	
FOXBOROUGH WATER	WELL # 6 PUMPING STATION NO. 2	WMA/PWS	G	0.192	0.246	0.135	0.576	118	47
			Totals	0.577	0.729	0.456			

Bungay R to Ten Mile R (Sub-Basin 24047)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
7.49	1.553	0	5	5	133%	1.675	1.209	5	77%	1	0	2.063	0.145	0.868	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
FOXBOROUGH WATER	WELL #14 PUMPING STATION NO. 6	WMA/PWS	G		0.010	0.064	0.720		
FOXBOROUGH WATER	WELL #15 PUMPING STATION NO.	WMA/PWS	G		0.147	0.089	0.720		
			Totals		0.157	0.154			

FOXBOROUGH WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Billings Bk and Rumford R to Robinson Bk Confluence (Sub-Basin 24103)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.02	1.572	1	5	5	81%	0.877	0.406	5	59%	1	0	1.270	0.000	0.339	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
FOXBOROUGH WATER	WELL # 9 PUMPING STATION NO. 3	WMA/PWS	G	0.168	0.393	0.246	0.576	33	55
FOXBOROUGH WATER	WELL # 10 PUMPING STATION NO.	WMA/PWS	G	0.154	0.324	0.272	0.720	374	47
FOXBOROUGH WATER	WELL # 7 PUMPING STATION NO. 3	WMA/PWS	G	0.168	0.018	0.001	0.360	210	38
FOXBOROUGH WATER	WELL # 8 PUMPING STATION NO. 3	WMA/PWS	G	0.168		0.000	0.216	610	
			Totals	0.658	0.736	0.519			

NR to Mine Brook Confluence (Sub-Basin 21150)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
11.59	2.290	0	5	5	144%	2.728	2.041	5	123%	2	2	3.301	0.000	0.481	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
FOXBOROUGH WATER	WELL # 1 PUMPING STATION NO.1	WMA/PWS	G	0.219	0.294	0.274	0.576	3231	46
FOXBOROUGH WATER	WELL # 12 PUMPING STATION NO. 4	WMA/PWS	G	0.181	0.145	0.097	0.468	1356	52
FOXBOROUGH WATER	WELL # 13 PUMPING STATION NO. 5	WMA/PWS	G	0.333	0.220	0.192	0.504	2492	58
FOXBOROUGH WATER	WELL # 2A PUMPING STATION NO. 1	WMA/PWS	G	0.219	0.249	0.129	0.504	3431	42
FOXBOROUGH WATER	WELL # 3 PUMPING STATION NO.1	PWS	G	0.000			0.000	3069	
			Totals	0.952	0.908	0.692			

Foxborough Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Wading R to Hodges Bk Confluence (Sub-Basin 24029)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
21.21	4.826	0	5	4	40%	0.709	0.000	4	28%	0	0	1.916	0.978	0.588	0.241	0.241

Stop R to Stony Bk Confluence (Sub-Basin 21167)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
3.13	0.523	0	5	3	23%	0.000	0.000	0	-10%	0	0	0.119	0.000	0.169	0.012	0.181

Hodges Brook to Wading River (Sub-Basin 24028)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.11	0.892	0	5	2	5%	0.000	0.000	0	-5%	0	0	0.048	0.000	0.095	0.042	0.137

Lake Miramichi to Wading R (Sub-Basin 24015)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
12.20	2.694	0	5	4	38%	0.353	0.000	4	26%	0	0	1.026	0.000	0.313	0.135	0.135

Robinson Bk to Rumford R Confluence (Sub-Basin 24102)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
2.80	0.517	0	5	1	0%	0.000	0.000	0	-20%	0	0	0.001	0.000	0.107	0.014	0.121

Foxborough Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Unnamed Trib to Inlet of Lake Mirimichi (Sub-Basin 24098)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.30	1.205	0	5	4	36%	0.130	0.000	3	20%	0	0	0.431	0.000	0.193	0.060	0.063

Upper Canoe R to Unnamed Brook Confluence (Sub-Basin 24104)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.64	1.265	0	5	5	81%	0.709	0.329	5	63%	0	0	1.025	0.000	0.234	0.000	0.000

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
24014	Taunton	0.578	0	0.289		0.578	1.000	0.000	0.289
24103	Taunton	1.27	0.406	0.877		0.658	0.518	0.210	0.454
24047**	Ten Mile	2.063	1.209	1.675				0.720	0.720
21150	Nep	3.301	2.041	2.728		0.952	0.288	0.589	0.787
Total								**1.519**	**2.250**
Total MGY (over 90 days)								**136.707**	**202.512**
** based on eliminating 50% of the daily pumping capacity of the two Ten Mile wells									

Cost of Imported Water	**$/MG**						
Net cost of imported water	3,050	MWRA usage, plus admission fee, less $500 treatment and electric					
One Time Costs							
Permitting cost	200,000						
Interconnection cost	1,500,000	Assuming two booster stations are needed					
Total One Time Costs	**1,700,000**						
Annualized one time costs if financed at 4% for 20 years	123,620						
Total number of service connections	5,511						
Goal	**MGY**	**$/yr**	**$/yr/ connection**				
Restore GWC4	137	541,470	98.25				
Restore GWC3	202	739,720	134.23				

MEDFIELD WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Mill Mine to NR Confluence (Sub-Basin 21016)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.22	1.519	1	5	5	101%	1.155	0.699	5	84%	1	0	1.535	0.000	0.258	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
MEDFIELD WATER	WELL # 3 (ELM ST.)	WMA/PWS	G	0.619	0.419	0.387	1.195	954	
MEDFIELD WATER	WELL # 4 (ELM ST.)	WMA/PWS	G	0.001		0.000	1.008	237	
			Totals	0.620	0.419	0.388			

CR and Vine Bk to Mill Bk Confluence (Sub-Basin 21127)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
109.27	19.941	0	5	5	55%	6.045	0.062	0	-2%	0	0	11.030	2.031	11.356	0.000	0.326

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
MEDFIELD WATER	WELL # 1 (MAIN ST.)	WMA/PWS	G	0.058	0.191	0.088	0.226	492	
MEDFIELD WATER	WELL # 2 (MAIN ST.)	WMA/PWS	G	0.058	0.330	0.119	0.606	93	
			Totals	0.115	0.521	0.207			

CR to Indian Bk Confluence (Sub-Basin 21116)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
148.15	27.292	0	5	4	52%	7.253	0.000	2	6%	0	0	14.076	2.067	12.390	0.934	5.137

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft

MEDFIELD WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

MEDFIELD WATER	WELL # 6 (RTE. 27)	WMA/PWS	G		0.916	0.812	0.696	1.699	200	62
				Totals	0.916	0.812	0.696			

Medfield Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

CR to Stop R Confluence (Sub-Basin 21133)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
89.27	15.991	0	5	5	60%	5.627	0.829	1	1%	0	0	9.624	2.031	9.415	0.000	1.390

Stop R to CR Confluence (Sub-Basin 21134)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
17.09	2.741	0	5	4	47%	0.594	0.000	2	8%	0	0	1.279	0.000	1.072	0.137	0.478

CR to Bogastow Brook Confluence (Sub-Basin 21124)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
114.35	20.925	0	5	4	53%	5.826	0.000	0	-2%	0	0	11.057	2.031	11.474	0.451	0.417

Bogastow Bk to Sewall Bk Confluence (Sub-Basin 21123)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
25.63	3.947	0	5	4	50%	0.977	0.000	4	29%	0	0	1.964	0.036	0.803	0.197	0.197

Mill Bk to CR Confluence (Sub-Basin 21125)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.18	0.597	0	4	2	4%	0.000	0.000	0	-14%	0	0	0.027	0.000	0.113	0.033	0.146

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
21127	Charles	11.03	0.062	6.045		0.115	0.010	0.001	0.063
21116	Charles	14.076	0	7.253		0.916	0.065	0.000	0.472
Charles Max								**0.001**	**0.472**
21016	Nep	1.535	0.699	1.155		0.62	0.404	0.282	0.467
Total								**0.283**	**0.939**
Total MGY (over 90 days)								**25.468**	**84.466**

Medfield 3 Interconnections.xlsx, Costs

Cost of Imported Water	**$/MG**		
Net cost of imported water	3,050	MWRA usage, plus admission fee, less $500 treatment and electric	
One Time Costs			
Permitting cost	200,000		
Upgrade interconnection with booster station	750,000		
One mile of pipe	1,000,000	to connect to DWWD	
Total One Time Costs	**1,950,000**		
Annualized one time costs if financed at 4% for 20 years	141,799		
Total number of service connections	3,973		
Goal	**Required MGY**	**$/yr**	**$/yr/ connection**
Vol to restore GWC4 for all sources seasonally	25	218,049	54.88
Vol to restore GWC3 for all sources seasonally	84	397,999	100.18

SHARON WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Placeholder for Water Purchases (Sub-Basin 0)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
SHARON WATER	Purchase from Foxboro	WMA/PWS	G			0.001			
SHARON WATER	Purchase from Stoughton	WMA/PWS	G			0.000			
			Totals			0.002			

Beaver Brook to Massapoag Confluence (Sub-Basin 21154)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
3.14	0.548	1	5	5	204%	0.983	0.819	5	178%	1	1	1.120	0.000	0.142	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
SHARON WATER	GP WELL # 2	WMA/PWS	G	0.133	0.117	0.062	0.469	131	35
SHARON WATER	GP WELL # 3	WMA/PWS	G	0.163	0.169	0.131	0.380	282	45
SHARON WATER	GP WELL # 4	WMA/PWS	G	0.818	0.653	0.618	1.001	46	85
			Totals	1.115	0.939	0.811			

SHARON WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Upper Canoe R to Unnamed Brook Confluence (Sub-Basin 24104)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.64	1.265	0	5	5	81%	0.709	0.329	5	63%	0	0	1.025	0.000	0.234	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
SHARON WATER	GP WELL # 6	WMA/PWS	G	0.058	0.206	0.040	0.353	135	55
			Totals	0.058	0.206	0.040			

Billings Bk and Rumford R to Robinson Bk Confluence (Sub-Basin 24103)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.02	1.572	1	5	5	81%	0.877	0.406	5	59%	1	0	1.270	0.000	0.339	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
SHARON WATER	GP WELL # 5	WMA/PWS	G	0.346	0.213	0.204	0.468	430	55
SHARON WATER	GP WELL # 7	WMA/PWS	G	0.248	0.286	0.256	0.454	177	44
			Totals	0.594	0.500	0.460			

Sharon Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

NR to East Branch Confluence (Sub-Basin 21017)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
43.99	8.795	0	5	5	59%	2.954	0.315	4	45%	2	0	5.152	0.061	1.224	0.000	0.440

NR to Traphole Confluence (Sub-Basin 21140)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
37.85	7.521	0	5	5	65%	3.008	0.751	4	50%	2	0	4.888	0.000	1.124	0.000	0.373

Poquanticut Bk to Mulberry Meadow Bk Confluence (Sub-Basin 24017)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
5.65	0.987	0	3	1	2%	0.000	0.000	0	-16%	0	0	0.019	0.000	0.177	0.011	0.188

Massapoag Brook to Steep Hill Confluence (Sub-Basin 21146)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
10.38	1.989	0	5	5	57%	0.644	0.047	4	32%	0	0	1.141	0.000	0.509	0.000	0.099

Traphole Brook to NR (Sub-Basin 21141)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.65	0.784	1	5	1	1%	0.000	0.000	0	-9%	0	0	0.009	0.061	0.079	0.014	0.094

Sharon Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Spring Brook to NR Confluence (Sub-Basin 21149)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
2.13	0.371	0	5	1	1%	0.000	0.000	0	-10%	0	0	0.002	-0.000	0.039	0.009	0.048

NR to Mine Brook Confluence (Sub-Basin 21150)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
11.59	2.290	0	5	5	144%	2.728	2.041	5	123%	2	2	3.301	0.000	0.481	0.000	0.000

Steep Hill to Beaver Meadow Confluence (Sub-Basin 21152)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.79	1.327	0	5	5	93%	0.906	0.508	5	69%	1	0	1.238	0.000	0.325	0.000	0.000

Queset Bk to Cowesset Bk Confluence (Sub-Basin 24009)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
10.45	1.850	0	5	5	134%	2.020	1.465	5	112%	2	1	2.482	0.000	0.406	0.000	0.000

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
21154	Nep	1.12	0.819	0.983		1.115	0.996	0.815	0.979
24104	Taunton	1.025	0.329	0.709		0.058	0.057	0.019	0.040
24103	Taunton	1.27	0.406	0.877		0.594	0.468	0.190	0.410
Total								**1.024**	**1.429**
Total MGY (over 90 days)								**92.147**	**128.603**

Cost of Imported Water	**$/MG**		
Net cost of imported water	3,050	MWRA usage fee of $3,000, plus effective admissin fee of $550 , less $500 treatment and electric	
One Time Costs			
Cost to construct/reconstruct interconnection	750,000	Assumes a large booster station which may or may not be needed	
Permitting cost	200,000		
Total One Time Costs	**950,000**		
Annualized one time costs if financed at 4% for 20 years	69,081		
Total number of service connections	5,719		
Goal	**Required MGY**	**$/yr**	**$/yr/ connection**
Vol to restore GWC4 for all sources seasonally	92	349,681	61.14
Vol to restore GWC3 for all sources seasonally	129	462,531	80.88

STOUGHTON DPW WATER DIVISION
Optimization Report (Summary of Sub-Basins and Sources)

Placeholder for Water Purchases (Sub-Basin 0)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
STOUGHTON DPW WATER	Purchase Canton	WMA/PWS	G			0.009			
STOUGHTON DPW WATER	Purchase Easton	WMA/PWS	G			0.001			
STOUGHTON DPW WATER	Purchase MWRA	WMA/PWS	G		0.534	0.455			
STOUGHTON DPW WATER	Purchase Randolph	WMA/PWS	G			0.000			
STOUGHTON DPW WATER	Purchase Sharon	WMA/PWS	G			0.006			
			Totals		0.534	0.472			

Steep Hill to Beaver Meadow Confluence (Sub-Basin 21152)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.79	1.327	0	5	5	93%	0.906	0.508	5	69%	1	0	1.238	0.000	0.325	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
STOUGHTON DPW WATER	HARRIS POND GRAVEL PACKED	WMA/PWS	G	0.458	0.436	0.430	0.864	395	60
STOUGHTON DPW WATER	HARRIS POND WELL	PWS	G	0.000					
STOUGHTON DPW WATER	MUDDY POND	WMA/PWS	G	0.418	0.276	0.283	0.400	66	
STOUGHTON DPW WATER	PRATTS COURT WELL	WMA/PWS	G	0.289	0.179	0.108	0.504	66	60
			Totals	1.166	0.892	0.821			

STOUGHTON DPW WATER DIVISION
Optimization Report (Summary of Sub-Basins and Sources)

Dorchester Coweeset to Queset Brook Confluence (Sub-Basin 24008)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
7.08	1.177	0	5	3	15%	0.000	0.000	0	-3%	0	0	0.182	0.000	0.220	0.113	0.333

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
STOUGHTON DPW WATER	GODDARD WELL	WMA/PWS	G	0.141	0.146	0.142	0.187		
			Totals	0.141	0.146	0.142			

Queset Bk to Cowesset Bk Confluence (Sub-Basin 24009)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
10.45	1.850	0	5	5	134%	2.020	1.465	5	112%	2	1	2.482	0.000	0.406	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
STOUGHTON DPW WATER	FENNEL GP WELL	WMA/PWS	G	0.415	0.230	0.174	0.480	302	60
STOUGHTON DPW WATER	Fennel Well 3A	WMA/PWS	G			0.051	0.000		
STOUGHTON DPW WATER	GURNEY GP WELL	WMA/PWS	G	0.276	0.235	0.234	0.200	73	62
STOUGHTON DPW WATER	MCNAMARA GP WELL	WMA/PWS	G	0.174			0.320	93	50
			Totals	0.865	0.465	0.459			

Stoughton PWD Water Division Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Salsbury and Beaver Brook to Salsbury Plain River (Sub-Basin 24007)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.25	1.232	0	5	2	5%	0.000	0.000	0	-10%	0	0	0.063	0.505	0.188	0.060	0.248

Poquanticut Bk to Mulberry Meadow Bk Confluence (Sub-Basin 24017)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
5.65	0.987	0	3	1	2%	0.000	0.000	0	-16%	0	0	0.019	0.000	0.177	0.011	0.188

Pequit Brook to East Branch Confluence (Sub-Basin 21144)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.63	1.168	0	5	1	1%	0.000	0.000	0	-8%	0	0	0.010	0.000	0.100	0.025	0.126

Massapoag Brook to Steep Hill Confluence (Sub-Basin 21146)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
10.38	1.989	0	5	5	57%	0.644	0.047	4	32%	0	0	1.141	0.000	0.509	0.000	0.099

Beaver Meadow to Steep Hill Confluence (Sub-Basin 21151)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
2.86	0.531	0	5	1	2%	0.000	0.000	0	-10%	0	0	0.010	0.000	0.061	0.006	0.067

Stoughton PWD Water Division Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Norroway Bk to Blue Hill R Confluence (Sub-Basin 21120)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
6.11	0.794	0	5	1	1%	0.000	0.000	0	-4%	0	0	0.011	6.545	0.039	0.013	0.052

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
21152	Nep	1.238	0.508	0.906		1.166	0.942	0.478	0.853
24008	Taunton	0.182	0	0		0.141	0.775	0.000	0.000
24009	Taunton	2.482	1.465	2.02		0.865	0.349	0.511	0.704
Total								**0.989**	**1.557**
Total MGY (over 90 days)								**89.012**	**140.157**

Cost of Imported Water	**$/MG**						
Net cost of imported water up to 36.5 MGY	2,500	MWRA usage fees of $3,000, less $500 treatment and electric					
Total number of service connections	8,565						
Cost to achieve volume goal	**Required MGY**	**$/yr**	**$/yr/ connection**				
Vol to restore GWC4 for all sources seasonally	89	222,500	25.98				
Vol to restore GWC3 for all sources seasonally	140	350,000	40.86				

WALPOLE WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

Mill Mine to NR Confluence (Sub-Basin 21016)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.22	1.519	1	5	5	101%	1.155	0.699	5	84%	1	0	1.535	0.000	0.258	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
WALPOLE WATER	MINE BROOK #1 GP WELL	WMA/PWS	G	0.144	0.073	0.051	0.720	186	40
WALPOLE WATER	MINE BROOK #1A GP WELL	WMA/PWS	G	0.050	0.118	0.077	0.000	186	37
WALPOLE WATER	MINE BROOK #2 GD WELL	WMA/PWS	G	0.022	0.126	0.075	1.152	150	50
WALPOLE WATER	MINE BROOK #2A GP WELL	WMA/PWS	G	0.044	0.160	0.091	0.000	180	47
WALPOLE WATER	MINE BROOK #3 GP WELL	WMA/PWS	G	0.170	0.070	0.058	0.720	147	57
WALPOLE WATER	MINE BROOK #3A GP WELL	WMA/PWS	G	0.021	0.035	0.032	0.000	139	54
WALPOLE WATER	MINE BROOK #5 GP WELL	WMA/PWS	G	0.203	0.041	0.034	0.720	707	65
WALPOLE WATER	MINE BROOK #5A GP WELL	PWS	G	0.030	0.058	0.051	0.000	676	61
			Totals	0.684	0.681	0.470			

NR to Mine Brook Confluence (Sub-Basin 21150)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
11.59	2.290	0	5	5	144%	2.728	2.041	5	123%	2	2	3.301	0.000	0.481	0.000	0.000

Permittee_Name	PointName	Prog	GW/SW	00-04 Aug MGD	09-12 Aug MGD	09-12 Ann MGD	Day Limit MGD	Dist ft	Depth ft
WALPOLE WATER	NEPONSET WELL 1 (P.S. #1)	WMA/PWS	G	0.211	0.161	0.131	0.252	480	
WALPOLE WATER	NEPONSET WELL 2 (P.S. #1)	WMA/PWS	G	0.130	0.153	0.137	0.252	480	
WALPOLE WATER	SOUTH ST. GP WELL	WMA/PWS	G	0.095				574	
WALPOLE WATER	WASHINGTON #1 TUB WF	WMA/PWS	G	0.000				112	
WALPOLE WATER	WASHINGTON #2 GP WELL	WMA/PWS	G	0.269	0.214	0.127	0.432	93	55
WALPOLE WATER	WASHINGTON #3 GP WELL	WMA/PWS	G	0.080	0.147	0.096	0.432	135	38

WALPOLE WATER DEPARTMENT
Optimization Report (Summary of Sub-Basins and Sources)

WALPOLE WATER	WASHINGTON #4 GP WELL	WMA/PWS	G	0.128					
WALPOLE WATER	WASHINGTON #4A GP WELL	WMA/PWS	G	0.087	0.166	0.154	0.576	131	62
WALPOLE WATER	WASHINGTON #4B GP WELL	WMA/PWS	G	0.000			0.000	131	65
WALPOLE WATER	WASHINGTON #5 GP WELL	WMA/PWS	G	0.364	0.201	0.175	0.576	269	0
WALPOLE WATER	WASHINGTON #6 GP WELL	WMA/PWS	G	0.911	0.775	0.708	1.008	557	69
WALPOLE WATER	Washington St #2A	PWS			0.208	0.105	0.432	197	
WALPOLE WATER	Washington St #2B	PWS			0.088	0.060	0.432	197	
WALPOLE WATER	Washington St #3A	PWS			0.141	0.095	0.432	150	
WALPOLE WATER	Washington St #3B	PWS			0.094	0.074	0.432	150	
			Totals	2.275	2.347	1.861			

Walpole Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Stop R to CR Confluence (Sub-Basin 21134)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
17.09	2.741	0	5	4	47%	0.594	0.000	2	8%	0	0	1.279	0.000	1.072	0.137	0.478

Hawes, Germany and Mill to NR Confluence (Sub-Basin 21135)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
8.68	1.389	1	5	2	3%	0.000	0.000	0	-11%	0	0	0.042	0.000	0.193	0.097	0.289

Stop R to Stony Bk Confluence (Sub-Basin 21167)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
3.13	0.523	0	5	3	23%	0.000	0.000	0	-10%	0	0	0.119	0.000	0.169	0.012	0.181

Traphole Brook to NR (Sub-Basin 21141)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
4.65	0.784	1	5	1	1%	0.000	0.000	0	-9%	0	0	0.009	0.061	0.079	0.014	0.094

Upper Wading R to Unnamed Trib Confluence (Sub-Basin 24014)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
5.66	1.156	0	5	4	50%	0.289	0.000	4	39%	0	0	0.578	0.030	0.131	0.057	0.058

Walpole Water Department Alternative Sources Report

Sub-basins in town but without permittee existing sources, sorted by net backslide volume

Spring Brook to NR Confluence (Sub-Basin 21149)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
2.13	0.371	0	5	1	1%	0.000	0.000	0	-10%	0	0	0.002	-0.000	0.039	0.009	0.048

NR to Hawes Confluence (Sub-Basin 21136)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
25.77	5.205	0	5	5	93%	3.543	1.982	5	75%	3	1	4.845	0.000	0.919	0.000	0.000

NR to Spring Brook Confluence (Sub-Basin 21148)

Area SM	Aug_U MGD	CFR	BC	GWC	Aug GW Deplt %	Restor GWC3 MGD	Restor GWC4 MGD	Aug Net Deplt Cat	Aug Net Deplt %	Aug Net Restor3 MGD	Aug Net Restor4 MGD	Aug GW Draw MGD	Aug SW Draw MGD	Aug WW Return MGD	BS Vol GWC 1-4 MGD	NET BS GWC 1-4 MGD
19.83	3.976	0	5	5	122%	3.841	2.648	5	103%	3	2	4.835	0.000	0.740	0.000	0.000

Sub-basin ID	Major Basin	Total Sub-bas Aug Draw Base Per, MGD	Total Sub-bas Vol to Restore GWC 4, MGD	Total Sub-bas Vol to Restore GWC 3, MGD		Permittee Aug Draw Base Per, MGD	Permitte Share Total Sub-bas Draw, %	Permittee Share GWC 4 Restore Vol, MGD	Permittee Share GWC 3 Restore Vol, MGD
21016	Nep	1.535	0.699	1.155		0.684	0.446	0.311	0.515
21150	Nep	3.301	2.041	2.728		2.275	0.689	1.407	1.880
Total								**1.718**	**2.395**
Total MGY (over 90 days)								**154.629**	**215.529**

Cost of Imported Water	**$/MG**						
Net cost of imported water	3,050	MWRA usage, plus admission fee, less $500 treatment and electric					
One Time Costs							
Permitting cost	200,000						
Upgrade interconnection with booster station	750,000	it is unclear if this is actually necessary					
Total One Time Costs	**950,000**						
Annualized one time costs if financed at 4% for 20 years	69,081						
Total number of service connections	7,852						
Goal	**Required MGY**	**$/yr**	**$/yr/ connection**				
Vol to restore GWC4 for all sources seasonally	155	541,831	69.01				
Vol to restore GWC3 for all sources seasonally	216	727,881	92.70				

5.0 EVALUATE STORMWATER RECHARGE OPPORTUNITIES

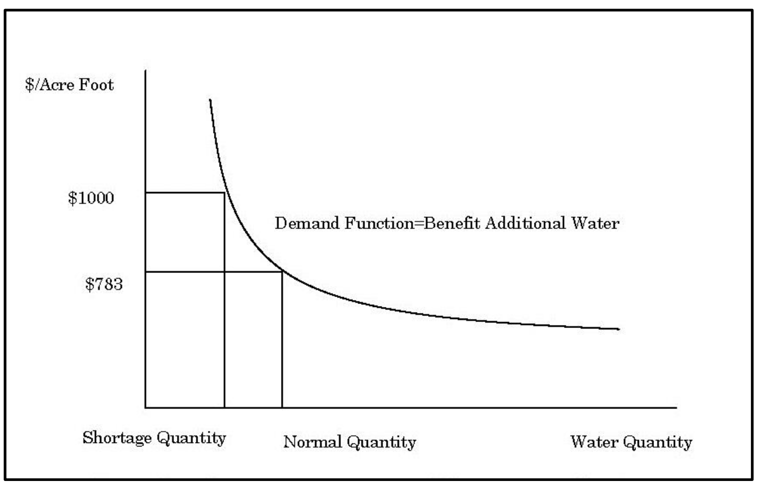
5.1 Introduction

Upon implementation of the Sustainable Water Management Initiative (SWMI) Framework, Water Management Act (WMA) permits will require mitigation commensurate with impacts for additional withdrawals that exceed Baseline. All of the municipalities within the study area are categorized under the SWMI Framework as having sources in subwatersheds with ground water categories that have over 25% alteration of median August streamflow (i.e. ground water withdrawal categories 4-5), which sets the additional requirement to minimize impacts from existing withdrawals.

One possible mitigation option is to make stormwater management improvements and reduce effective impervious cover. Specifically, stormwater recharge is a critical component to offsetting and mitigating impacts of water withdrawals due to the direct positive relationship between volume of recharge and water supply (i.e. the more recharge to groundwater, the more water available in the subwatershed for drinking water supply as well as maintaining streamflows). This is particularly critical in Massachusetts Department of Environmental Protection-designated Wellhead protection areas. Furthermore, while stormwater recharge is not directly identified as one of the items that must be evaluated as part of the required Minimization plan, it is one of the elements included in the NEWWA BMP Toolbox and is certainly consistent with “other measures” that help restore streamflows.

In addition, recharge helps to ensure the reliability of water supplies, thereby also providing benefits to the supplier and consumer. A study by the University of California Riverside, Department of Environmental Sciences, titled: Valuing Groundwater Recharge in an Urban Context studied the benefit to consumers in avoiding water reductions, as shown in Figure 5-1a (Cutter, B. 2007). This figure, created for the Los Angeles and San Gabriels Rivers Watershed Council Water Augmentation Study, shows the decrease in costs to water suppliers during periods of larger water supplies and therefore lowering costs to consumers.

Figure 5-1a Reliability of Water Supplies



The SWMI framework states that priority will be given to mitigation projects that are near the source of impact as opposed to further away. This statement is made to encourage stormwater recharge (and other streamflow enhancements) that are located within the boundaries of depleted subwatersheds. The final SWMI requirements are expected to include a “Location Adjustment Factor” which will reduce the amount of mitigation credit awarded for actions located downstream of an impacted subwatershed, or in unrelated subwatersheds. However, MassDEP has yet to issue clear guidance on how it plans to implement the Location Adjustment Factor. Irrespective of MassDEP's finial interpretation on this point, collecting and recharging precipitation where it is generated is the best approach to infiltrating to groundwater to enhance the volume of water available to augment water supplies, while also ensure that the hydrology of a subwatershed is maintained.

Keeping these principles in mind, the project team evaluated the potential for increasing stormwater recharge through remediation of existing, impervious surfaces, and requiring additional recharge from new development.

Note that readers may wish to refer to Chapter 1 for a discussion of the differences between the terms subwatershed, Sub-basin and Hydrologic Unit.

5.2 Data Analysis

Data available from MassGIS, including soils, impervious cover, land use, Zones I and II and other relevant information was overlain with local parcel-level data using ESRI Arc 10 software to identify the recharge potential for both undeveloped and developed areas in each Hydrologic Unit within the study area. The potential volume of recharge enhancement attainable over time was estimated for these areas. Zoning and proximate land use compatibility and local land use/development regulations were considered to determine future impervious cover. In developed areas, retrofitting or redevelopment of existing and future impervious cover was taken into account, and scenarios were run to determine potential requirements for greater than "natural" recharge in areas of new development. Where available, existing stormwater infrastructure was overlain with the above, to focus and prioritize recharge opportunities. Water quality constraints were considered such as sensitive receptors requiring treatment or time of travel.

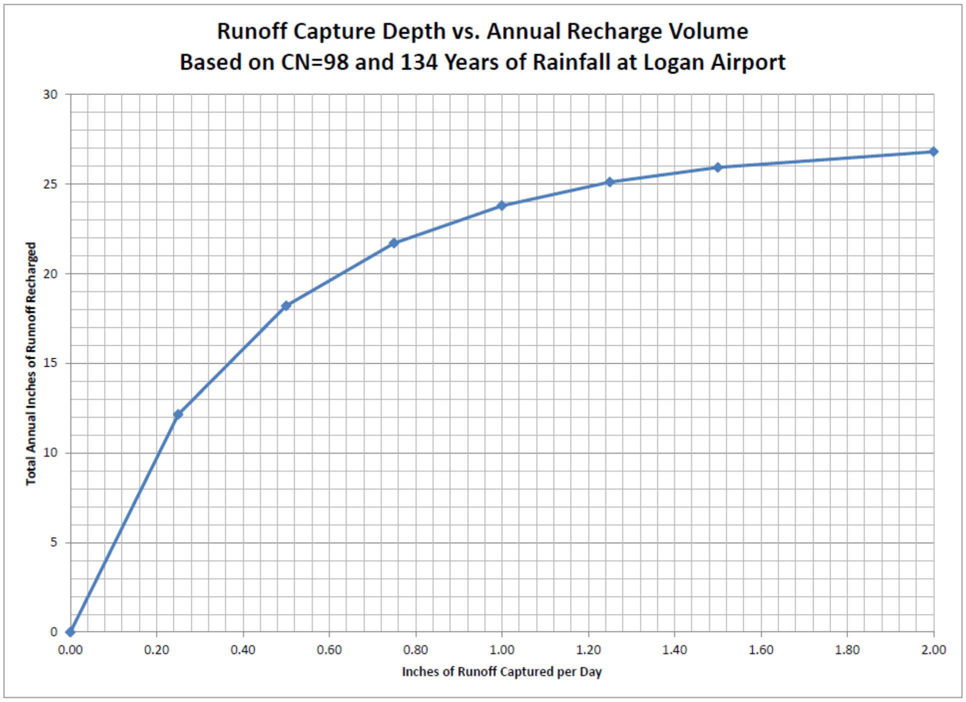
5.2.1 Approach

The approach to this work was driven by the objective to determine the total number of acres available in the project area for recharge and an estimate of the potential recharge volume by Hydrologic Unit. For each Hydrologic Unit, five categories of data were calculated and analyzed, as described below.

1. <u>Potential Recharge from Existing Impervious Surfaces</u>: The volume of potential recharge from runoff from existing impervious surfaces on all developed parcels in each Hydrologic Unit was estimated. Impervious surfaces within developed parcels included driveways and sidewalks, rooftops, and any other smaller impervious areas (e.g. parcel walkways, paths, etc.). Massachusetts Geographic Systems (Mass GIS) Parcel Level 3 (2008) data was used in the analysis. Impervious surface data, also from Mass GIS, was overlain. Computations for roadways were completed separately, as there are differing funding, ownership and maintenance considerations.

   Runoff volumes were estimated for each precipitation event (rain and snowfall) using 134 years of record at Logan Airport (1872 to 2005), and broken-down by range of storm sizes (Figure 5-1b). To estimate runoff, TR-55 calculations were applied to the entire rainfall data set using a daily time step, and assuming a curve number of 98 for all impervious areas. A frequency analysis was prepared to estimate the total annual volume of runoff that could be recharged, based on sizing a recharge facility to capture a given depth of runoff.

Figure 5-1b Runoff Capture Depth vs. Annual Recharge Volume



Recharge potential was determined by applying the required recharge depths for the applicable UDSA Natural Resource Conservation Service hydrologic soil group as specified in the MA Stormwater Handbook. Specific assumptions included:

a. All developed areas have impervious surfaces that include rooftops, driveways, walkways, and sidewalks.

b. The hydrologic soil groups for soils underlying areas of pavement were used to define the depth of runoff capture based on the guidelines in the MA Stormwater Handbook. Potential recharge values were calculated for all soil types from A to D.

c. Areas subject to the Massachusetts Stormwater Standards, and which have been developed since 1997, are assumed to have infiltration facilities that comply with the standards, and thus are presumed not to have additional recharge potential.

2. Future Projections: Recharge from Undeveloped Land that is likely to be rendered impervious by new development. This calculation was based on the same procedures outlined above subject to the following additional assumptions:

    a. That existing MassDEP recharge requirements approximate “natural” recharge, and thus in areas of new development, this level of recharge does not accrue mitigation credit under SWMI.

    b. Municipalities will adopt an “over-recharge” requirement that exceeds the basic MassDEP requirements in net-depleted Hydrologic Units where A and B soils are present and this will generate a SWMI mitigation credit.

3. Identification of areas that would be most promising for retrofitting, based on the information collected above. Assumptions included:

    a. Areas within net-depleted Hydrologic Units are most desired.

b. Parcels that are owned by municipalities are most likely to be most easily funded and implemented.

c. Parcels that have aging buildings and/or infrastructure are ideal candidates for retrofit opportunities and are more likely to be subject to private redevelopment activities.

4. Estimation of a potential over-recharge credit for retrofit, new development or redevelopment. Mechanisms by which each category of cover might be retrofitted, including:

   a. Town-owned properties being retrofitted proactively by municipalities, and

   b. Commercial properties being retrofitted through:

   Permitting of redevelopment projects,

   Use of mitigation credit trading, and/or grants from a municipal water bank; and

   Residential properties through a rain garden outreach campaign.

5.2.2 Existing Conditions

Total impervious surfaces (parcels and roadways) account for 16% of the entire study area. The total volume of runoff that could be captured from existing impervious cover within the study area, if areas that pre-date the MA Stormwater Policy were retrofitted to meet those standards, is 15.3 million gallons per day. As shown in Table 5.1, the range of impervious surface areas vary greatly between the Neponset Watershed and both the Charles and Taunton Watersheds within the municipalities included in the study area. Clearly, municipalities within the Neponset include a higher number of developed areas with impervious surfaces (see Figure 5-2). The positive correlation to this conclusion is that the Neponset River Watershed has the greatest potential for increasing recharge within the study area.

Table 5-1 Total Impervious Surface Areas and Potential Additional Recharge per Major Watershed

	Hydrologic Area (acres)	Estimated Existing Impervious Area (acres)			Potential Additional Recharge (MGD)		
		Parcels	**Roads**	**TOTAL**	**Parcels**	**Roads**	**TOTAL**
Neponset	58,097	7,143.25	3,348.59	10,491.84	7.16	3.53	10.69
Charles	15,880	0.16	0.08	2,214.55	1.20	0.71	1.91
Taunton	21,548	1,619.56	969.70	2,589.26	1.61	1.08	2.69
Ten Mile	66	1.89	2.01	3.90	0.00	0.00	0.01
TOTALS:	95,592	8,764.86	4,320.38	15,299.55	9.97	5.33	15.30

➢

The analysis also showed that the potential for additional recharge from existing impervious cover on developed parcels accounts for 65% of the total for the study areas as a whole on an annual basis; 9.97 million gallons per day. Roadways account for 35% of the total potential for enhanced recharge on an annual basis; 5.33 million gallons per day.

For the purposes of this study, an assumption was made that Hydrologic Units with developed parcels and impervious surfaces, particularly those developed prior to the revised Stormwater Standards, and that also contain public water wells, will be net depleted. This assumption was based on two central factors:

1) Impervious surfaces from development typically remove stormwater from the Hydrologic Unit through a piped system or allow for only modest recharge through a stormwater management facility, creating a lag-time that does not allow for baseflow maintenance; and

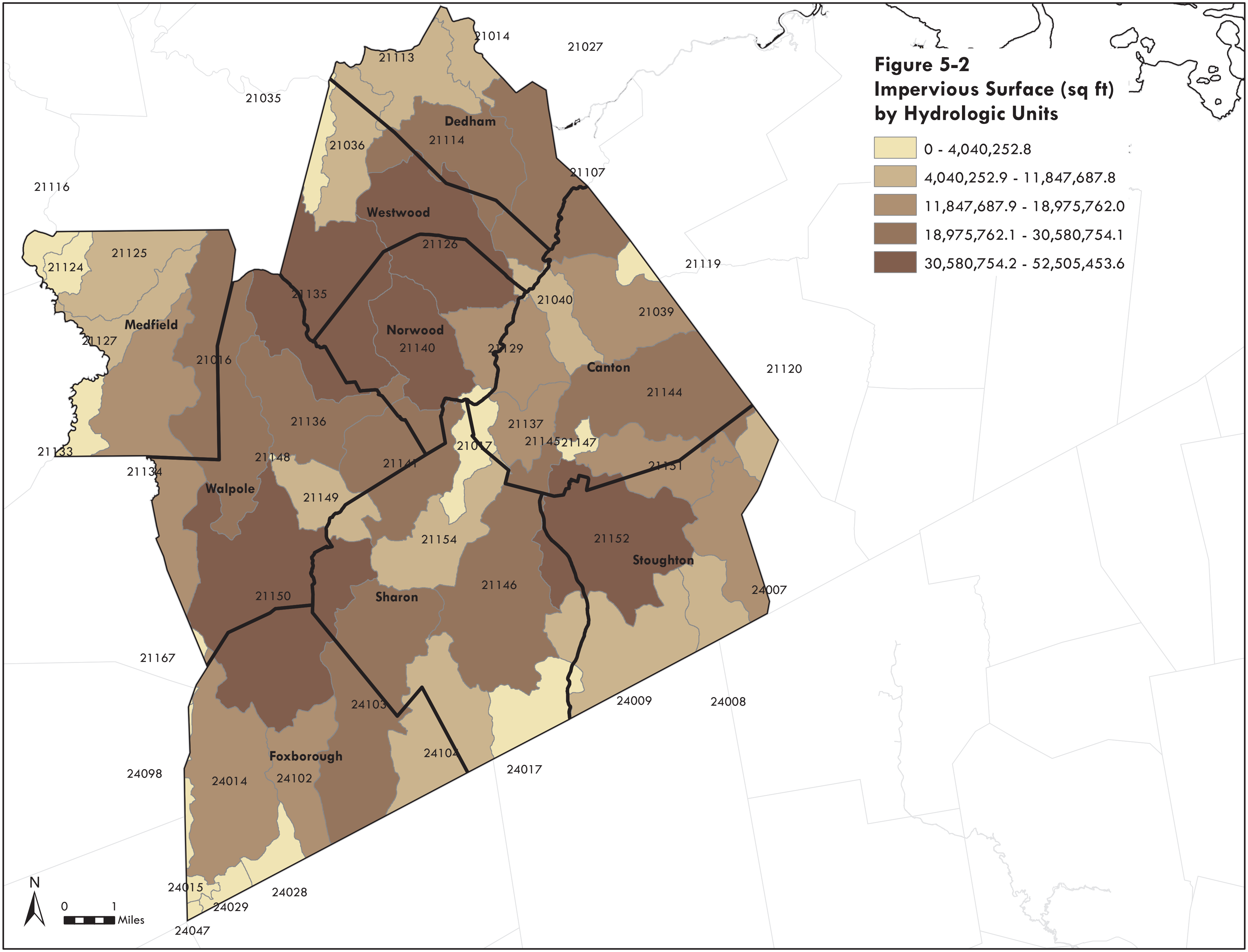


Figure 5-2
Impervious Surface (sq ft)
by Hydrologic Units
0 - 4,040,252.8
4,040,252.9 - 11,847,687.8
11,847,687.9 - 18,975,762.0
18,975,762.1 - 30,580,754.1
30,580,754.2 - 52,505,453.6
Dedham
Westwood
Medfield
Norwood
Canton
Walpole
Sharon
Stoughton
Foxborough
21014
21027
21113
21035
21036
21114
21116
21107
21125
21124
21126
21119
21135
21040
21039
21127
21016
21140
21129
21120
21144
21136
21137
21133
21148
21017
21145
21147
21141
21134
21151
21149
21154
21152
24007
21146
21150
21167
24103
24009
24008
24104
24017
24098
24014
24102
24015
24028
24029
24047
N
0
1
Miles

2) Pumping wells lower groundwater levels, modifies natural flow paths, and causes groundwater to flow towards the well (Weiskel, Peter K. et al 2008).

There are sixteen (16) Hydrologic Units that are estimated to be net-depleted; of the total fifty (50) within the study area (approximately 30% of the study area). These Hydrologic Units have been identified in Table 5.2. Note however that when net depletion is evaluated from a nested Sub-basin perspective rather than a Hydrologic Unit perspective, additional areas will likely also be considered to be net depleted.

As shown in Table 5-2, the net-depleted Hydrologic Unit with the highest recharge potential is the Neponset River segment to the Mine Brook confluence (Hydrologic Unit 21150) with a potential recharge volume of 1.45 million gallons per day. It is the second largest Hydrologic Unit within the study area (second to the Neponset River segment to Pine Tree Brook confluence Hydrologic Unit), and has the largest acreage of impervious surface (1,205 acres). This Hydrologic Unit includes the municipality of Foxborough and portions of Walpole. Hydrologic Unit 21152 has the second largest acreage of impervious surface area (1,004 acres) and second largest recharge volume potential (1.23 MGD), which includes the municipality of Stoughton and a small portion of Canton (Figure 5-3a).

It is important to note that data regarding existing stormwater recharge best management practices generally does not exist in electronic form and was not considered in this portion of the analysis. Similarly, no data was available regarding which areas of existing impervious cover are directly connected to drainage collection systems. Thus, in some cases, the figures presented below may overestimate the volume of runoff from existing impervious cover.

Table 5-2 Total Runoff Volumes in Net-Depleted Hydrologic Units

Major Basin	Hydrologic Unit Name	Hydro Unit ID	SWMI GWC	Town	Total Imperv (acres)	Lost Recharge (MGD)
Ten Mile	Bungay R to Ten Mile R	24047	4	FOXBOROUGH	3.90	0.0058
Neponset	NR to East Branch Confluence	21017	5	CANTON	79.99	0.0886
Charles	CR and Vine Bk to Mill Bk Confluence	21127	5	MEDFIELD	168.74	0.1490
Charles	CR to Mother Bk Confluence	21113	4	DEDHAM	177.86	0.1321
Neponset	NR to Ponkapoag Confluence	21040	5	CANTON	197.34	0.1649
Neponset	NR to Ponkapoag Confluence	21040	5	WESTWOOD	197.34	0.1649
Neponset	Beaver Brook to Massapoag Confluence	21154	5	SHARON	199.02	0.2255
Taunton	Queset Bk to Cowesset Bk Confluence	24009	5	STOUGHTON	241.11	0.2541
Taunton	Upper Canoe R to Unnamed Brook Confluence	24104	5	SHARON	271.99	0.3060
Neponset	East Branch all to NR	21137	4	CANTON	296.24	0.2695
Taunton	Upper Wading R to Unnamed Trib Confluence	24014	4	FOXBOROUGH	309.53	0.3601
Neponset	Mill Mine to NR Confluence	21016	5	WALPOLE	477.82	0.5604
Taunton	Billings Bk and Rumford R to Robinson Bk Confluence	24103	5	FOXBOROUGH	566.16	0.6433
Neponset	NR to Pine Tree Brook Confluence	21107	5	DEDHAM	702.04	0.6071
Neponset	Steep Hill to Beaver Meadow Confluence	21152	5	STOUGHTON	1,004.24	1.2393
Neponset	NR to Mine Brook Confluence	21150	5	FOXBOROUGH	1,205.36	1.4534
Totals					6,098.65	6.6241

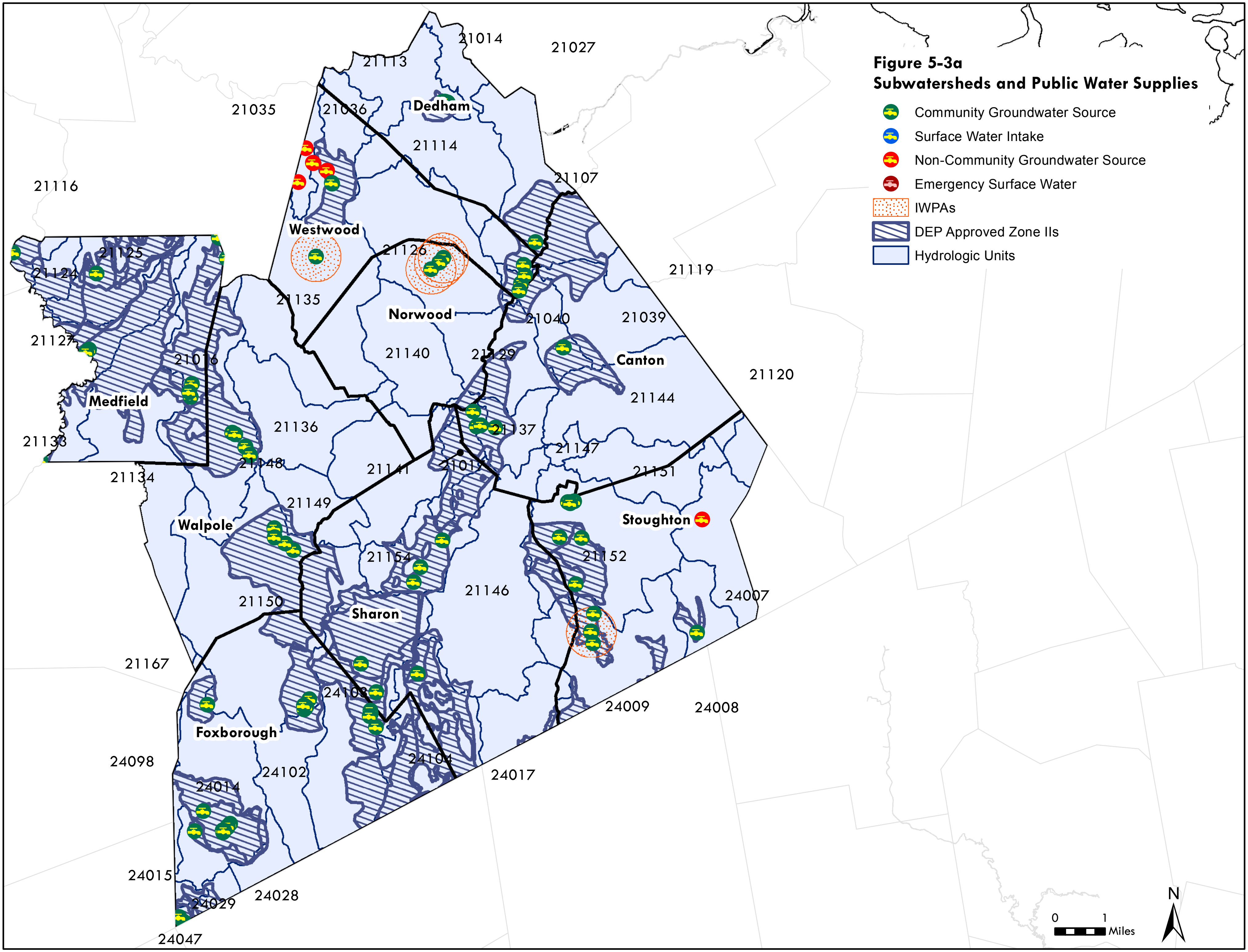


Figure 5-3a
Subwatersheds and Public Water Supplies
Community Groundwater Source
Surface Water Intake
Non-Community Groundwater Source
Emergency Surface Water
IWPAs
DEP Approved Zone IIs
Hydrologic Units
Dedham
Westwood
Norwood
Canton
Medfield
Walpole
Stoughton
Sharon
Foxborough
21014
21027
21113
21035
21036
21114
21116
21107
21125
21126
21124
21119
21135
21039
21040
21127
21016
21140
21129
21120
21144
21136
21137
21133
21147
21148
21134
21141
21019
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5.3 Recharge Opportunities

There is a tremendous opportunity within the project area to replenish water supplies and stream flow via recharging stormwater runoff to groundwater, under both existing conditions and future projections. Stormwater is a significant component of the watershed's water budget and greatly influences the amount of streamflow and public water supplies available. It should be noted that both the Massachusetts Water Management Act and Stormwater Management Standards recommend that recharge be achieved "close to its site of origin". Therefore, recharge opportunities that are located in parcels within net-depleted Hydrologic Units have been given the greatest consideration.

5.3.1 Already Developed Parcels

In order to best determine potential recharge opportunities, the most currently available planning data was used to conduct a parcel level analysis. An initial screening was first completed in order to determine only the sites that are feasible for recharge. Parcels that met the following hydrologic criteria were selected:

1) Having NRCS Soil Classification A or B – with the most feasible recharge potential;
2) Parcels with the largest impervious surfaces (imperviousness of over 1 acre); and
3) Parcels located within net-depleted Hydrologic Units.

Of approximately 63,000 total parcels across all nine towns, 361 were chosen through application of this screening (see Figure 5-3b). It's important to note that these parcels encompass the total universe of priority stormwater recharge opportunities available in each municipality due to their soil suitability and greatest potential to replenish groundwater for public water supplies. This list should be referred to if municipalities are interested in applying alternative or additional suitability criteria to that subsequently described.

The second phase of the analysis included selection and ranking of selected sites within the 361 parcels described above for best suitability and favorability for recharge opportunities based on land use criteria, as follows:

1) Having a designated Land Use Code as either Public/Tax Exempt or Commercial, which were determined to have the greatest likelihood of retrofitting (or implementing new) stormwater practices;
2) Containing a building that was built prior to the Stormwater Standards (1997), indicating that there are likely no stormwater management facilities onsite; and
3) Having a low property value to size ratio (dollars per sq ft), indicating that these property owners may be more willing to redevelop and/or enhance their properties, and therefore; include stormwater management facilities that meet new standards.

Approximately 120 parcels were found to have the highest, best potential for recharge opportunities, upon application of the above land use criteria. It should be noted that industrial uses were purposefully excluded due to concerns regarding potential pollution hotspots that are typically located at industrial parcels.

Potential Stormwater Recharge: Initial Parcels Selceted By Hydrologic Criteria

Major Watershed	Subwatershed ID	Town	Parcel Area (Sq Ft)	LUC	Land Value	Total Value	Dollars/Sq Ft	Yr. Built	Soil Group	Total Imperv (sq ft)	Total Recharge (mil gal/yr)
NEPONSET	21137	Canton	251,058.48	102	$0	$19,476,200	$77.58	1984	B	122,298.62	1.14
NEPONSET	21137	Canton	292,772.51	102	$0	$18,593,500	$63.51	1999	B	127,116.26	1.19
NEPONSET	21137	Canton	67,897.72	102	$0	$5,373,800	$79.15	1973	B	44,422.45	0.42
NEPONSET	21137	Canton	156,038.47	102	$0	$14,523,400	$93.08	1999	B	77,360.05	0.72
NEPONSET	21137	Canton	96,029.37	112	$924,000	$3,299,500	$34.36	1967	B	61,523.44	0.57
NEPONSET	21040	Canton	1,991,411.17	170	$2,129,440	$3,164,440	$1.59	1916	B	158,303.91	1.48
NEPONSET	21137	Canton	50,511.21	310	$259,200	$301,000	$5.96	1950	B	50,511.21	0.47
NEPONSET	21137	Canton	65,809.70	332	$308,900	$811,000	$12.32	1976	B	52,745.05	0.49
NEPONSET	21137	Canton	55,490.31	332	$280,800	$734,200	$13.23	1952	B	50,793.46	0.47
NEPONSET	21040	Canton	284,454.06	340	$873,200	$2,444,100	$8.59	1983	A	78,199.64	0.97
NEPONSET	21040	Canton	8,304,103.62	380	$6,333,900	$9,318,400	$1.12	1956	A	438,639.71	5.42
NEPONSET	21137	Canton	1,479,775.24	400	$3,097,800	$3,398,400	$2.30	1930	B	776,560.13	7.26
NEPONSET	21137	Canton	140,344.32	400	$706,100	$2,310,900	$16.47	1985	B	100,784.71	0.94
NEPONSET	21152	Canton	289,072.68	400	$998,100	$2,992,100	$10.35	1982	A	148,944.29	1.84
NEPONSET	21152	Canton	105,134.36	400	$509,800	$1,939,400	$18.45	1980	A	98,412.12	1.22
NEPONSET	21152	Canton	297,385.58	400	$850,500	$1,827,200	$6.14	1981	A	210,457.80	2.60
NEPONSET	21152	Canton	102,416.20	400	$359,700	$1,096,800	$10.71	1981	A	59,431.45	0.73
NEPONSET	21152	Canton	451,649.68	400	$884,600	$2,282,400	$5.05	1985	A	259,143.31	3.20
NEPONSET	21152	Canton	173,639.81	400	$633,600	$2,583,800	$14.88	1973	A	124,411.22	1.54
NEPONSET	21152	Canton	218,893.45	400	$1,080,000	$2,876,900	$13.14	1974	A	157,488.37	1.95
NEPONSET	21152	Canton	114,466.74	400	$352,600	$1,197,500	$10.46	2002	A	45,093.35	0.56
NEPONSET	21152	Canton	146,156.27	400	$539,600	$1,629,000	$11.15	1975	A	64,978.53	0.80
NEPONSET	21152	Canton	128,691.35	400	$427,800	$1,064,900	$8.27	1967	A	51,234.25	0.63
NEPONSET	21040	Canton	302,469.00	401	$1,656,600	$4,848,700	$16.03	1997	A	99,914.83	1.24
NEPONSET	21152	Canton	339,197.76	401	$383,400	$939,600	$2.77	2007	A	83,006.12	1.03
NEPONSET	21152	Canton	168,743.80	401	$682,300	$2,300,000	$13.63	1975	A	129,714.41	1.60
NEPONSET	21137	Canton	130,626.80	424	$335,700	$391,200	$2.99	0	B	60,650.34	0.57
NEPONSET	21107	Canton	5,455,618.85	910	$9,836,900	$9,836,900	$1.80	0	B	78,889.18	0.74
NEPONSET	21107	Canton	616,430.31	930	$0	$0	$0.00	0	B	121,039.77	1.13
NEPONSET	21137	Canton	2,236,301.92	934	$5,010,000	$41,014,700	$18.34	1956	B	826,775.65	7.72
NEPONSET	21040	Canton	749,017.94	935	$564,300	$931,400	$1.24	2009	A	66,894.70	0.83
NEPONSET	21040	Canton	2,953,655.42	953	$1,269,000	$1,269,000	$0.43	0	A	393,847.90	4.87
NEPONSET	21152	Canton	158,493.00	954	$348,500	$723,300	$4.56	1960	A	60,998.49	0.75
NEPONSET	21137	Canton	518,540.06	959	$521,100	$3,257,400	$6.28	1973	B	81,438.74	0.76
NEPONSET	21107	Dedham	117,161.47	102	$0	$8,041,500	$68.64	1972	B	48,658.22	0.45
NEPONSET	21107	Dedham	181,009.94	310	$2,114,600	$7,029,500	$38.83	1977	A	151,320.15	1.87
NEPONSET	21107	Dedham	54,772.25	316	$261,100	$843,000	$15.39	1973	B	47,231.46	0.44
NEPONSET	21107	Dedham	175,727.79	316	$577,300	$2,364,300	$13.45	1932	A	145,389.81	1.80
NEPONSET	21107	Dedham	645,030.97	316	$3,804,900	$10,784,600	$16.72	1964	A	520,919.79	6.44
NEPONSET	21107	Dedham	90,329.07	323	$1,681,600	$4,135,700	$45.78	1969	B	80,165.49	0.75
NEPONSET	21107	Dedham	59,275.69	332	$369,000	$540,400	$9.12	1960	A	47,583.58	0.59

Potential Stormwater Recharge: Initial Parcels Selceted By Hydrologic Criteria

Major Watershed	Subwatershed ID	Town	Parcel Area (Sq Ft)	LUC	Land Value	Total Value	Dollars/Sq Ft	Yr. Built	Soil Group	Total Imperv (sq ft)	Total Recharge (mil gal/yr)
NEPONSET	21107	Dedham	407,891.13	332	$731,000	$933,100	$2.29	1940	A	144,353.88	1.79
NEPONSET	21126	Dedham	68,108.42	340	$1,008,700	$4,670,500	$68.57	1984	A	49,795.18	0.62
NEPONSET	21107	Dedham	84,671.83	340	$0	$6,559,200	$77.47	1989	A	71,557.39	0.88
NEPONSET	21107	Dedham	96,720.04	340	$2,147,100	$4,792,800	$49.55	1981	B	74,328.55	0.69
NEPONSET	21107	Dedham	102,020.97	375	$292,000	$807,800	$7.92	1989	A	76,894.49	0.95
NEPONSET	21107	Dedham	67,153.34	400	$400,200	$1,043,200	$15.53	1933	B	45,624.35	0.43
NEPONSET	21107	Dedham	271,655.95	401	$1,642,000	$6,622,200	$24.38	1906	A	227,560.70	2.81
NEPONSET	21107	Dedham	75,901.70	931	$656,500	$1,087,000	$14.32	1930	A	44,245.11	0.55
NEPONSET	21107	Dedham	1,810,851.54	931	$959,700	$1,063,800	$0.59	1960	B	446,790.68	4.17
NEPONSET	21107	Dedham	80,133.87	931	$302,900	$1,246,100	$15.55	1950	B	52,730.68	0.49
NEPONSET	21107	Dedham	474,593.99	934	$4,305,100	$19,761,800	$41.64	1970	B	217,813.82	2.03
NEPONSET	21107	Dedham	167,536.86	934	$325,100	$2,627,100	$15.68	1921	B	67,032.92	0.63
NEPONSET	21107	Dedham	708,314.39	934	$649,300	$5,053,600	$7.13	1950	B	142,400.52	1.33
NEPONSET	21107	Dedham	204,371.20	970	$1,328,000	$5,964,200	$29.18	1977	B	85,126.31	0.80
CHARLES	21113	Dedham	206,089.18	340	$937,500	$3,272,300	$15.88	1954	A	64,119.51	0.79
CHARLES	21036	Dedham	214,454.18	380	$2,113,600	$6,843,400	$31.91	1922	A	75,540.26	0.93
CHARLES	21036	Dedham	1,179,653.68	805	$276,800	$786,800	$0.67	0	A	144,151.31	1.78
CHARLES	21113	Dedham	80,277.45	991	$516,000	$597,100	$7.44	0	A	61,728.58	0.76
CHARLES	21113	Dedham	64,257.39	992	$513,700	$11,730,200	$182.55	1903	A	47,834.37	0.59
NEPONSET	21150	Foxborough	426,669.55	102	$1,411,000	$9,726,600	$22.80	2011	A	103,098.53	1.27
NEPONSET	21150	Foxborough	184,059.40	112	$963,100	$3,095,000	$16.82	1978	A	68,072.25	0.84
NEPONSET	21150	Foxborough	146,181.92	130	$161,900	$611,700	$4.18	1989	A	106,489.49	1.32
NEPONSET	21150	Foxborough	4,325,010.90	132	$304,200	$304,200	$0.07	0	A	345,862.29	4.28
NEPONSET	21150	Foxborough	69,047.10	300	$24,676,600	$121,918,300	$1,765.73	2008	B	66,930.88	0.63
NEPONSET	21150	Foxborough	91,841.00	316	$240,000	$380,900	$4.15	1980	B	54,885.99	0.51
NEPONSET	21150	Foxborough	69,409.48	323	$999,400	$1,843,300	$26.56	1988	A	68,471.74	0.85
NEPONSET	21150	Foxborough	247,073.37	326	$520,400	$840,500	$3.40	1997	A	96,928.70	1.20
NEPONSET	21150	Foxborough	140,274.37	332	$463,900	$1,232,700	$8.79	1996	B	100,678.77	0.94
NEPONSET	21150	Foxborough	79,034.79	337	$571,200	$645,600	$8.17	0	B	77,267.53	0.72
NEPONSET	21150	Foxborough	277,999.21	338	$435,200	$588,500	$2.12	1967	B	249,270.83	2.33
NEPONSET	21150	Foxborough	125,434.90	340	$900,100	$8,169,300	$65.13	1900	A	64,225.16	0.79
NEPONSET	21150	Foxborough	9,851,699.84	366	$12,303,100	$15,910,700	$1.62	1995	A	6,945,399.08	85.88
NEPONSET	21150	Foxborough	3,502,405.85	390	$8,565,900	$8,565,900	$2.45	0	B	966,154.84	9.03
NEPONSET	21150	Foxborough	215,252.07	391	$228,700	$228,700	$1.06	0	A	96,721.74	1.20
NEPONSET	21150	Foxborough	406,806.14	400	$2,502,400	$12,040,100	$29.60	1915	B	372,356.04	3.48
NEPONSET	21150	Foxborough	193,066.66	440	$853,100	$853,100	$4.42	0	A	182,712.62	2.26
NEPONSET	21150	Foxborough	1,846,849.39	930	$1,985,700	$2,480,700	$1.34	0	A	402,684.41	4.98
NEPONSET	21150	Foxborough	1,051,702.11	931	$12,068,300	$465,426,100	$442.55	2002	A	955,302.05	11.81
NEPONSET	21150	Foxborough	397,947.52	931	$1,541,100	$10,375,200	$26.07	2006	B	96,786.67	0.90
NEPONSET	21150	Foxborough	203,939.48	970	$1,041,900	$4,792,800	$23.50	1980	B	68,025.19	0.64
TAUNTON	24104	Foxborough	136,127.06	101	$160,000	$307,400	$2.26	1900	A	60,059.47	0.74

Potential Stormwater Recharge: Initial Parcels Selceted By Hydrologic Criteria

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TAUNTON	24103	Foxborough	438,725.42	102	$0	$5,744,700	$13.09	1995	A	70,883.86	0.88
TAUNTON	24103	Foxborough	228,703.17	102	$0	$3,973,000	$17.37	1995	A	78,922.02	0.98
TAUNTON	24103	Foxborough	468,552.59	102	$0	$12,558,300	$26.80	1997	B	96,566.81	0.90
TAUNTON	24104	Foxborough	211,388.36	102	$0	$3,702,000	$17.51	1992	A	45,061.10	0.56
TAUNTON	24104	Foxborough	93,723.04	106	$161,400	$182,400	$1.95	0	B	78,754.76	0.74
TAUNTON	24103	Foxborough	293,464.62	130	$195,300	$195,300	$0.67	0	B	47,764.22	0.45
TAUNTON	24014	Foxborough	842,332.21	131	$263,700	$263,700	$0.31	0	A	105,186.29	1.30
TAUNTON	24014	Foxborough	414,685.50	301	$1,134,200	$1,740,400	$4.20	1984	A	102,337.49	1.27
TAUNTON	24014	Foxborough	160,293.44	301	$426,800	$724,300	$4.52	1968	A	52,796.50	0.65
TAUNTON	24103	Foxborough	78,242.37	310	$161,700	$372,000	$4.75	2006	A	44,672.98	0.55
TAUNTON	24014	Foxborough	86,666.70	314	$234,800	$280,500	$3.24	1978	B	75,823.85	0.71
TAUNTON	24014	Foxborough	238,482.68	316	$929,800	$1,964,100	$8.24	1999	B	98,065.08	0.92
TAUNTON	24014	Foxborough	199,745.92	316	$1,411,500	$2,645,800	$13.25	1985	A	122,887.33	1.52
TAUNTON	24014	Foxborough	88,582.27	316	$139,500	$247,400	$2.79	1987	A	49,713.97	0.61
TAUNTON	24103	Foxborough	126,957.56	316	$356,700	$526,800	$4.15	1969	B	62,489.89	0.58
TAUNTON	24103	Foxborough	558,414.16	318	$362,400	$763,900	$1.37	0	A	246,477.37	3.05
TAUNTON	24014	Foxborough	216,799.56	324	$3,293,000	$6,218,900	$28.69	2001	B	191,558.71	1.79
TAUNTON	24014	Foxborough	84,999.23	326	$497,700	$1,104,000	$12.99	1784	A	71,530.81	0.88
TAUNTON	24014	Foxborough	166,150.99	326	$300,800	$1,135,600	$6.83	1960	A	99,778.23	1.23
TAUNTON	24014	Foxborough	163,975.50	330	$1,000,500	$2,291,000	$13.97	1988	A	157,432.97	1.95
TAUNTON	24014	Foxborough	180,148.21	330	$452,000	$972,500	$5.40	1984	B	89,813.20	0.84
TAUNTON	24014	Foxborough	59,730.67	332	$218,900	$334,000	$5.59	1950	A	56,201.85	0.69
TAUNTON	24014	Foxborough	234,132.33	340	$1,278,700	$3,997,500	$17.07	2001	B	128,899.50	1.20
TAUNTON	24014	Foxborough	61,468.08	340	$218,900	$623,300	$10.14	1960	B	50,549.90	0.47
TAUNTON	24014	Foxborough	200,272.62	374	$940,700	$1,624,700	$8.11	1990	B	157,061.21	1.47
TAUNTON	24014	Foxborough	1,248,826.96	386	$1,396,700	$2,905,500	$2.33	1900	B	411,036.46	3.84
TAUNTON	24014	Foxborough	68,812.27	390	$224,900	$224,900	$3.27	0	B	57,290.42	0.54
TAUNTON	24014	Foxborough	389,985.67	390	$1,610,700	$1,610,700	$4.13	0	B	91,737.50	0.86
TAUNTON	24103	Foxborough	503,556.98	390	$122,300	$122,300	$0.24	0	A	129,609.08	1.60
TAUNTON	24103	Foxborough	74,014.93	400	$88,400	$320,100	$4.32	1910	A	49,265.37	0.61
TAUNTON	24103	Foxborough	242,103.76	401	$228,500	$474,300	$1.96	1994	B	185,706.46	1.74
TAUNTON	24103	Foxborough	211,990.35	401	$280,800	$448,600	$2.12	2005	B	174,497.53	1.63
TAUNTON	24103	Foxborough	79,028.93	930	$131,400	$216,400	$2.74	0	A	49,844.52	0.62
TAUNTON	24103	Foxborough	316,877.05	931	$547,700	$1,675,900	$5.29	1900	A	218,708.94	2.70
TAUNTON	24014	Foxborough	1,267,572.33	953	$395,200	$607,100	$0.48	1900	A	185,725.68	2.30
NEPONSET	21016	Medfield	94,702.12	719	$273,150	$806,250	$8.51	1890	A	63,268.41	0.78
NEPONSET	21016	Medfield	106,553.83	719	$2,300	$2,300	$0.02	0	B	50,048.17	0.47
NEPONSET	21016	Medfield	283,050.95	719	$6,700	$6,700	$0.02	0	B	63,613.14	0.59
NEPONSET	21016	Medfield	548,074.59	814	$75,700	$115,300	$0.21	1950	B	46,764.30	0.44
NEPONSET	21016	Medfield	459,685.43	903	$193,700	$193,700	$0.42	0	A	108,958.52	1.35
NEPONSET	21016	Medfield	975,458.76	903	$343,100	$343,100	$0.35	0	B	53,464.24	0.50

Potential Stormwater Recharge: Initial Parcels Selceted By Hydrologic Criteria

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CHARLES	21125	Medfield	278,880.43	043	$556,900	$586,100	$2.10	1962	A	43,094.46	0.53
CHARLES	21125	Medfield	1,333,424.16	101	$1,566,100	$3,162,500	$2.37	1920	A	83,566.90	1.03
CHARLES	21125	Medfield	147,414.86	102	$0	$10,692,300	$72.53	1993	A	64,393.02	0.80
CHARLES	21127	Medfield	145,741.57	112	$621,800	$2,247,900	$15.42	1977	A	43,429.53	0.54
CHARLES	21127	Medfield	68,902.81	324	$750,000	$1,609,900	$23.36	1956	A	55,909.88	0.69
CHARLES	21127	Medfield	132,721.20	325	$1,093,300	$2,711,400	$20.43	1980	A	108,344.92	1.34
CHARLES	21125	Medfield	173,070.88	400	$680,000	$2,738,700	$15.82	1980	A	83,728.63	1.04
CHARLES	21125	Medfield	152,856.03	400	$578,000	$978,200	$6.40	1963	A	119,929.61	1.48
CHARLES	21127	Medfield	1,359,622.91	903	$2,116,600	$2,116,600	$1.56	0	A	239,970.39	2.97
CHARLES	21125	Medfield	181,583.41	903	$309,700	$613,700	$3.38	1973	A	86,132.48	1.07
CHARLES	21125	Medfield	750,728.30	903	$2,818,500	$20,786,400	$27.69	1942	A	264,792.00	3.27
CHARLES	21125	Medfield	120,341.39	903	$600,000	$1,669,600	$13.87	1975	A	65,498.01	0.81
NEPONSET	21126	Norwood	130,991.05	304	$2,865,000	$7,053,800	$53.85	1973	A	66,729.33	0.83
NEPONSET	21126	Norwood	344,268.58	316	$2,041,900	$6,751,700	$19.61	1966	A	293,346.84	3.63
NEPONSET	21126	Norwood	383,398.27	316	$2,543,900	$8,494,400	$22.16	1980	A	253,866.61	3.14
NEPONSET	21126	Norwood	1,615,649.86	316	$1,943,000	$15,652,400	$9.69	1999	A	761,740.13	9.42
NEPONSET	21126	Norwood	49,648.08	326	$1,008,700	$1,707,100	$34.38	1979	A	45,048.16	0.56
NEPONSET	21126	Norwood	99,515.89	326	$1,672,300	$3,048,500	$30.63	1970	A	86,349.69	1.07
NEPONSET	21126	Norwood	72,441.21	337	$550,200	$590,200	$8.15	0	A	50,986.53	0.63
NEPONSET	21126	Norwood	293,748.09	337	$1,440,700	$1,555,400	$5.30	0	B	231,785.46	2.17
NEPONSET	21126	Norwood	145,366.87	340	$1,433,400	$3,801,100	$26.15	1981	A	96,642.83	1.20
NEPONSET	21126	Norwood	313,629.35	340	$3,045,300	$5,924,400	$18.89	1979	A	217,745.80	2.69
NEPONSET	21126	Norwood	140,971.87	392	$88,900	$88,900	$0.63	0	A	61,575.51	0.76
NEPONSET	21126	Norwood	863,551.27	401	$3,533,600	$7,968,600	$9.23	1975	A	482,260.33	5.96
NEPONSET	21126	Norwood	818,368.20	401	$4,747,700	$18,621,400	$22.75	1974	A	628,145.90	7.77
NEPONSET	21126	Norwood	185,418.11	402	$771,700	$2,129,300	$11.48	1983	A	102,190.14	1.26
NEPONSET	21126	Norwood	539,223.28	404	$7,890,100	$13,420,000	$24.89	1980	A	306,778.56	3.79
NEPONSET	21154	Sharon	124,445.37	112	$1,988,000	$9,530,500	$76.58	2009	B	91,743.59	0.86
NEPONSET	21154	Sharon	146,046.61	130	$177,500	$177,500	$1.22	0	A	62,900.28	0.78
NEPONSET	21150	Sharon	111,526.43	301	$965,800	$1,780,500	$15.96	1950	A	76,464.24	0.95
NEPONSET	21150	Sharon	481,574.44	316	$1,134,400	$4,382,400	$9.10	1995	A	273,356.61	3.38
NEPONSET	21150	Sharon	135,794.84	316	$338,500	$1,147,000	$8.45	1996	A	62,258.46	0.77
NEPONSET	21150	Sharon	117,760.27	326	$450,300	$903,800	$7.67	1961	A	91,765.92	1.13
NEPONSET	21150	Sharon	102,086.90	340	$647,000	$1,794,200	$17.58	1985	A	71,490.79	0.88
NEPONSET	21150	Sharon	126,597.37	340	$712,300	$1,933,500	$15.27	1989	A	55,785.06	0.69
NEPONSET	21150	Sharon	136,612.47	400	$595,600	$1,219,000	$8.92	1975	B	93,233.38	0.87
NEPONSET	21150	Sharon	139,780.45	400	$897,400	$1,884,200	$13.48	1967	A	107,835.46	1.33
NEPONSET	21150	Sharon	224,526.62	400	$659,600	$1,473,800	$6.56	1981	A	73,502.98	0.91
NEPONSET	21150	Sharon	143,986.66	401	$594,200	$1,259,800	$8.75	1978	B	64,121.53	0.60
NEPONSET	21150	Sharon	103,770.36	401	$675,200	$1,784,500	$17.20	1988	A	81,334.74	1.01
NEPONSET	21150	Sharon	102,850.61	401	$647,000	$1,251,900	$12.17	1970	A	68,651.96	0.85

Potential Stormwater Recharge: Initial Parcels Selceted By Hydrologic Criteria

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NEPONSET	21150	Sharon	100,306.55	401	$647,000	$1,322,200	$13.18	1971	A	61,536.54	0.76
NEPONSET	21150	Sharon	436,925.31	401	$2,131,700	$11,799,800	$27.01	2002	A	234,386.59	2.90
NEPONSET	21150	Sharon	360,219.34	404	$1,025,800	$3,918,100	$10.88	1969	A	149,426.95	1.85
NEPONSET	21017	Sharon	8,642,105.78	805	$1,392,500	$4,099,900	$0.47	0	A	481,209.00	5.95
NEPONSET	21154	Sharon	2,023,412.39	932	$464,300	$464,300	$0.23	0	A	222,677.34	2.75
NEPONSET	21152	Sharon	601,532.72	934	$1,969,900	$8,845,000	$14.70	1954	A	190,129.19	2.35
NEPONSET	21154	Sharon	416,017.43	935	$367,600	$1,740,600	$4.18	1980	A	278,840.55	3.45
NEPONSET	21017	Sharon	5,959,157.15	953	$2,204,200	$2,675,600	$0.45	1962	B	787,484.22	7.36
NEPONSET	21154	Sharon	308,681.02		$0	$0	$0.00	0	B	69,143.59	0.65
NEPONSET	21017	Sharon	188,833.83		$0	$0	$0.00	0	B	46,820.14	0.44
NEPONSET	21154	Sharon	150,978.82		$0	$0	$0.00	0	B	80,227.14	0.75
NEPONSET	21154	Sharon	430,814.25		$0	$0	$0.00	0	A	245,452.99	3.04
NEPONSET	21150	Sharon	125,069.86		$0	$0	$0.00	0	B	53,590.96	0.50
TAUNTON	24103	Sharon	101,699.55	323	$305,900	$1,272,400	$12.51	1948	A	101,586.53	1.26
TAUNTON	24103	Sharon	2,465,879.96	390	$10,154,100	$10,154,100	$4.12	0	A	101,014.41	1.25
TAUNTON	24103	Sharon	990,928.37	393	$219,200	$428,700	$0.43	2000	A	57,231.55	0.71
TAUNTON	24103	Sharon	866,528.04	423	$400,700	$400,700	$0.46	0	A	84,807.29	1.05
TAUNTON	24103	Sharon	415,964.37	423	$147,300	$147,300	$0.35	0	A	60,879.46	0.75
TAUNTON	24103	Sharon	260,807.65	712	$211,200	$679,900	$2.61	2000	A	101,343.00	1.25
TAUNTON	24103	Sharon	491,738.12	934	$1,102,300	$8,375,000	$17.03	1954	A	197,325.60	2.44
TAUNTON	24103	Sharon	2,436,944.90	939	$752,900	$807,800	$0.33	1989	A	88,118.04	1.09
TAUNTON	24103	Sharon	3,238,057.90	955	$2,091,900	$2,091,900	$0.65	0	A	65,022.88	0.80
TAUNTON	24103	Sharon	1,494,647.63	960	$360,100	$360,100	$0.24	0	A	69,602.93	0.86
TAUNTON	24104	Sharon	126,083.75		$0	$0	$0.00	0	A	72,958.79	0.90
NEPONSET	21152	Stoughton	232,094.09	031	$170,300	$916,500	$3.95	1900	A	44,496.97	0.55
NEPONSET	21152	Stoughton	1,089,862.99	041	$253,400	$398,600	$0.37	1955	A	71,591.10	0.89
NEPONSET	21152	Stoughton	246,226.84	102	$0	$10,981,600	$44.60	1973	B	101,219.84	0.95
NEPONSET	21152	Stoughton	442,742.77	102	$0	$9,436,700	$21.31	1974	B	116,181.02	1.09
NEPONSET	21152	Stoughton	383,270.76	102	$0	$8,915,200	$23.26	1977	A	104,834.72	1.30
NEPONSET	21152	Stoughton	366,698.89	102	$0	$20,635,000	$56.27	1976	B	208,725.07	1.95
NEPONSET	21152	Stoughton	1,066,520.34	102	$0	$57,348,300	$53.77	1976	A	628,793.70	7.78
NEPONSET	21152	Stoughton	116,464.07	102	$0	$3,042,900	$26.13	1984	A	48,035.62	0.59
NEPONSET	21152	Stoughton	371,313.64	102	$0	$17,318,500	$46.64	1980	A	187,409.29	2.32
NEPONSET	21152	Stoughton	100,944.92	102	$0	$4,897,200	$48.51	1970	A	52,874.87	0.65
NEPONSET	21152	Stoughton	168,612.94	102	$0	$7,818,300	$46.37	1971	B	102,584.94	0.96
NEPONSET	21152	Stoughton	75,451.79	112	$960,000	$3,268,500	$43.32	1972	B	44,308.96	0.41
NEPONSET	21152	Stoughton	248,280.57	112	$1,440,000	$5,138,800	$20.70	1972	B	85,478.18	0.80
NEPONSET	21152	Stoughton	536,587.32	112	$2,640,000	$8,391,300	$15.64	2006	A	43,936.38	0.54
NEPONSET	21152	Stoughton	196,965.84	112	$1,275,000	$5,486,700	$27.86	1968	A	111,811.73	1.38
NEPONSET	21152	Stoughton	94,323.50	313	$329,300	$1,166,600	$12.37	1978	B	92,457.53	0.86
NEPONSET	21152	Stoughton	51,989.90	313	$186,000	$708,600	$13.63	1971	B	48,807.57	0.46

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NEPONSET	21152	Stoughton	640,148.02	313	$1,727,600	$3,085,900	$4.82	1968	A	472,918.47	5.85
NEPONSET	21152	Stoughton	86,539.09	313	$306,400	$847,000	$9.79	1978	B	83,387.48	0.78
NEPONSET	21152	Stoughton	74,451.58	316	$260,600	$831,600	$11.17	1970	B	65,716.01	0.61
NEPONSET	21152	Stoughton	221,324.82	316	$398,800	$1,254,400	$5.67	1983	A	112,945.49	1.40
NEPONSET	21152	Stoughton	80,281.94	316	$283,400	$1,228,100	$15.30	1976	A	68,760.97	0.85
NEPONSET	21152	Stoughton	71,188.86	316	$243,900	$665,700	$9.35	1972	A	63,146.96	0.78
NEPONSET	21152	Stoughton	214,133.89	316	$777,400	$2,817,100	$13.16	1983	A	156,951.30	1.94
NEPONSET	21152	Stoughton	98,216.16	316	$319,300	$769,100	$7.83	1970	A	78,796.06	0.97
NEPONSET	21152	Stoughton	59,647.49	316	$143,700	$433,300	$7.26	1950	A	55,418.79	0.69
NEPONSET	21152	Stoughton	70,646.21	316	$565,100	$1,090,100	$15.43	1903	A	55,539.45	0.69
NEPONSET	21152	Stoughton	137,502.84	316	$1,053,200	$2,797,100	$20.34	2002	A	94,354.92	1.17
NEPONSET	21152	Stoughton	146,021.24	318	$264,200	$442,600	$3.03	1980	A	49,213.44	0.61
NEPONSET	21152	Stoughton	99,783.67	323	$1,077,300	$4,948,800	$49.60	2002	A	78,794.70	0.97
NEPONSET	21152	Stoughton	273,880.37	323	$3,024,500	$6,256,100	$22.84	1981	B	247,823.15	2.32
NEPONSET	21152	Stoughton	230,789.02	324	$2,518,700	$6,175,900	$26.76	1988	A	200,722.27	2.48
NEPONSET	21152	Stoughton	106,278.32	325	$1,212,300	$4,081,700	$38.41	1958	A	99,300.55	1.23
NEPONSET	21152	Stoughton	54,380.40	325	$639,200	$1,526,800	$28.08	1960	A	48,790.99	0.60
NEPONSET	21152	Stoughton	57,647.77	326	$468,000	$1,311,900	$22.76	1986	A	49,521.96	0.61
NEPONSET	21152	Stoughton	62,651.33	337	$724,400	$735,700	$11.74	0	A	51,438.33	0.64
NEPONSET	21152	Stoughton	66,547.45	341	$693,300	$1,355,400	$20.37	2006	A	53,032.34	0.66
NEPONSET	21152	Stoughton	132,310.04	374	$449,800	$2,042,600	$15.44	2009	A	71,826.33	0.89
NEPONSET	21152	Stoughton	277,636.10	400	$717,800	$2,323,000	$8.37	1981	A	105,433.24	1.30
NEPONSET	21152	Stoughton	126,183.18	400	$221,100	$1,012,400	$8.02	1969	B	83,278.96	0.78
NEPONSET	21152	Stoughton	243,637.65	400	$835,500	$2,582,200	$10.60	1960	A	180,761.00	2.24
NEPONSET	21152	Stoughton	240,502.59	400	$566,500	$1,377,100	$5.73	1920	A	164,754.56	2.04
NEPONSET	21152	Stoughton	122,444.24	400	$510,500	$1,098,200	$8.97	1920	B	95,499.66	0.89
NEPONSET	21152	Stoughton	79,773.15	401	$252,000	$574,000	$7.20	1995	A	51,420.38	0.64
NEPONSET	21152	Stoughton	52,097.24	401	$176,000	$834,400	$16.02	1969	A	48,277.67	0.60
NEPONSET	21152	Stoughton	94,331.52	401	$242,100	$674,100	$7.15	0	A	65,305.38	0.81
NEPONSET	21152	Stoughton	202,199.76	404	$401,000	$1,191,000	$5.89	1952	A	130,779.76	1.62
NEPONSET	21152	Stoughton	233,664.29	440	$370,200	$370,200	$1.58	0	A	47,755.11	0.59
NEPONSET	21152	Stoughton	780,786.22	440	$917,200	$917,200	$1.17	0	A	47,222.87	0.58
NEPONSET	21152	Stoughton	84,845.90	444	$0	$2,105,400	$24.81	2004	A	69,452.21	0.86
NEPONSET	21152	Stoughton	58,714.12	900	$480,900	$807,000	$13.74	1976	B	57,098.08	0.53
NEPONSET	21152	Stoughton	191,084.04	901	$99,500	$99,500	$0.52	0	A	92,984.07	1.15
NEPONSET	21152	Stoughton	57,615.84	901	$126,900	$127,400	$2.21	0	A	43,519.62	0.54
NEPONSET	21152	Stoughton	146,868.35	902	$760,000	$1,913,900	$13.03	1958	A	47,038.91	0.58
NEPONSET	21152	Stoughton	674,546.16	903	$227,600	$1,800,200	$2.67	1957	A	103,305.00	1.28
NEPONSET	21152	Stoughton	125,857.43	903	$31,100	$31,100	$0.25	0	A	56,569.91	0.70
NEPONSET	21152	Stoughton	1,565,063.24	903	$330,500	$332,300	$0.21	0	A	112,391.06	1.39
NEPONSET	21152	Stoughton	372,122.15	903	$202,600	$4,118,900	$11.07	0	A	84,900.69	1.05

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NEPONSET	21152	Stoughton	155,523.69	903	$151,600	$83,992,096	$540.06	0	A	66,567.82	0.82
NEPONSET	21152	Stoughton	509,819.81	903	$205,400	$1,524,700	$2.99	1945	A	156,490.03	1.94
NEPONSET	21152	Stoughton	307,322.00	903	$183,900	$6,065,800	$19.74	1960	A	73,519.93	0.91
NEPONSET	21152	Stoughton	119,568.44	903	$148,200	$148,200	$1.24	0	A	45,696.15	0.57
NEPONSET	21152	Stoughton	884,261.83	903	$276,900	$10,683,600	$12.08	1900	A	392,190.38	4.85
NEPONSET	21152	Stoughton	672,308.73	903	$205,200	$3,167,100	$4.71	1971	A	212,442.61	2.63
NEPONSET	21152	Stoughton	67,871.71	903	$418,200	$2,490,900	$36.70	1997	A	63,608.05	0.79
NEPONSET	21152	Stoughton	106,894.28	903	$119,700	$615,900	$5.76	2003	A	100,085.19	1.24
NEPONSET	21152	Stoughton	82,002.86	903	$140,600	$3,217,100	$39.23	1957	A	52,404.21	0.65
NEPONSET	21152	Stoughton	323,363.37	903	$188,000	$188,000	$0.58	0	A	68,955.85	0.85
NEPONSET	21152	Stoughton	144,919.25	906	$135,800	$453,800	$3.13	1988	A	53,328.00	0.66
NEPONSET	21152	Stoughton	120,886.00	906	$130,700	$778,100	$6.44	1972	A	50,471.73	0.62
NEPONSET	21152	Stoughton	174,113.13	908	$525,000	$2,764,200	$15.88	1981	A	48,658.39	0.60
NEPONSET	21152	Stoughton	923,990.60	909	$296,400	$296,400	$0.32	0	A	143,554.00	1.78
NEPONSET	21152	Stoughton	1,154,736.82	920	$350,000	$363,900	$0.32	0	A	259,632.86	3.21
TAUNTON	24009	Stoughton	162,257.30	013	$113,600	$299,300	$1.84	1940	A	90,288.59	1.12
TAUNTON	24009	Stoughton	1,127,215.59	017	$165,778	$861,778	$0.76	2001	A	178,586.40	2.21
TAUNTON	24009	Stoughton	60,077.23	130	$177,400	$177,400	$2.95	0	B	60,061.28	0.56
TAUNTON	24008	Stoughton	1,001,740.98	305	$4,673,200	$12,371,000	$12.35	1989	A	413,199.15	5.11
TAUNTON	24009	Stoughton	81,654.81	311	$389,000	$909,600	$11.14	1977	B	72,082.16	0.67
TAUNTON	24009	Stoughton	70,080.08	316	$375,500	$631,000	$9.00	2003	B	55,443.36	0.52
TAUNTON	24008	Stoughton	162,114.96	318	$379,300	$549,200	$3.39	1930	B	45,591.16	0.43
TAUNTON	24007	Stoughton	65,502.78	323	$602,800	$1,880,200	$28.70	1963	B	51,449.20	0.48
TAUNTON	24008	Stoughton	67,604.45	355	$366,500	$779,400	$11.53	1974	B	50,777.68	0.47
TAUNTON	24007	Stoughton	810,953.05	400	$1,741,800	$5,372,400	$6.62	1980	B	332,550.57	3.11
TAUNTON	24007	Stoughton	76,375.07	400	$202,600	$779,900	$10.21	1937	A	60,171.51	0.74
TAUNTON	24007	Stoughton	255,093.12	401	$477,700	$1,225,600	$4.80	1979	A	76,022.57	0.94
TAUNTON	24007	Stoughton	56,126.17	410	$127,800	$127,800	$2.28	0	A	55,824.32	0.69
TAUNTON	24008	Stoughton	358,648.51	424	$178,000	$184,000	$0.51	0	B	67,727.86	0.63
TAUNTON	24007	Stoughton	831,899.32	905	$425,900	$6,073,400	$7.30	1987	B	225,961.62	2.11
TAUNTON	24007	Stoughton	488,612.36	906	$203,200	$1,329,700	$2.72	1960	A	97,124.60	1.20
NEPONSET	21150	Walpole	318,948.87	101	$194,700	$511,100	$1.60	1990	B	79,657.13	0.74
NEPONSET	21016	Walpole	284,218.23	101	$179,900	$700,500	$2.46	1998	A	86,322.76	1.07
NEPONSET	21016	Walpole	575,178.34	101	$231,300	$558,700	$0.97	1994	B	58,540.74	0.55
NEPONSET	21016	Walpole	2,087,026.78	102	$0	$54,428,900	$26.08	1999	A	630,595.72	7.80
NEPONSET	21016	Walpole	1,427,902.11	102	$0	$43,352,300	$30.36	1993	A	400,437.23	4.95
NEPONSET	21016	Walpole	323,176.04	102	$0	$8,245,800	$25.51	1985	A	90,891.89	1.12
NEPONSET	21150	Walpole	95,738.19	102	$0	$4,406,500	$46.03	1990	A	44,557.07	0.55
NEPONSET	21150	Walpole	865,153.04	112	$4,800,000	$30,077,000	$34.76	2004	A	696,217.23	8.61
NEPONSET	21150	Walpole	112,579.05	314	$293,200	$551,900	$4.90	1980	B	83,755.23	0.78
NEPONSET	21150	Walpole	104,137.67	316	$301,100	$901,600	$8.66	1900	A	81,644.22	1.01

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NEPONSET	21150	Walpole	102,442.40	316	$278,700	$1,192,000	$11.64	2000	A	51,931.42	0.64
NEPONSET	21150	Walpole	67,367.38	316	$387,500	$713,600	$10.59	1940	A	58,566.46	0.72
NEPONSET	21016	Walpole	146,481.89	322	$555,700	$720,500	$4.92	1985	A	68,181.28	0.84
NEPONSET	21016	Walpole	176,450.72	322	$543,100	$677,300	$3.84	1964	A	73,599.61	0.91
NEPONSET	21016	Walpole	131,332.81	326	$334,700	$1,246,400	$9.49	1924	A	83,685.40	1.03
NEPONSET	21016	Walpole	273,552.55	332	$407,100	$1,086,700	$3.97	1962	A	104,663.10	1.29
NEPONSET	21150	Walpole	352,397.76	332	$1,357,500	$2,421,500	$6.87	1965	A	236,569.46	2.93
NEPONSET	21150	Walpole	74,481.16	337	$341,400	$341,400	$4.58	0	A	62,685.20	0.78
NEPONSET	21150	Walpole	581,644.92	371	$2,687,700	$6,183,800	$10.63	1995	B	274,815.85	2.57
NEPONSET	21150	Walpole	1,065,715.47	387	$419,200	$486,100	$0.46	1999	B	93,250.80	0.87
NEPONSET	21150	Walpole	172,162.02	390	$374,600	$399,600	$2.32	0	A	113,621.22	1.40
NEPONSET	21150	Walpole	108,931.25	400	$290,600	$857,300	$7.87	1989	A	72,629.05	0.90
NEPONSET	21016	Walpole	252,356.93	400	$478,800	$3,497,300	$13.86	1974	A	131,704.75	1.63
NEPONSET	21150	Walpole	956,963.99	400	$992,200	$1,061,700	$1.11	1956	A	80,553.16	1.00
NEPONSET	21150	Walpole	105,462.10	400	$249,700	$890,000	$8.44	1900	B	89,565.83	0.84
NEPONSET	21150	Walpole	106,042.84	400	$319,000	$1,016,800	$9.59	1965	A	53,280.05	0.66
NEPONSET	21016	Walpole	78,669.80	401	$233,200	$1,172,600	$14.91	1989	A	43,773.86	0.54
NEPONSET	21016	Walpole	104,231.62	401	$278,200	$573,500	$5.50	1998	A	55,973.55	0.69
NEPONSET	21150	Walpole	46,356.18	401	$212,700	$480,800	$10.37	2005	A	46,356.18	0.57
NEPONSET	21016	Walpole	186,896.27	401	$385,600	$1,354,600	$7.25	1967	A	114,176.74	1.41
NEPONSET	21150	Walpole	294,819.61	402	$583,800	$5,705,900	$19.35	1986	A	230,272.10	2.85
NEPONSET	21150	Walpole	272,210.62	402	$449,700	$2,998,300	$11.01	2002	A	173,809.67	2.15
NEPONSET	21150	Walpole	405,079.60	402	$663,700	$5,282,000	$13.04	1989	A	237,233.11	2.93
NEPONSET	21150	Walpole	259,214.09	402	$413,400	$3,044,000	$11.74	2004	A	176,294.89	2.18
NEPONSET	21150	Walpole	103,869.72	402	$335,600	$1,978,800	$19.05	1986	A	65,062.10	0.80
NEPONSET	21150	Walpole	233,749.23	402	$490,700	$3,170,900	$13.57	1996	A	182,119.14	2.25
NEPONSET	21150	Walpole	428,758.46	402	$605,700	$3,050,600	$7.11	1999	A	256,883.86	3.18
NEPONSET	21016	Walpole	473,458.93	410	$564,400	$587,400	$1.24	1900	A	75,414.85	0.93
NEPONSET	21016	Walpole	655,075.64	410	$110,900	$110,900	$0.17	0	A	221,581.24	2.74
NEPONSET	21016	Walpole	1,447,594.55	410	$1,088,000	$1,560,200	$1.08	1979	A	1,072,510.54	13.26
NEPONSET	21016	Walpole	2,173,594.95	423	$755,700	$755,700	$0.35	0	A	414,529.94	5.13
NEPONSET	21150	Walpole	969,712.48	424	$1,725,500	$1,787,100	$1.84	1930	A	121,078.04	1.50
NEPONSET	21150	Walpole	122,380.65	440	$258,900	$258,900	$2.12	0	B	77,537.26	0.72
NEPONSET	21150	Walpole	70,626.61	441	$70,000	$70,000	$0.99	0	A	56,161.60	0.69
NEPONSET	21150	Walpole	976,987.20	441	$612,100	$614,200	$0.63	0	A	165,306.48	2.04
NEPONSET	21150	Walpole	292,978.43	442	$172,400	$172,400	$0.59	0	A	58,728.33	0.73
NEPONSET	21016	Walpole	262,528.65	442	$58,000	$58,000	$0.22	0	A	51,267.59	0.63
NEPONSET	21016	Walpole	724,302.46	442	$157,500	$157,500	$0.22	0	A	130,094.30	1.61
NEPONSET	21016	Walpole	192,670.72	442	$49,300	$49,300	$0.26	0	A	103,160.34	1.28
NEPONSET	21016	Walpole	834,962.93	442	$142,800	$142,800	$0.17	0	A	352,351.54	4.36
NEPONSET	21016	Walpole	722,427.26	442	$116,000	$116,000	$0.16	0	A	127,972.88	1.58

Potential Stormwater Recharge: Initial Parcels Selceted By Hydrologic Criteria

Major Watershed	Subwatershed ID	Town	Parcel Area (Sq Ft)	LUC	Land Value	Total Value	Dollars/Sq Ft	Yr. Built	Soil Group	Total Imperv (sq ft)	Total Recharge (mil gal/yr)
NEPONSET	21150	Walpole	212,001.81	442	$22,400	$22,400	$0.11	0	A	89,250.86	1.10
NEPONSET	21150	Walpole	1,147,918.54	931	$1,095,200	$2,571,500	$2.24	1955	A	210,055.28	2.60
NEPONSET	21150	Walpole	1,184,244.16	933	$381,600	$635,200	$0.54	0	B	43,695.28	0.41
NEPONSET	21016	Walpole	483,590.50	934	$1,417,200	$9,898,700	$20.47	1979	A	189,559.41	2.34
NEPONSET	21150	Walpole	248,120.13	934	$1,524,400	$7,841,800	$31.60	1900	A	140,504.95	1.74
NEPONSET	21016	Walpole	2,242,772.14	934	$2,090,200	$6,189,500	$2.76	1970	A	231,268.63	2.86
NEPONSET	21150	Walpole	558,770.67	934	$4,125,700	$21,025,800	$37.63	1920	A	306,491.67	3.79
NEPONSET	21150	Walpole	234,313.18	934	$1,468,100	$2,661,000	$11.36	1914	B	107,763.96	1.01
NEPONSET	21150	Walpole	687,627.08	953	$1,183,700	$1,183,700	$1.72	0	A	91,827.73	1.14
NEPONSET	21126	Westwood	237,937.96	330	$2,885,850	$9,088,000	$38.19	2003	A	155,481.05	1.92
NEPONSET	21107	Westwood	331,427.60	337	$0	$0	$0.00	0	A	185,951.00	2.30
NEPONSET	21126	Westwood	73,161.43	340	$0	$0	$0.00	0	A	49,815.13	0.62
NEPONSET	21126	Westwood	55,533.66	340	$1,074,150	$2,680,950	$48.28	1971	A	43,381.33	0.54
NEPONSET	21107	Westwood	313,899.05	340	$7,114,200	$15,861,100	$50.53	1985	B	199,377.27	1.86
NEPONSET	21107	Westwood	100,090.11	340	$1,272,450	$4,441,800	$44.38	1980	B	65,786.93	0.61
NEPONSET	21126	Westwood	1,939,940.54	380	$608,250	$1,755,500	$0.90	1980	A	62,840.19	0.78
NEPONSET	21126	Westwood	213,561.24	390	$591,850	$591,850	$2.77	0	B	128,175.17	1.20
NEPONSET	21107	Westwood	464,077.29	390	$5,112,450	$5,137,700	$11.07	0	A	285,257.39	3.53
NEPONSET	21107	Westwood	482,539.28	390	$5,424,450	$5,460,250	$11.32	0	A	380,413.40	4.70
NEPONSET	21107	Westwood	251,929.90	390	$2,731,450	$2,745,850	$10.90	0	A	168,221.07	2.08
NEPONSET	21107	Westwood	706,191.71	390	$11,495,300	$11,495,300	$16.28	0	A	293,310.46	3.63
NEPONSET	21126	Westwood	177,059.57	401	$680,700	$901,000	$5.09	1960	A	143,042.06	1.77
NEPONSET	21126	Westwood	196,120.27	401	$2,261,250	$3,775,700	$19.25	1974	A	170,831.21	2.11
NEPONSET	21126	Westwood	75,041.70	401	$866,500	$1,936,050	$25.80	1969	A	73,709.42	0.91
NEPONSET	21126	Westwood	143,827.52	401	$852,700	$1,921,100	$13.36	1973	A	85,379.33	1.06
NEPONSET	21126	Westwood	513,870.93	402	$4,527,200	$6,678,250	$13.00	1983	A	369,066.06	4.56
NEPONSET	21126	Westwood	462,660.20	404	$4,236,450	$11,312,500	$24.45	1970	A	239,098.89	2.96
NEPONSET	21126	Westwood	58,721.14	404	$687,050	$1,440,900	$24.54	1958	A	45,851.03	0.57
NEPONSET	21126	Westwood	80,212.95	404	$948,550	$2,117,850	$26.40	1960	A	61,080.93	0.76
NEPONSET	21107	Westwood	255,416.60	440	$2,793,850	$2,793,850	$10.94	0	A	161,136.13	1.99
NEPONSET	21107	Westwood	239,989.50	440	$3,907,400	$3,907,400	$16.28	0	A	171,573.44	2.12
CHARLES	21036	Westwood	51,192.02	323	$437,900	$1,048,200	$20.48	1964	B	47,705.13	0.45
CHARLES	21036	Westwood	968,419.09	805	$395,000	$483,600	$0.50	1900	B	54,884.80	0.51
			183,526,611.49							57,854,837.18	674.06

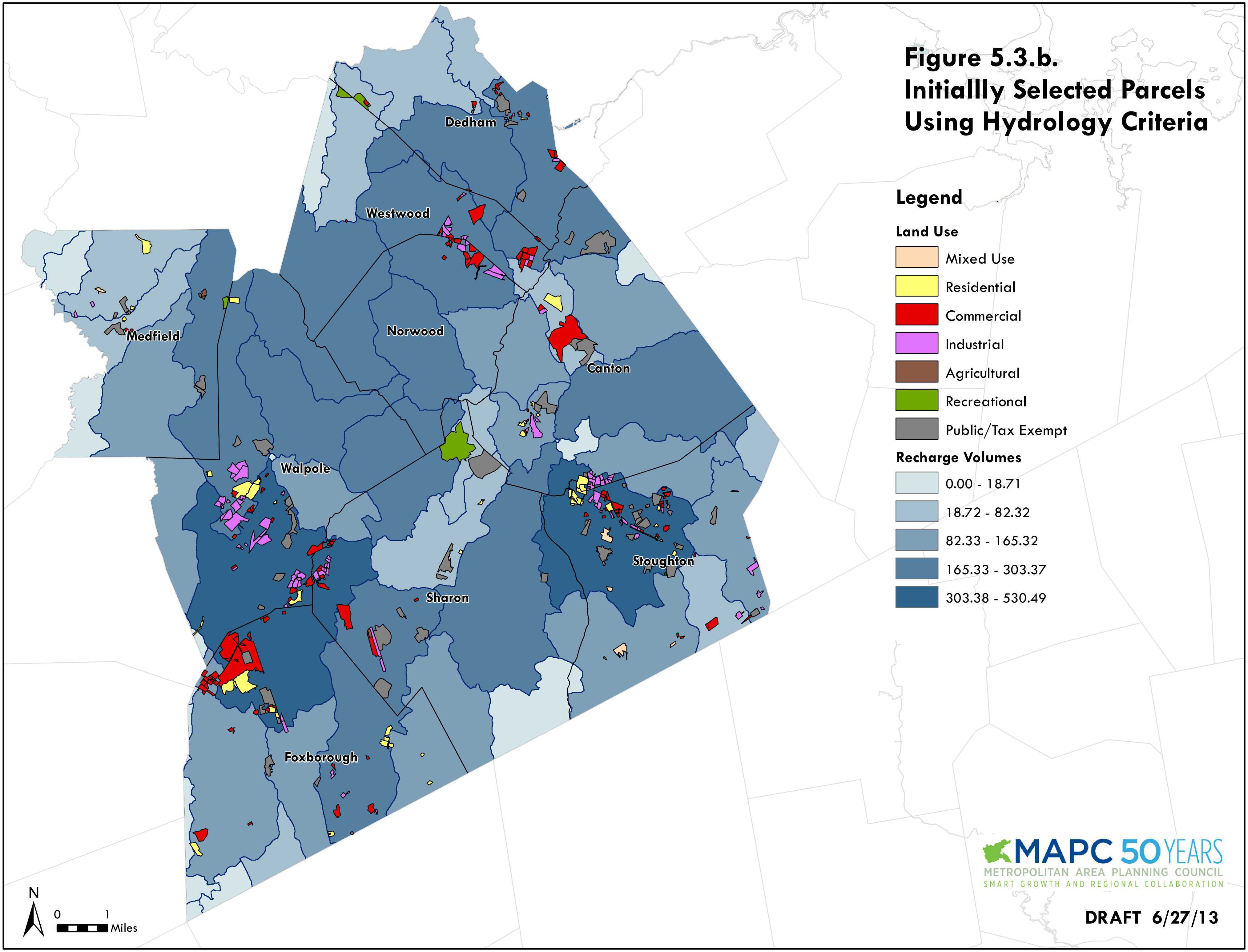


Figure 5.3.b. Initiallly Selected Parcels Using Hydrology Criteria

The last phase of this analysis included the disaggregation of these 120 selected parcels into the two primary Land Use Codes: Public/Tax Exempt and Commercial, in order for municipalities to best organize and prioritize which areas to focus on. As shown in Table 5.3, there are thirty nine (39) local or state owned and/or managed properties. It is commonly stated that these parcels would have the greatest potential for proactive retrofit and/or implementation of stormwater infiltration facilities since local/state entities can more easily access funding and capital resources to move these projects forward. However, municipal officials should recognize that commercial (and residential) properties, also generate stormwater, and therefore; have a significant responsibility to assist in protecting and replenishing groundwater. Therefore, we have also included a list of the selected seventy-seven (77) commercial parcels that have the greatest potential for recharging to groundwater, as shown in Table 5-3.

Table 5-3 Priority Recharge Opportunities Already Developed Parcels – Public/Tax Exempt

Major Basin	Hydrologic Unit ID	Town	Soil Grp.	Parcel Size (Sq Ft)	Land Use Code	Yr. Bldg. Built	Parcel Value	Parcel Value Per Sq Ft	Imperv (acres)	Rech. (MGY)
NEPONSET	21152	Canton	A	158,493.00	954	1960	$723,300	$4.56	1.40	0.75
NEPONSET	21137	Canton	B	2,236,301.92	934	1956	$41,014,700	$18.34	18.98	7.72
NEPONSET	21137	Canton	B	518,540.06	959	1973	$3,257,400	$6.28	1.87	0.76
NEPONSET	21107	Dedham	A	75,901.70	931	1930	$1,087,000	$14.32	1.02	0.55
NEPONSET	21107	Dedham	B	1,810,851.54	931	1960	$1,063,800	$0.59	10.26	4.17
NEPONSET	21107	Dedham	B	474,593.99	934	1970	$19,761,800	$41.64	5.00	2.03
NEPONSET	21107	Dedham	B	708,314.39	934	1950	$5,053,600	$7.13	3.27	1.33
NEPONSET	21107	Dedham	B	204,371.20	970	1977	$5,964,200	$29.18	1.95	0.80
NEPONSET	21107	Dedham	B	167,536.86	934	1921	$2,627,100	$15.68	1.54	0.63
NEPONSET	21107	Dedham	B	80,133.87	931	1950	$1,246,100	$15.55	1.21	0.49
TAUNTON	24103	Foxborough	A	316,877.05	931	1900	$1,675,900	$5.29	5.02	2.70
TAUNTON	24014	Foxborough	A	1,267,572.33	953	1900	$607,100	$0.48	4.26	2.30
NEPONSET	21150	Foxborough	B	203,939.48	970	1980	$4,792,800	$23.50	1.56	0.64
CHARLES	21125	Medfield	A	750,728.30	903	1942	$20,786,400	$27.69	6.08	3.27
CHARLES	21125	Medfield	A	181,583.41	903	1973	$613,700	$3.38	1.98	1.07
CHARLES	21125	Medfield	A	120,341.39	903	1975	$1,669,600	$13.87	1.50	0.81
NEPONSET	21154	Sharon	A	416,017.43	935	1980	$1,740,600	$4.18	6.40	3.45
TAUNTON	24103	Sharon	A	491,738.12	934	1954	$8,375,000	$17.03	4.53	2.44
NEPONSET	21152	Sharon	A	601,532.72	934	1954	$8,845,000	$14.70	4.36	2.35
TAUNTON	24103	Sharon	A	2,436,944.90	939	1989	$807,800	$0.33	2.02	1.09
NEPONSET	21017	Sharon	B	5,959,157.15	953	1962	$2,675,600	$0.45	18.08	7.36
NEPONSET	21152	Stoughton	A	884,261.83	903	1900	$10,683,600	$12.08	9.00	4.85
NEPONSET	21152	Stoughton	A	672,308.73	903	1971	$3,167,100	$4.71	4.88	2.63
NEPONSET	21152	Stoughton	A	509,819.81	903	1945	$1,524,700	$2.99	3.59	1.94
NEPONSET	21152	Stoughton	A	674,546.16	903	1957	$1,800,200	$2.67	2.37	1.28
NEPONSET	21152	Stoughton	A	307,322.00	903	1960	$6,065,800	$19.74	1.69	0.91
NEPONSET	21152	Stoughton	A	67,871.71	903	1997	$2,490,900	$36.70	1.46	0.79
NEPONSET	21152	Stoughton	A	144,919.25	906	1988	$453,800	$3.13	1.22	0.66
NEPONSET	21152	Stoughton	A	82,002.86	903	1957	$3,217,100	$39.23	1.20	0.65
NEPONSET	21152	Stoughton	A	120,886.00	906	1972	$778,100	$6.44	1.16	0.62
NEPONSET	21152	Stoughton	A	174,113.13	908	1981	$2,764,200	$15.88	1.12	0.60
NEPONSET	21152	Stoughton	A	146,868.35	902	1958	$1,913,900	$13.03	1.08	0.58
NEPONSET	21152	Stoughton	B	58,714.12	900	1976	$807,000	$13.74	1.31	0.53
NEPONSET	21150	Walpole	A	558,770.67	934	1920	$21,025,800	$37.63	7.04	3.79
NEPONSET	21016	Walpole	A	2,242,772.14	934	1970	$6,189,500	$2.76	5.31	2.86
NEPONSET	21150	Walpole	A	1,147,918.54	931	1955	$2,571,500	$2.24	4.82	2.60
NEPONSET	21016	Walpole	A	483,590.50	934	1979	$9,898,700	$20.47	4.35	2.34
NEPONSET	21150	Walpole	A	248,120.13	934	1900	$7,841,800	$31.60	3.23	1.74
NEPONSET	21150	Walpole	B	234,313.18	934	1914	$2,661,000	$11.36	2.47	1.01
								TOTALS:	**159.59**	**77.09**

Table 5-4 Priority Recharge Opportunities Already Developed Parcels – Commercial

Major Basin	Hydro logic Unit Id	Town	Soil Grp.	Parcel (Sq Ft)	LUC	Yr. Built	Parcel Value	$ Per Sq Ft	Imper. (acr)	Rech. (MGY)
NEPONSET	21040	Canton	A	8,304,103.62	380	1956	$9,318,400	1.12	10.07	5.42
NEPONSET	21040	Canton	A	284,454.06	340	1983	$2,444,100	8.59	1.80	0.97
NEPONSET	21137	Canton	B	65,809.70	332	1976	$811,000	12.32	1.21	0.49
NEPONSET	21137	Canton	B	55,490.31	332	1952	$734,200	13.23	1.17	0.47
NEPONSET	21137	Canton	B	50,511.21	310	1950	$301,000	5.96	1.16	0.47
NEPONSET	21107	Dedham	A	645,030.97	316	1964	$10,784,600	16.72	11.96	6.44
NEPONSET	21107	Dedham	A	181,009.94	310	1977	$7,029,500	38.83	3.47	1.87
NEPONSET	21107	Dedham	A	175,727.79	316	1932	$2,364,300	13.45	3.34	1.80
NEPONSET	21107	Dedham	A	407,891.13	332	1940	$933,100	2.29	3.31	1.79
NEPONSET	21107	Dedham	A	102,020.97	375	1989	$807,800	7.92	1.77	0.95
CHARLES	21113	Dedham	A	206,089.18	340	1954	$3,272,300	15.88	1.47	0.79
NEPONSET	21107	Dedham	A	59,275.69	332	1960	$540,400	9.12	1.09	0.59
NEPONSET	21107	Dedham	B	90,329.07	323	1969	$4,135,700	45.78	1.84	0.75
NEPONSET	21107	Dedham	B	96,720.04	340	1981	$4,792,800	49.55	1.71	0.69
NEPONSET	21107	Dedham	B	54,772.25	316	1973	$843,000	15.39	1.08	0.44
NEPONSET	21150	Foxborough	A	9,851,699.84	366	1995	$15,910,700	1.62	159.44	85.88
TAUNTON	24014	Foxborough	A	163,975.50	330	1988	$2,291,000	13.97	3.61	1.95
TAUNTON	24014	Foxborough	A	199,745.92	316	1985	$2,645,800	13.25	2.82	1.52
TAUNTON	24014	Foxborough	A	414,685.50	301	1984	$1,740,400	4.20	2.35	1.27
TAUNTON	24014	Foxborough	A	166,150.99	326	1960	$1,135,600	6.83	2.29	1.23
NEPONSET	21150	Foxborough	A	247,073.37	326	1997	$840,500	3.40	2.23	1.20
TAUNTON	24014	Foxborough	A	84,999.23	326	1784	$1,104,000	12.99	1.64	0.88
NEPONSET	21150	Foxborough	A	69,409.48	323	1988	$1,843,300	26.56	1.57	0.85
TAUNTON	24014	Foxborough	A	59,730.67	332	1950	$334,000	5.59	1.29	0.69
TAUNTON	24014	Foxborough	A	160,293.44	301	1968	$724,300	4.52	1.21	0.65
TAUNTON	24014	Foxborough	A	88,582.27	316	1987	$247,400	2.79	1.14	0.61
TAUNTON	24014	Foxborough	B	1,248,826.96	386	1900	$2,905,500	2.33	9.44	3.84
NEPONSET	21150	Foxborough	B	277,999.21	338	1967	$588,500	2.12	5.72	2.33
TAUNTON	24014	Foxborough	B	200,272.62	374	1990	$1,624,700	8.11	3.61	1.47
NEPONSET	21150	Foxborough	B	140,274.37	332	1996	$1,232,700	8.79	2.31	0.94
TAUNTON	24014	Foxborough	B	180,148.21	330	1984	$972,500	5.40	2.06	0.84
TAUNTON	24014	Foxborough	B	86,666.70	314	1978	$280,500	3.24	1.74	0.71
TAUNTON	24103	Foxborough	B	126,957.56	316	1969	$526,800	4.15	1.43	0.58
NEPONSET	21150	Foxborough	B	91,841.00	316	1980	$380,900	4.15	1.26	0.51
TAUNTON	24014	Foxborough	B	61,468.08	340	1960	$623,300	10.14	1.16	0.47
CHARLES	21127	Medfield	A	132,721.20	325	1980	$2,711,400	20.43	2.49	1.34
CHARLES	21127	Medfield	A	68,902.81	324	1956	$1,609,900	23.36	1.28	0.69
NEPONSET	21150	Sharon	A	481,574.44	316	1995	$4,382,400	9.10	6.28	3.38
TAUNTON	24103	Sharon	A	101,699.55	323	1948	$1,272,400	12.51	2.33	1.26
NEPONSET	21150	Sharon	A	117,760.27	326	1961	$903,800	7.67	2.11	1.13
NEPONSET	21150	Sharon	A	111,526.43	301	1950	$1,780,500	15.96	1.76	0.95
NEPONSET	21150	Sharon	A	102,086.90	340	1985	$1,794,200	17.58	1.64	0.88
NEPONSET	21150	Sharon	A	135,794.84	316	1996	$1,147,000	8.45	1.43	0.77
NEPONSET	21150	Sharon	A	126,597.37	340	1989	$1,933,500	15.27	1.28	0.69
NEPONSET	21152	Stoughton	A	640,148.02	313	1968	$3,085,900	4.82	10.86	5.85
TAUNTON	24008	Stoughton	A	1,001,740.98	305	1989	$12,371,000	12.35	9.49	5.11
NEPONSET	21152	Stoughton	A	230,789.02	324	1988	$6,175,900	26.76	4.61	2.48

Major Basin	Hydro logic Unit Id	Town	Soil Grp.	Parcel (Sq Ft)	LUC	Yr. Built	Parcel Value	$ Per Sq Ft	Imper. (acr)	Rech. (MGY)
NEPONSET	21152	Stoughton	A	214,133.89	316	1983	$2,817,100	13.16	3.60	1.94
NEPONSET	21152	Stoughton	A	221,324.82	316	1983	$1,254,400	5.67	2.59	1.40
NEPONSET	21152	Stoughton	A	106,278.32	325	1958	$4,081,700	38.41	2.28	1.23
NEPONSET	21152	Stoughton	A	98,216.16	316	1970	$769,100	7.83	1.81	0.97
NEPONSET	21152	Stoughton	A	80,281.94	316	1976	$1,228,100	15.30	1.58	0.85
NEPONSET	21152	Stoughton	A	71,188.86	316	1972	$665,700	9.35	1.45	0.78
NEPONSET	21152	Stoughton	A	70,646.21	316	1903	$1,090,100	15.43	1.28	0.69
NEPONSET	21152	Stoughton	A	59,647.49	316	1950	$433,300	7.26	1.27	0.69
NEPONSET	21152	Stoughton	A	57,647.77	326	1986	$1,311,900	22.76	1.14	0.61
NEPONSET	21152	Stoughton	A	146,021.24	318	1980	$442,600	3.03	1.13	0.61
NEPONSET	21152	Stoughton	A	54,380.40	325	1960	$1,526,800	28.08	1.12	0.60
NEPONSET	21152	Stoughton	B	273,880.37	323	1981	$6,256,100	22.84	5.69	2.32
NEPONSET	21152	Stoughton	B	94,323.50	313	1978	$1,166,600	12.37	2.12	0.86
NEPONSET	21152	Stoughton	B	86,539.09	313	1978	$847,000	9.79	1.91	0.78
TAUNTON	24009	Stoughton	B	81,654.81	311	1977	$909,600	11.14	1.65	0.67
NEPONSET	21152	Stoughton	B	74,451.58	316	1970	$831,600	11.17	1.51	0.61
TAUNTON	24008	Stoughton	B	67,604.45	355	1974	$779,400	11.53	1.17	0.47
NEPONSET	21152	Stoughton	B	51,989.90	313	1971	$708,600	13.63	1.12	0.46
TAUNTON	24008	Stoughton	B	162,114.96	318	1930	$549,200	3.39	1.05	0.43
NEPONSET	21150	Walpole	A	352,397.76	332	1965	$2,421,500	6.87	5.43	2.93
NEPONSET	21016	Walpole	A	273,552.55	332	1962	$1,086,700	3.97	2.40	1.29
NEPONSET	21016	Walpole	A	131,332.81	326	1924	$1,246,400	9.49	1.92	1.03
NEPONSET	21150	Walpole	A	104,137.67	316	1900	$901,600	8.66	1.87	1.01
NEPONSET	21016	Walpole	A	176,450.72	322	1964	$677,300	3.84	1.69	0.91
NEPONSET	21016	Walpole	A	146,481.89	322	1985	$720,500	4.92	1.57	0.84
NEPONSET	21150	Walpole	A	67,367.38	316	1940	$713,600	10.59	1.34	0.72
NEPONSET	21150	Walpole	B	581,644.92	371	1995	$6,183,800	10.63	6.31	2.57
NEPONSET	21150	Walpole	B	112,579.05	314	1980	$551,900	4.90	1.92	0.78
NEPONSET	21107	Westwood	B	313,899.05	340	1985	$15,861,100	50.53	4.58	1.86
NEPONSET	21107	Westwood	B	100,090.11	340	1980	$4,441,800	44.38	1.51	0.61
								TOTALS:	**366.34**	**188.4**

5.3.2 Future Development Predictions

An analysis was conducted to determine the possible increase in impervious cover from future development. Estimates for future commercial development were based upon data for Transportation Analysis Zones (TAZ), which assigns information on population, employment, and households to specific locations. The recharge likely needed to satisfy the MA Stormwater Standards, and the recharge possible under an “extra recharge” scenario for new development, based on TAZ data, was calculated, as shown in Table 5.5.

This scenario evaluates what would happen if communities were to adopt rules requiring new development to recharge stormwater at rates higher than currently required by the MA Stormwater Policy in depleted Hydrologic Units, such that the additional increment above the standard stormwater policy requirements could be counted as a SWMI credit against the increased water demand associated with the new development

Communities could structure such a requirement in any number of ways, but this analysis assumes that the annual stormwater recharge volume would be modestly increased by approximately 8%. This equates to requiring the capture of 0.75 inches of runoff per event for Group A soils and 0.45 inches for Group B soils versus the 0.6 and 0.35 inches required respectively under the DEP stormwater standards. The difference in recharge between the two is the possible Recharge "Credit." Under this scenario the potential SWMI credit totals 0.02 MGD (7.3 MGY) across the study area (see Figure 5-4).

5.3.3 Conclusions

There is a tremendous opportunity within the project area to replenish water supplies and stream flow via recharging stormwater runoff to groundwater, both from the retrofitting of existing impervious surfaces and from increasing recharge requirements for future development projects.

The total volume of recharge that would be gained by bringing all existing impervious surfaces in the watershed into compliance with the recharge requirements of the MA Stormwater Policy would be on the order of 15.3 MGD.

Retrofitting a small minority of parcels selected as priority retrofit opportunities; representing approximately one-fifth of one percent of all parcels in the study area, would achieve approximately 0.73 MGD of recharge. As shown in Table 5.3, public/tax exempt parcels, in net-depleted watersheds across the study area, include 159.59 acres of impervious surfaces from development. If stormwater infiltration was implemented on these parcels, 0.21 million gallons per day (77.09 million gallons per year) of recharge would replenish groundwater resources. Commercial parcels include approximately double the amount of impervious surface: 366.34 acres; and would generate 0.52 million gallons per day (188.4 million gallons per year) of stormwater recharge to net-depleted Hydrologic Units (Figure 5.5).

Lastly as discussed above, applying a very modest requirement for additional recharge to potential new development projects would add 0.02 million gallons a day (7.3 MGY).

Retrofitting the selected existing municipal and commercial parcels, and requiring that new development meet stricter recharge standards, would provide a total recharge volume of 0.75 million gallons per day (273.7 million gallons per year) across the study area. This is a significant volume of recharge that would be quite possible to achieve. As shown in both tables, the average number of parcels that each municipality would need to address is about 5 public properties and 10 commercial properties per town. Using different selection criteria, the model could easily be used to identify alternative potential recharge areas (for example sites with less than one acre of impervious cover).

5.4 Recommendations

Generally, it is recommended that municipalities within the study area utilize the data provided to either enhance existing or prepare new stormwater management plans, policies and regulations to ensure that groundwater supplies are replenished. In order to adequately achieve this recommendation, municipalities will need to consider making strides on stormwater recharge that go above and beyond the current Stormwater Standards to account for new development that will occur, as well as changing climate conditions. Communities can also realize significant efficiencies by integrating SWMI related stormwater management efforts with actions that will be required separately under anticipated revisions to the EPA municipal stormwater permitting program (MS4 permit).

It is recommended that municipalities consider both a percent volume approach to recharge, as well as a percent area method. The percent volume approach, which the Stormwater Recharge Standard is based on, promotes infiltration of the recharge volume using one or more approved structural practices (e.g.,

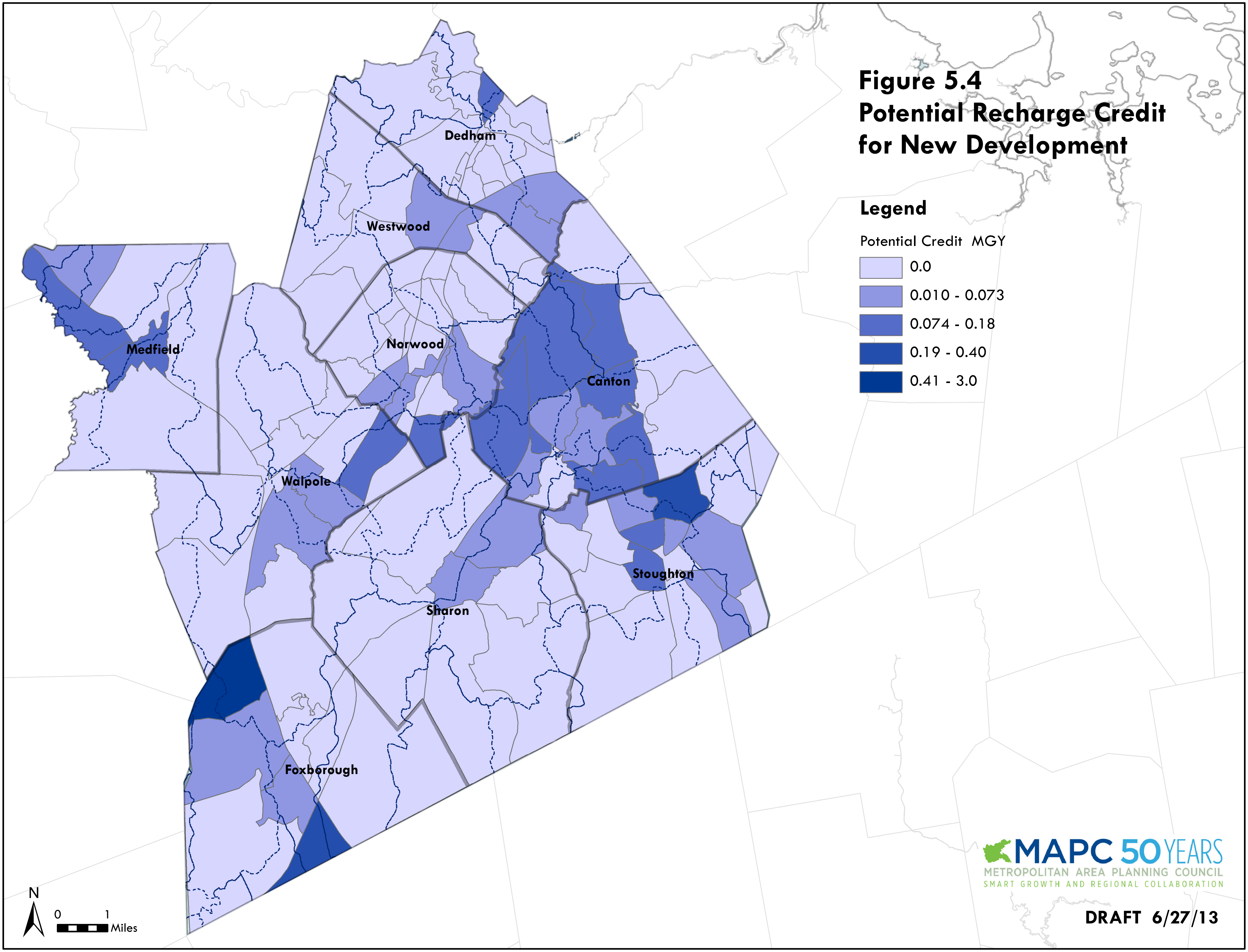


Figure 5.4
Potential Recharge Credit
for New Development
Legend
Potential Credit MGY
0.0
0.010 - 0.073
0.074 - 0.18
0.19 - 0.40
0.41 - 3.0
Dedham
Westwood
Medfield
Norwood
Canton
Walpole
Stoughton
Sharon
Foxborough
N
0 1
Miles
MAPC 50 YEARS
METROPOLITAN AREA PLANNING COUNCIL
SMART GROWTH AND REGIONAL COLLABORATION
DRAFT 6/27/13

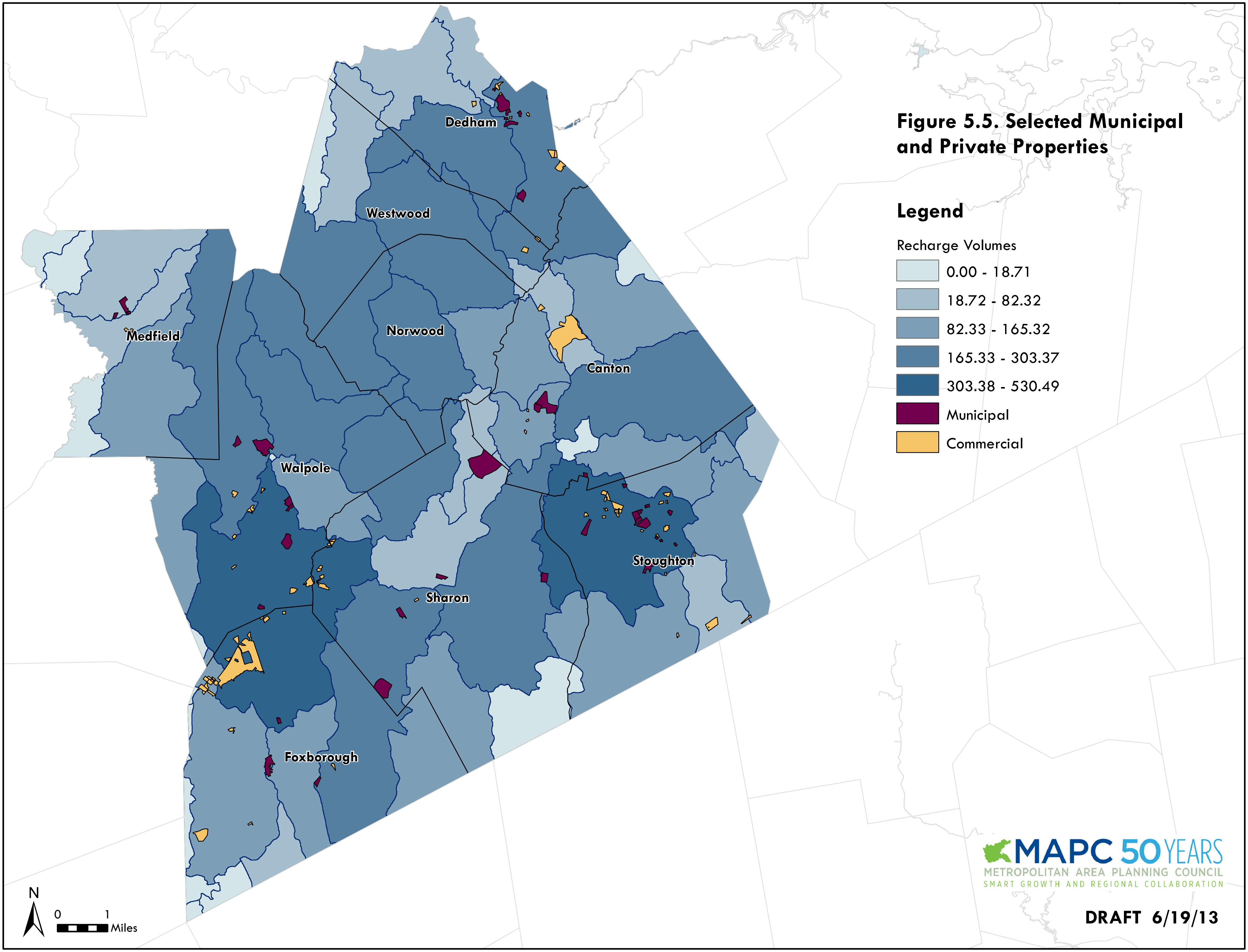


Figure 5.5. Selected Municipal and Private Properties
Legend
Recharge Volumes
0.00 - 18.71
18.72 - 82.32
82.33 - 165.32
165.33 - 303.37
303.38 - 530.49
Municipal
Commercial
Dedham
Westwood
Medfield
Norwood
Canton
Walpole
Stoughton
Sharon
Foxborough
N
0
1
Miles
MAPC 50 YEARS
METROPOLITAN AREA PLANNING COUNCIL
SMART GROWTH AND REGIONAL COLLABORATION
DRAFT 6/19/13

infiltration trench, infiltration basins, drywells, etc.). The percent area method is based on draining runoff from a site's impervious area through the use of nonstructural practices, where it can either infiltrate into the soil or flow over it with sufficient time and velocity to allow for filtering.

5.4.1 Over-Recharge Credit

The DEP Stormwater Handbook provides recharge capture depth requirements for the four U.S. Department of Agriculture Natural Resources Conservation Service's hydrologic soil groups. These capture depths represent an estimate of annual recharge volume for undeveloped land of that soil type. However, as discussed previously, the majority of the study area currently includes impervious surfaces (parcels and roadways). Therefore, it seems feasible that for new development, municipalities should require developers to recharge more than the volume required by the Handbook.

This concept of "over-recharge" describes any recharge volumes calculated that would go above and beyond the MA Standards. For the purposes of this study, these volumes, per subwatershed area, would classify as a "credit" towards further protecting water supplies for both new development and redevelopment. For example, the Handbook requires 0.6 inches of recharge in type A soils, however; if a town requires 1.2 inches, the town could legitimately claim the difference as credit toward SWMI minimization or mitigation requirements. This is a particularly important consideration in the identified net-depleted Hydrologic Units. One appealing feature of such an approach is that new development would partially or even fully mitigate their increased water demand through stormwater improvements.

In addition to over-recharge, a suite of nonstructural practices can be required; focused on disconnecting impervious surfaces form the municipal piped system to drain over pervious areas, which can result in significant recharge to groundwater. A model stormwater bylaw was developed for the Towns of Duxbury, Marshfield and Scituate by the Horsley Witten Group that includes a procedure for the receipt of credits (i.e., incentives) for better environmental site design. This model bylaw lists the following nonstructural practices that property owners can receive credit for:

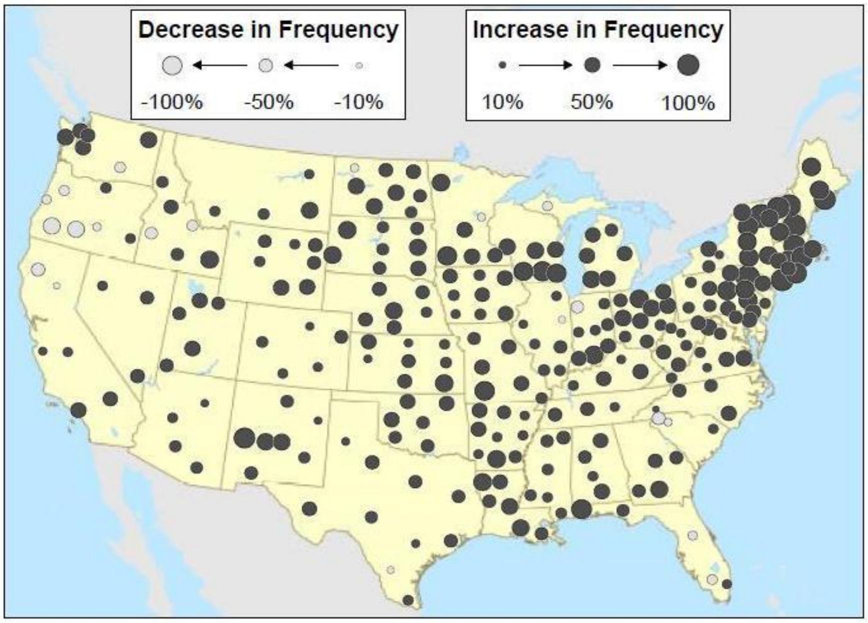
1) Disconnection of Rooftop and Non-Rooftop Runoff
2) Stream Buffers
3) Grass Channels
4) Environmentally Sensitive Development

It should be noted that towns have the power to revise local subdivision regulations, and/or zoning bylaws, to ensure that the credit will be applicable.

5.4.2 Climate Change Considerations

Consideration of conditions under the influence of our changing climate is critical due to the changes in precipitation patterns already occurring and projected. Standard recharge volumes will provide municipalities with volumes to work towards in order to merely maintain water supplies under existing ***precipitation conditions***. However, the calculation does not take into account increasing frequency and intensity of precipitation events in New England. Figure 5-6 shows the changes in the intensity and frequency of rainfall, with New England bearing the brunt of these changes. Therefore, we recommend that in sizing infiltration facilities, municipalities consider using data that includes predictions for rainfall during more intense storms such as the *Extreme Precipitation in New York and New England* online tools by the Northeast Regional Climate Center at Cornell University, NY.

Figure 5-6 Intensity and Frequency of Rainfall



Source: *When it Rains It Pours*, Environment America Research Center, July 2012

5.4.3 Mechanisms

The Massachusetts Stormwater Management Standards state, as mandated under the Massachusetts Wetlands Protection Act; "Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance." Low Impact Development (LID) does not just refer to alternative stormwater management techniques. It is a more sustainable land development approach, which begins with a site planning process that first identifies critical natural resource areas for preservation. LID ensures that maintenance of natural drainage flow paths, minimization of land clearance, building clustering, and impervious surface reduction are incorporated into the project design. LID also includes a specific set of strategies that treat stormwater management at the site level, ensuring that water is managed locally rather than engineering the discharge of water away from its source. Low impact techniques are used nationwide, with an established set of design and performance standards that can be applied to achieve compliance with state and local codes.

The MAPC Low Impact Development Toolkit is a primary resource for municipalities to use while considering design guidelines to establish and regulatory changes to incorporate. It builds from the efforts of the State's Smart Growth/Smart Energy Toolkit, providing a practical set of visual fact sheets on LID methods including bioretention, pervious pavement, green roofs, etc. The toolkit also includes model bylaw language and an LID codes checklist. There are other numerous resources municipalities can check regarding LID and alternative stormwater techniques.

6.0 SUMMARY OF MITIGATION AND MINIMIZATION OPTIONS

6.1 Introduction

The overall intent of the project was to establish a model for watershed based planning that could be utilized by multiple communities in a watershed. This tool could enhance the effectiveness of the Water Management Act (WMA) permitting process and shed additional light on how to measure and implement the concepts of Minimization and Mitigation under the Sustainable Water Management Initiative Framework. The analyses described in Sections 2 through 5 provide data on a range of quantifiable alternatives, per topic area, for responding to potential future permit requirements. The aim of these sections was to help communities develop innovative strategies for complying with the new requirements, with the least impact on area residents.

This summary section transitions from discussing potential Minimization and Mitigation measures by topic to the application of these measures on a municipal level. Although the project team advocates for study and implementation of water management across municipal boundaries, accounting for the inextricable linkage of hydrologic systems; the independence of each municipality is recognized. Therefore, the following sections describe potential opportunities for Minimization and Mitigation within the geographic area of each municipality. It should be noted that assumptions will change over time; therefore, implementation will require further discrete analysis and planning.

6.2 SWMI Permitting Requirements

Under the SWMI Framework the analysis and actions required of a permittee are a function of several factors:

- The System Baseline volume (reference point against which a withdrawal request will be compared in order to determine a new or increasing withdrawal);
- Separate Major Basin Baselines where an applicant has sources in more than one major basin (i.e. Charles, Neponset, Taunton, Ten Mile); and
- The Ground Water Category of the Sub-basin(s) where the applicant's sources are located, also known as the Ground Water Level (see the Final SWMI Framework at http://www.mass.gov/eea/docs/eea/water/swmi-framework-nov-2012.pdf); and
- The total volume of water being requested, as well as the volume being requested from each major basin where the permittee has sources.

This section of the report describes these elements of the SWMI Framework and how their interaction affects the study area communities.

6.2.1 Definitions of Mitigation and Minimization

Under the SWMI Framework, an action taken to offset or compensate for the environmental impacts of that portion of a requested withdrawal that exceeds Baseline (see below) is referred to as Mitigation. An action taken to offset or reduce the environmental impact of that portion of an existing withdrawal below or up to a Baseline volume is referred to as Minimization.

The actions one can undertake to satisfy a Mitigation requirement are largely the same actions that one could undertake to satisfy a Minimization requirement. Water conservation, stormwater recharge, sewer system infiltration reduction, returning treated wastewater, and a range of other options can all be used to satisfy a community's Minimization requirements or their Mitigation requirements. The difference is largely why the action is taken and how it is accounted for, rather than what kind of action is undertaken.

As mentioned previously, all communities in the study area will be required to submit a Minimization plan with their WMA application and implement that plan over the course of the permit. The SWMI Framework outlines a number of specific actions that must be evaluated and implemented to the "maximum extent feasible" under the heading of Minimization, but also includes several open ended categories that include anything that improves flow. To date MassDEP has not issued clear guidance on how an applicant would evaluate Minimization and how one assesses "maximum extent feasible." However it appears that Minimization planning will likely be less quantitative and less rigorous that that required for Mitigation.

If an applicant makes a request that exceeds one or more of its Baseline volumes, they will also have to submit a Mitigation Plan with their application. The Mitigation plan should be a quantitative plan that identifies feasible offset actions that meet or exceed the Mitigation volume. The Mitigation volume is the difference between the requested volume and the applicable Baseline volume. For example, if the requested volume is 1.5 MGD and the applicable Baseline is 1.0 MGD, then the Mitigation volume is 0.5 MGD. One important planning consideration regarding Mitigation is that it need not be completed until and unless the requested volume above Baseline is actually needed. However, Mitigation does need to be completed before the Mitigation volume is utilized.

6.2.2 Baseline

Under SWMI, each permittee has one or more "Baseline" volumes. There are two types of Baselines. System Baselines apply to the community as a whole and to all of the community's individual sources, irrespective of where they are located. Communities that have sources in more than one of the state's 27 "major planning basins" (i.e. Charles, Neponset, Taunton), will also have two or more Major Basin Baseline volumes. Each Major Basin Baseline applies only to the sources in that particular Major Basin.

The two kinds of Baseline volumes are intended to represent a slight increase over the annual daily average volumes that the community used from 2003 to 2005 (for either the system as a whole or the major basin). However, the calculation incorporates a number of other factors such as registered volume, water needs forecast and compliance volumes. As a result, Baselines are usually higher than current use. The Baseline calculation is fully explained in the SWMI Framework.

A community's Baseline volumes play a key role in determining what is required of a community under SWMI. In essence, Baseline establishes the dividing line between what is treated as a continuation of an existing withdrawal level (and by extension existing environmental impacts), and what is considered an increase over existing withdrawal levels (and impacts). Because a request for a volume above Baseline is presumed to be a new impact, the SWMI Framework requires that this increase be Mitigated (at least in the study area communities). If the volume requested is at or below the Baseline it is treated as an existing impact, and only Minimization is required. The baselines for each community in the study area are summarized in Table 6-1 below.

Table 6-1 System and Major Basin Baseline Volumes

Community	System Baseline	Neponset Baseline	Charles Baseline	Taunton Baseline	Ten Mile Baseline
Canton	0.38	-	-	-	-
Dedham-Westwood (DWWD)	4.62	3.11	1.91	-	-
Foxborough	2.24	0.56	-	1.60	0.00
Medfield	1.46	0.92	1.03	n/a	-
Sharon	1.63	0.97	-	0.72	-
Stoughton	2.26	1.21	-	1.14	-
Walpole	2.25	-	-	-	-

6.2.3 Volume of Water Requested

Under the Water Management Act, MassDEP has indicated that applicants are welcome to request any volume of water they deem desirable. However, MassDEP has also indicated that except in unusual circumstances, they expect almost all permits to be issued for a volume at or near the applicable Department of Conservation and Recreation (DCR) Water Needs Forecast (WNF) prepared using the 65/10 method. The DCR 65/10 WNF is based on DCR's estimate of population and employment growth in the community. The DCR WNFs were prepared in 2009 using MAPC population and employment projection data. The DCR 65/10 WNF assumes that within five years of permit issuance, residential consumption will be 65 gallons per person per day (RGPCD) and that unaccounted for water (UAW) will be 10%. Note that two communities in the study area (DWWD and Medfield) do not have DCR WNF's because DCR will only calculate a WNF for communities with UAW of 20% or less.

For communities that presently do not meet the 65 RGPCD or 10% UAW requirements, the DCR 65/10 forecast assumes an increase in efficiency or reduction in "lost" water over the life of the permit. For communities who already meet or exceed the 65/10 standards, the DCR 65/10 forecast assumes there will be a decrease in efficiency over the permit period.

Each community in the study area will have to make its own decision regarding how much water to request from MassDEP. However, in order to evaluate the level of Minimization and Mitigation that may be required for purposes of this report, it was necessary to select a scenario regarding the volume each community would request from MassDEP. For purposes of discussion, it is assumed that all communities in the study area will apply for their DCR 65/10 WNF withdrawal volume. Notably, communities do have the option of applying for less than this, which would help to reduce or eliminate Mitigation and/or Minimization requirements and their associated implementation costs.

When evaluating how much water to request, communities may wish to consider a number of other demand forecasts as well. These other volumes to consider include:

- DCR "Current Trends" WNF": DCR also developed a second set of WNF's referred to as the unchanged throughout the 20 year permit term while population grows. For communities who do not meet the 65/.10 RGPCD and 10% UAW requirements, the Current Trends WNF will be higher than the 65/.10 WNF. For most communities that already meet or exceed the 65/10 RGPCD and/or 10% UAW requirements, the Current Trends WNF will be lower than the volume equal to their DCR Current Trends WNF to minimize their level of required Mitigation. MassDEP has also indicated that for the more efficient communities, the difference between the Current Trends WNF and the 65/10 WNF will definitely be available as a "water conservation Mitigation credit" for those that request a volume equal to their 65/10 WNF, though it appears that MassDEP will also entertain proposals for larger water conservation credits as well.
- MAPC Current Use: MAPC has assembled figures for total water use for each community based on an average of their total reported volumes from 2009 to 2012. This indicator provides a valuable point of reference when considering the volumes of water that will likely be needed in the future.
- MAPC 2030 Use with Population Change and No Efficiency (AKA Status Quo): MAPC has prepared an estimate of future use assuming current use patterns will remain unchanged (i.e. zero efficiency gain); however, taking into account the likely influence of growth in housing and employment as well as the trend of declining average household size for existing housing. The anticipated decline in household population for existing housing has a small but noticeable effect on demand, which results in somewhat lower long term demand figures than those in the DCR Current Trends WNF for most communities.
- MAPC 2030 Conservation Scenario (AKA the 6.5/20 Scenario): MAPC also developed a set of projections based on assumptions for modest continued efficiency gains. Both this scenario and the previous two are discussed at greater length in Chapter 2 of this report. The efficiency gains contemplated in this scenario are consistent with a conservative estimate of those expected from application of the demand management tools discussed in Chapter 2.

Although actions undertaken by permittees under the WMA and SWMI Framework are dependent on demand predictions and compliance with current conservation standards, it is clear that a variety of options exist for communities to affect both Minimization efforts and Mitigation strategies relative to watershed impacts.

6.2.4 Ground Water Category

DEP has calculated a Ground Water Category (GWC, sometimes also referred to a as Ground Water Level) for each of the 1,400 SWMI Sub-basins. A Sub-basin's GWC can range from GWC 1 (very healthy) to GWC 5 (very impacted). The GWC of the Sub-basins in which a community's sources are located, in conjunction with Baseline and the requested volume, determine where a community's application falls in the SWMI Framework's Tiers Table. The Tiers Table in turn dictates what is required during permitting. The technical definition of the term GWC is discussed at great length in Chapter 4 of this report, which also includes maps showing GWC levels throughout the study area. As mentioned previously, all study area communities have sources in GWC 4-5 and as such, the Tiers Table requires Minimization by all communities.

Most public water supply wells in the study area are located in Sub-basins with a GWC of 5, though a minority of wells, is located in Sub-basins with a GWC of 4 or 3. MassDEP has yet to issue final guidance on how it will determine the Tier Classification for requests over Baseline, but it appears likely most requests over Baseline in the study area will first need to demonstrate that there is "no feasible alternative source that is less environmentally harmful" where the increased volume could be obtained before moving on to develop a Mitigation Plan.

6.3 Results Summary

This section provides a summary of the data analysis conducted for the study area as a whole and a discussion of the anticipated Minimization and Mitigation required, as well as an explanation of the notion of water conservation credits (i.e. avoiding the need to utilize requested permit volumes). This summary also includes a description of the findings for each municipality.

6.3.1 Anticipated Minimization and Mitigation Volumes

As mentioned above, it is presumed that communities in the study area will request their DCR 65/10 WNF as the total system volume for the final 5 year period of the 20 year permit, when they apply to renew their WMA permits. Table 6.2 below summarizes this hypothetical request in relation to each community's System Baseline and the presents the Mitigation and Minimization volumes that would result if the presumed volume is requested.

The Mitigation volume is the portion of the request which exceeds the System Baseline, and is the volume of Mitigation credits which an applicant would have to identify as part of the application. Where the presumed request (i.e. the DCR 65/10 WNF) is less than System Baseline, the Mitigation Volume is zero. In some communities where the Mitigation volume is indicated as zero, but where current use is over 65/10 there may be some Mitigation actions required during the earlier years of the 20 year permit until demand falls to the DCR 65/10 WNF. Also note that some communities have one or more Major Basin Baselines in addition to their System Baseline, and depending on how their request is distributed between Major Basins, these communities may face Mitigation requirements in addition to those indicated in Table 6-2.

The Minimization volume is simply the portion of the requested volume below System Baseline. In communities where the DCR 65/10 WNF is less than System Baseline, the Minimization volume is the DCR 65/10 WNF.

Table 6-2 Summary of Presumed Mitigation and Minimization Volumes

Community	DCR 65/10 WNF, 2030 (MGD)	System Baseline (MGD)	Mitigation Volume (MGD)	Minimization Volume (MGD)
Canton	2.56	0.38	2.18	0.38
DWWD*	4.62	4.62	0	4.62
Foxborough	1.95	2.24	0	1.95
Medfield*	1.46	1.46	0	1.46
Sharon	1.55	1.63	0	1.55
Stoughton	2.77	2.26	0.51	2.26
Walpole	2.07	2.25	0	2.07
* Neither Dedham-Westwood nor Medfield currently has a DCR water needs forecast, therefore the system Baseline was used as a proxy for the DCR forecast in the absence of this data, in order to determine potential Minimization volumes.				

One surprising observation from this table is that given the assumption that communities will be requesting their DCR 65/10 WNF as their permit volume; only two of the communities would need to implement Mitigation. Note that if a community request more than the presumed permit volume, their Mitigation and/or Minimization volumes will be higher.

6.3.2 Water Conservation Credits

The SWMI framework allows for the possibility of credits against any required Mitigation and/or Minimization volumes, in exchange for adopting a credible program of water conservation activities that can reasonably be expected to result in a community not using the entire requested permit volume. For example, if a community requests a permit volume of 1.5 MGD and has a Baseline of 1 MGD then they will have to provide Mitigation for 0.5 MGD. That community could propose a credible conservation plan that they believe will enable them to avoid needing to use 0.3 MGD of the requested increase over Baseline. MassDEP would then issue the permit for 1.5 MGD and give community a water conservation credit of 0.3 MGD against their overall Mitigation requirement of 0.5 MGD. The community would have to meet the balance of the Mitigation requirement (0.2 MGD) using other means. However, if over the course of the permit, the proposed water conservation plan is not working, and it appears demand will actually rise above Baseline by more than 0.2 MGD, then an applicant will need to propose additional Mitigation measures to substitute for the failed water conservation program.

As mentioned above, this report assumes for the sake of discussion that all communities will request and be granted their DCR 65/10 WNF volume as their permit volume. With this in mind, Table 6-3 calculates the amount of potential SWMI water conservation credit available under each of three higher efficiency scenarios. These scenarios are discussed briefly in the section 6.2.3. above, and the two MAPC scenarios are explained in full detail in Chapter 2.

The “A Minus B” conservation scenario illustrates the Water Conservation credit available if the DCR 65/10 WNF becomes the permit volume, but the DCR Current Trends WNF is the conservation goal. This scenario only results in a positive Credit for Stoughton. The “A Minus C” conservation scenario shows the SWMI credit available if the DCR 65/10 WNF is the permit volume but the MAPC Status Quo Forecast is adopted as a conservation goal. Under this scenario, which includes no actual efficiency improvement, most communities would be able to realize significant Minimization and/or Mitigation credit. The final, “A Minus D” conservation scenario displays the volume of Minimization or Mitigation credit available when the DCR 65/10 WNF is the permit volume but MAPC’s “6.5/20” forecast is the conservation goal. This scenario highlights the potential of deliberate policies and programs to substantially reduce system demand. With the exception of Walpole, achieving this scenario provides a positive SWMI credit for all study area communities. Walpole does not receive a credit in this scenario because the level of efficiency gain required by the MassDEP 65 RGPCD standard condition is greater than the assumed uniform efficiency gain that was applied to current use in all communities under the MAPC conservation scenario.

Table 6-3 Water Demand and Minimization Scenarios

	Water Demand Scenarios (MGD)				**Potential Conservation Min/Mit Volumes (MGD)**		
	A	**B**	**C**	**D**	**1**	**2**	**3**
Town	**DCR 2030 65/10% Presumed Permit Vol**	**DCR Current Trends 2030**	**MAPC Forecast 2030 Status Quo**	**MAPC Forecast 2030 6.5/25%**	**Conserv. Volume (A-B)**	**Conserv. Vol. (A-C)**	**Conserv. Vol. (A-D)**
Canton	2.56	2.83	2.55	2.35	0.00	0.01	0.21
Dedham-Westwood *	4.62	4.62	4.32	3.95	0.00	0.30	0.67
Foxborough	1.95	2.11	2.02	1.85	0.00	0.00	0.10
Medfield*	1.46	1.46	1.53	1.39	0.00	0.00	0.07
Sharon	1.55	1.61	1.37	1.27	0.00	0.17	0.28
Stoughton	2.77	2.40	1.92	1.78	0.37	0.85	0.99
Walpole	2.07	2.26	2.61	2.38	0.00	0.00	0.00

* Neither Dedham-Westwood nor Medfield currently has a DCR water needs forecast, therefore the system Baseline was carried forward as the DCR forecast in the absence of this data, in order to determine potential Minimization volumes.

Conservation practices that all municipalities will be required to implement, along with a number of recommendations for communities to consider that go beyond the minimum requirements, are discussed at length in Chapter 2.

6.3.3 I/I and Wastewater Credits

At the present time MassDEP has contemplated issuing credit for I/I reduction only in the form of an indirect credit. This decision was based on the fact that it is difficult to quantify: 1) the volume of reduced water loss from a Sub-basin that will result from I/I reduction efforts, 2) what Sub-basin the I/I credits should be attributed to. In addition the SWMI Groundwater Category and Biological Category models do not currently account for I/I losses and an environmental impact. Communities may wish to use the information developed in Chapter 3 to make the case for obtaining at least Minimization credit for I/I work.

In Chapter 3, potential sewer system infiltration credits are discussed, and the level of existing wastewater return from septic systems is assessed at a Hydrologic Unit level. A methodology was developed for estimating the potentially removable quantities of sewer system infiltration at the Hydrologic Unit and municipal level. In addition, a methodology to estimate the quantity of infiltration that is likely to be removed per mile of sewer inspection or repair is presented. This methodology provides a valuable planning tool enabling communities to evaluate the amount of water savings and potential SWMI credit that could result from a given level of effort on infiltration repairs.

In terms of wastewater returns, MassDEP has indicated that they intend to offer communities SWMI credit for wastewater returns in depleted Sub-basins, but has yet to issue any guidance on how such credit would be calculated. The concept under discussion is to use the rate at which a community's existing withdrawals are returned to groundwater through treated septic system effluent or permitted groundwater discharges as a credit for new or increased withdrawals only. For example, in a community that is served 100% by septic systems, one might assume that, on average, 85% of existing annual water demand is returned to the ground as septic effluent. In calculating the SWMI wastewater credit, MassDEP would assume that any future withdrawals would be returned to the ground at the same rate as existing withdrawals. Thus in the example, if the community requested an additional 0.5 MGD over Baseline, they would be eligible for a wastewater return credit of 0.425 MGD (i.e. 85% of the increase being requested). Our understanding is that this approach would not offer credit for wastewater which is returned via surface water discharge.

Table 6-4 summarizes the potential volume of I/I credit that may be available in each community. These values are based on the data presented in Table 3.8 as an estimate of potential I/I reduction over a forward looking five year period, given assumptions regarding the length of pipe that will be inspected and repaired over five years. The figures reflect an adjustment of approximately 50% to convert from peak day I/I to average daily annual I/I, which is built into the underlying linear foot metrics, as well as an additional discount of 20% to account for I/I migrating back into the system following repairs. The table also includes a qualitative rating of the potential for a wastewater return credit against Mitigation requirements for each community.

Table 6-4 Potential Wastewater and I/I Credits

Community	Potential Sewer Infiltration Credit (80% of 5-year removal, MGD)	Potential for Wastewater Return Credit (Mitigation Only)
Canton	0.15	+
DWWD	0.46	-
Foxborough	0.00	+
Medfield*	n/d	+
Norwood	0.15	n/a
Sharon	0.00	+
Stoughton	0.12	+
Walpole	0.23	+
Legend		
+ Some significant and potentially feasible opportunities exist		
- Some minor and/or marginally feasible opportunities exist		
x No potentially feasible opportunities exist		

Outstanding questions remain regarding how MassDEP would calculate a wastewater return credit, such as whether:

- It matters what sub-basin the septic effluent is returned to,
- A location adjustment factor is applied,
- The degree to which future development driving increased water demand is likely to be serviced by septic or sewer is considered, and
- If a credit would be available for Mitigation, Minimization or both.

Because of this uncertainty, this study does not calculate a specific wastewater credit value for each community. However, it should be noted that the wastewater credit could be quite significant for communities in the study area that have a substantial number of remaining septic systems or substantial volume associated with permitted groundwater discharges. Communities may also want to begin considering the issue of depleted Sub-basins in any ongoing wastewater planning activities in which they are engaged. As discussed further in Chapter 3, preserving septic systems in depleted Sub-basins and/or locating permitted groundwater discharges in depleted Sub-basins may have long term regulatory benefits to the extent that doing so is also compatible with water quality goals. The information presented in Chapter 3, will provide communities with the tools needed to calculate potential wastewater credits once the methodology is finalized.

6.3.4 Stormwater Credits

Chapter 5 discusses and quantifies potential stormwater credits under SWMI, based on an adaptation of the methodology outlined in the SWMI Pilot Projects. Stormwater recharge should be eligible for both Mitigation and Minimization credit; however, these credits will also likely be subjected to a location adjustment factor (i.e. a reduced credit if they are not located in the same Sub-basin as the sources being permitted), which is still under discussion at MassDEP.

In Chapter 5, the potential credit that would result from retrofitting all existing impervious surfaces is estimated, as well as the potential credit from requiring new development to recharge volumes in excess of requirements in the MA Stormwater Handbook. The identification of priority retrofit opportunities within approximately 120 parcels across the study area with sizeable areas of existing impervious cover, favorable soils and ownership characteristics, and location within depleted Hydrologic Units, will prove quite useful to communities for both the purposes of meeting SWMI and new MS4 requirements.

The volume of potential stormwater recharge credit from retrofitting these selected parcels in each community is summarized in Table 6-5 below. It is important to note that these priority parcels represent only one-fifth (1/5) of one percent (1%) of all the parcels in the study area, and thus do not capture the maximum potential for stormwater recharge credits by any means. Communities may wish to utilize the GIS data layers developed for Chapter 5 to identify additional parcels that could be targeted for stormwater credits.

Table 6-5 Potential Stormwater Recharge Credits

	Potential SW Recharge at Priority Sites (MGD)	Potential SW Recharge for All Imperv. Cover (MGD)
Canton	0.159	1.45
Dedham - Westwood	0.216	1.55
Foxborough	0.491	1.42
Medfield	0.054	0.57
Norwood	0.123	1.17
Sharon	0.165	0.95
Stoughton	0.311	1.27
Walpole	0.329	1.58

6.3.5 Optimization, Alternate Sources and Interconnections

The SWMI Framework lays out a number of specific questions that must be addressed as part of the required Minimization evaluation. These include, but are not limited to; Optimization of existing supplies, use of Alternative Sources, and the use of Interconnections and Surface Water Releases. Each of these issues is discussed in depth in Chapter 4.

In summary, Optimization involves evaluating opportunities to reduce environmental impacts by modifying when and where existing sources are pumped. Optimization is required for Minimization and, in certain other circumstances, such as where a cold water fishery resource is involved. Optimization does not translate directly into a specific volume of SWMI Mitigation credit, though optimization could potentially be used to reduce the required Mitigation volume in limited circumstances.

Alternate Sources involve evaluating the development of new wells or surface supplies within a community's boundaries that would provide for a reduction of depletion levels in the Sub-basins where existing sources are located. As with Optimization, an analysis of Alternate Sources is required as part of Minimization but does not translate directly into a Mitigation Volume.

The use of Interconnections implies importing water from outside of a community from a source which has lower environmental impacts than the community's existing sources. Use of Interconnections must be evaluated as part of the required Minimization plan, and the discussion of Interconnections in Chapter 4 focuses on quantifying the volume of imported water that might be desirable for Minimization use and the rough cost of that water. Though not directly discussed in Chapter 4, Interconnections can also be used to reduce the required level of Mitigation by reducing the volume requested from local sources. In addition, most communities in the study area requesting an increase above Baseline will need to demonstrate that this additional water cannot be obtained from an alternative source with lesser environmental impacts, before they proceed to develop their Mitigation plan. The information presented in Chapter 4 on Interconnections should also be useful to those communities which need to demonstrate that they have no feasible alternative source.

All of these opportunities are very specific to each municipality, and are therefore discussed in detail on a community-by-community basis in Chapter 4, and mentioned briefly in the summary of each community presented below. Table 6-6 provides a qualitative summary of Optimization, Alternate Source, and Interconnection options for communities in the study area.

Table 6-6 Summary of Optimization, Alternate Source and Interconnection Opportunities

Town	Optimization	Alternative Sources	Inter-Connections
Canton	+	x	+
Dedham-Westwood	+	-	+
Foxborough	-	-	-
Medfield	+	x	-
Sharon	x	+	+
Stoughton	-	x	+
Walpole	-	-	+
+ Some significant and potentially feasible opportunities exist			
- Some minor and/or marginally feasible opportunities exist			
x No potentially feasible opportunities exist			

6.3.6 Overall Summary of Minimization and Mitigation

Table 6-7 below provides an overall summary of the Minimization and Mitigation options evaluated for this report.

Table 6.7 Summary of Mitigation and Minimization Requirements and Opportunities

Community	Current Use (MAPC 2009-2012, MGD)	Presumed 2030 Request (DCR 65/10 WNF MGD)	Mitigation Volume at Presumed Request (MGD)	Minimization Volume at Presumed Request (MGD)	Potential Water Conservation Credit, (MAPC 2030 Cons. Scenario, MGD)	Volume of UAW >10% Included in MAPC 2030 Conservation Scenario (MGD)	Potential Sewer Infiltration Credit (80% of 5-year removal, MGD)
Canton	2.33	2.56	2.18	0.38	0.21	0.07	0.15
DWWD*	3.86	4.62	0	4.62	0.67	0.55	0.46
Foxborough	1.80	1.95	0	1.95	0.1	0.06	0.00
Medfield*	1.26	1.46	0	1.46	0.07	0.19	n/d
Norwood**	n/a	n/a	n/a	n/a	n/a	n/a	0.15
Sharon	1.31	1.55	0	1.55	0.28	0.05	0.00
Stoughton	1.87	2.77	0.51	2.26	0.99	0.04	0.12
Walpole	2.05	2.07	0	2.07	0	0.00	0.23

Community	Potential Stormwater Credit for Priority Sites Only (MGD)	Maximum Theoretical Stormwater Credit (All Imperv. Areas, MGD)	Potential for Wastewater Return Credit (Mitigation Only)	Potential for Optimization (Minimization Only)	Potential for Alternate Sources	Potential for Inter-connections
Canton	0.159	1.45	+	+	x	+
DWWD*	0.216	1.55	-	+	-	+
Foxborough	0.491	1.42	+	-	-	-
Medfield*	0.054	0.57	+	+	x	-
Norwood**	0.123	1.17	n/a	n/a	n/a	n/a
Sharon	0.165	0.95	+	x	+	+
Stoughton	0.311	1.27	+	-	x	+
Walpole	0.329	1.58	+	-	-	+

* Neither Dedham-Westwood nor Medfield currently has a DCR water needs forecast, therefore the system baseline was carried forward as the DCR forecast in the absence of this data, in order to determine potential minimization volumes.

** Norwood does not have a WMA permit and is included only to reference potential Minimization and Mitigation volumes

Legend
+ Some significant and potentially feasible opportunities exist
- Some minor and/or marginally feasible opportunities exist
x No potentially feasible opportunities exist

6.4 Results for Individual Municipalities

A more detailed discussion regarding permit implications for each municipality is provided in the subsequent subsections. Note that the most of the figures discussed below can be found in Table 6.7 above.

6.4.1 Canton

Canton is unique among the study area communities in that it has a low System Baseline (0.38 MGD) and faces a very large Mitigation volume (2.18 MGD). This low system Baseline is the result of all of Canton's sources being permitted rather than registered and the fact that most of Canton's sources were largely shut down during the period (2003-2005) during which Baseline volumes were calculated. All of Canton's sources are located in the Neponset Basin, so Canton's System Baseline and Major Basin Baseline are the same. Canton could potentially petition MassDEP to raise its Baseline, but the outcome of such a request is unknown.

Assuming Canton was to request 2.18 MGD above Baseline, it would need to demonstrate that it is unable to obtain this water from a feasible alternative source with lesser environmental impacts. As of yet, MassDEP has offered no indication of how they intend to interpret this standard. However, given that Canton is already a full member of the MWRA, it may be difficult to demonstrate that they have no feasible alternative source.

If Canton were able to clear the hurdle of "no feasible alternative source" the sum of all the feasible Mitigation credits identified in this report for Canton would likely be less than the required Mitigation Volume.
That said, Canton potentially has substantial credits at its disposal. These include potential water conservation credits of 0.21 MGD though with concerted efforts this could likely be significantly higher by the end of the permit term, a modest additional credit of 0.07 MGD for reducing UAW to 10% assuming that current UAW reflects leakage rather than metering problems, and a stormwater recharge credit of 0.16 MGD at priority sites or up to 1.45 MGD as a theoretical maximum across the community as a whole. Depending on the final guidance issued by MassDEP in the months ahead, Canton, which still has a significant number of septic systems, may also be able to claim a significant credit for wastewater recharge and/or I/I reduction (0.15 MGD or more).

To make up for any remaining Mitigation volume, Canton could consider pursuing indirect credits for habitat restoration projects or direct credits for a variety of more innovative measures such as recharging depleted sub-basins through groundwater discharge of treated wastewater.

In terms of Minimization options, Canton has opportunities to further enhance its existing demand management efforts as discussed in Chapter 2, undertake any number stormwater or I/I reduction efforts as discussed in Chapters 3 and 5, or make a limited seasonal use of their MWRA Interconnection and other modest Optimization measures as discussed in Chapter 4.

6.4.2 Dedham-Westwood

The DWWD lacks a DCR Water Needs Forecast because of its high level of unaccounted for water. For discussion purposes it is assumed that DWWD will request a permit volume equal to their Baseline (4.62 MGD). As such, DWWD would be required to Minimize their impacts but would face no Mitigation requirements. Based on its use during 2003-2005, DWWD's Neponset Basin Baseline provides relatively little headroom to increase withdrawals from Neponset sources (1.6%) as compared to the substantial headroom available to increase withdrawals from DWWD's Charles River Sources below their Charles River Baseline (42%) however in both basins headroom has increased due to continued efficiency gains since 2003-2005. Nonetheless, given the potential for implementation of the Minimization measures below, it is not anticipated that DWWD will need to pursue Mitigation measures on the basis of their Major Basin Baselines.

DWWD has a range of Minimization options at its disposal. DWWD has a longstanding water conservation program and a relatively low RGPCD, however they could take steps to further strengthen this program as described in Chapter 2, which would generate an estimated water conservation credit of 0.67 MGD or more. DWWD also has significant Optimization opportunities in terms of rebalancing withdrawals between the Charles and Neponset and Interconnection opportunities in terms of more aggressive seasonal use of their existing MWRA allocation or an expanded MWRA allocation all as described further in Chapter 4.

As a district, DWWD has limited direct control over stormwater management and I/I reduction in its associated towns, however, there are substantial opportunities in the areas of stormwater recharge (0.22 MGD at priority sites or a theoretical maximum of 1.55 MGD overall) and sewer system infiltration reduction (0.46 MGD or more). DWWD could effectively work with the Towns of Dedham and Westwood to encourage and support them in adopting policies such as increased stormwater recharge requirements or private infiltration programs that would help to take advantage of these opportunities as discussed in Chapters 3 and 5.

Lastly, DWWD has a very high level of unaccounted for water, which they suspect to be largely the result of leakage rather than meter under-registration. DWWD may realize a substantial conservation credit if UAW is reduced to 10%. This could be up to an additional 0.55 MGD which is not reflected in the conservation credit mentioned above. DWWD should prioritize continuation and expansion of their existing efforts to reduce unaccounted for water as one of the cornerstones of their required Minimization plan.

6.4.3 Foxborough

Across all water demand scenarios prepared, including their presumed request volume of 1.95 MGD (i.e. DCR 65/10 WNF), Foxborough's demand is expected to be significantly lower than their System Baseline of 2.24 MGD. Therefore, Foxborough is not expected to face any Mitigation requirements on the basis of their System Baseline. However, the Town is in the process of increasing its withdrawals in the Ten Mile Basin, which has a Major Basin Baseline of zero that will result in a Mitigation requirement equal to the total withdrawal volume requested from these sources (two wells with a daily pumping limit of .72 MGD each, though annual average request will likely be lower). For the sake of discussion, it is presumed that Foxborough will request an allocation of 0.72 MGD in the Ten Mile Basin. An increase over Baseline of this magnitude in the Ten Mile Basin would precipitate not only a Mitigation requirement, but also a preliminary hurdle of demonstrating that there is no feasible alternative source with lesser environmental impacts. In addition, recent pumping in the Neponset basin (2009-2012 average) is over Foxborough's Neponset Baseline by approximately 0.13 MGD, while pumping in the Taunton has been well below Foxborough's Taunton Baseline. In the last few years, a variety of infrastructure improvements have been underway for Foxborough's Taunton sources, which may allow Foxborough to reallocate between Neponset and Taunton sources, but barring that, Foxborough will likely need to provide a total of 0.85 or more in Mitigation.

As discussed in Chapter 4, there are several hypothetical Interconnections available to Foxborough including the MWRA, the Aquaria Taunton Desalination Plant or sources in the Taunton River Watershed. All of these options would require delivering, or at least wheeling, water over substantial distances and are likely to be deemed infeasible by MassDEP for purposes of Minimization. However, Foxborough will likely need to examine these potential interconnections more carefully as part of demonstrating that it has no "feasible alternative" to expanding use of the Ten Mile Basin sources.

Assuming that Foxborough is able to surmount the "no feasible alternative" test, and given the very small portion of the Ten Mile Basin which is located within the borders of the Town, it will be difficult for Foxborough to deliver the required volume of Mitigation in the Ten Mile Basin. As a result, Foxborough will likely face the choice of pursuing Mitigation options in the Ten Mile Basin that are located outside of Town boundaries, or pursuing Mitigation measures in the Neponset and Taunton Basins which will be subject to a location adjustment factor. MassDEP has yet to definitively describe its policy on location adjustment factors, but it could represent a deduction of 50% or more on Mitigation credits delivered outside the Major Basin of concern.
Foxborough has significant potential Mitigation credits at its disposal. Given Foxborough's higher than average RGPCD relative to other communities in the study area, there is significant potential for water conservation credits through the expansion of Foxborough's existing conservation efforts. Although conservation credits under the standard conservation scenario are estimated at only 0.1 MGD, in practice, the potential for water conservation in Foxborough is significantly higher as discussed in Chapter 2.

Of the study area communities, Foxborough has the largest acreage of impervious surfaces on selected priority sites (219.18 acres), and using the study selection criteria for parcels, a moderate scenario for potential recharge to groundwater from stormwater is 0.31 MGD (114.07 MGY). Retrofit opportunities to achieve this include only 10 commercial properties and 5 municipal properties. These opportunities are discussed further in Chapter 5.

Only limited areas of Foxborough are presently served by sewer systems, all of which are directed to the Mansfield Treatment plant. Because of the limited sewer service area, Foxborough's opportunities for sewer system infiltration credits are limited. Conversely, because Foxborough is served largely by septic systems it can anticipate a quite sizeable Mitigation credit for wastewater return once MassDEP clarifies its policy on such credits. The data presented in Chapter 3 can be used to calculate this credit when the time comes. Foxborough may wish to consider local wastewater treatment and groundwater discharge as an alternative to expanding use of the Mansfield treatment plant in order to maximize its potential wastewater credits.

Foxborough has somewhat limited options for Optimization and Alternative Sources. The most interesting of these is maximizing the use of already available “reuse” water which is presently not being used to its potential. These opportunities, along with potential Interconnection opportunities, are discussed in greater detail in Chapter 4. Lastly, unaccounted for water throughout the system is approximately 13% of the total finished water offering the opportunity for modest additional credit in this area as well.

6.4.4 Medfield

Medfield is the one community in the study area that elected not to participate in the project. As such, the level of information available regarding Medfield was substantially more limited than for other communities. It is also important to note that Medfield is the only community in the study area which has already received a renewal of its WMA permit. This permit, along with all the Charles River Basin permits, was issued before the completion of the SWMI Framework under an interim set of rules. It is anticipated that once new WMA regulations based on the SWMI Framework are finalized, MassDEP will be bringing permits such as Medfield’s into compliance with the SWMI rules during the regularly scheduled five-year reviews.

Medfield currently does not have a DCR water needs forecast due to very high unaccounted for water. Therefore, Medfield’s System Baseline of 1.46 MGD was used as the presumed volume that Medfield would request as its 20 year permit volume for discussion purposes. If this assumption holds true, no Mitigation would be required based on Medfield’s System Baseline. This lack of Mitigation seems almost certain given that Medfield’s current use (Based on the MAPC estimate of current use) allows for a 15% increase before the System Baseline will be met. Furthermore, Medfield has 10% headroom available on its Charles River sources before the Charles Basin Baseline would be exceeded and 100% headroom available relative to its Neponset Basin Baseline (based on 2003-2005 use). Available headroom relative to Neponset and Charles Baselines has increased slightly since 2003-2005.Notwithstanding, it is notable that the MAPC 2030 Status Quo demand forecast is 1.53 MGD and as such Medfield will need to be proactive in pursuing Minimization measures, particularly demand management and UAW reduction, in order to live below its system Baseline.

Medfield has a variety of Minimization options at its disposal. Under the MAPC standard water conservation scenario, Medfield would receive credit for 0.07 MGD. However, in practice, given Medfield’s high RGPCD and the limited range of conservation efforts already undertaken, actual conservation potential in Medfield is substantially higher. Medfield should refer to Chapter 2 for a discussion of measures that might be incorporated into a new water conservation program for the town. Medfield also has significant opportunities to reduce UAW. According to Medfield’s 2012 ASR, it estimates that approximately 60% of its reported UAW is leakage, with the balance being accounting concerns. Assuming this 60% ratio is accurate and that Medfield reduces UAW to 10% it could access an additional conservation credit of 0.11 MGD which is not included in the conservation scenario above. Medfield should make UAW reduction a cornerstone of its overall Minimization plan.

Medfield has some significant opportunities to reduce overall depletion levels and better protect CFR resources through source optimization, though these options are potentially constrained by its Major Basin Baselines. Medfield also has the potential to create an Interconnection with the

MWRA system through Westwood. However, given that is unlikely to be subject to Mitigation requirements, it is unlikely that MassDEP would require Medfield to evaluate this option. Both of these issues are discussed in greater depth in Chapter 4.

Medfield did not provide the information required to evaluate potential sewer system infiltration reduction credits nor wastewater return credits. However there are indications that infiltration levels in the Medfield sewer system are significant. Medfield's sewer flows go to a treatment plant that discharges to the Charles River, thus reductions in sewer infiltration will result in reduced surface discharges to the Charles River. However, given the water quality problems associated with surface wastewater discharges, Medfield is still encouraged to pursue sewer infiltration reduction efforts. A significant portion of Medfield is still served by septic systems, and as such, Medfield will likely be eligible for a sizeable wastewater return credit. To the extent that Medfield may be contemplating further expansion of its sewer collection system, it may wish to consider the regulatory benefits of minimizing the loss of groundwater recharge via septic systems.

Medfield has somewhat limited potential for stormwater recharge on priority sites (0.05 MGD) although its maximum theoretical stormwater recharge potential is significantly higher (0.57 MGD).

6.4.5 Norwood

Norwood was not a participating municipality within this study, as they are serviced entirely by the MWRA water system and do not have, nor are expected to seek, a WMA permit. However, Norwood was included in the offset/Mitigation analysis to show the potential benefits to the Neponset River Watershed. Both DWWD and Canton have sources downstream of Norwood. As such, Canton and DWWD could work with the Town of Norwood to pursue Mitigation or Minimization activities in Norwood, and then claim these as SWMI credits for their own purposes, without being subject to a location adjustment factor deduction.

Upon application of the initial hydrologic screening of existing parcels for stormwater recharge potential, approximately 15 parcels were shown to have good retrofit opportunities. These parcels have a total of 85 acres of impervious surfaces and would return 0.123 MGD to groundwater. In addition there exist significant potential credits for sewer system infiltration reduction in Norwood on the order of 0.15 or potentially much more.

6.4.6 Sharon

Sharon's presumed permit request volume (i.e. its DCR 65/10 WNF) is well below Sharon's System Baseline. Furthermore, Sharon has the ability to increase its current level of withdrawals (based on MAPC current use) by 18% without exceeding its System Baseline. Thus, it appears unlikely that Sharon will be required to undertake any Mitigation due to its System Baseline. Based on data collected by MassDEP from 2003-2005, Sharon is exceeding its existing permit and Major Baseline for its Neponset sources, which would potentially result in a Mitigation requirement. More recent data indicate that Sharon's pumping in the Neponset Basin has declined, reestablishing roughly 19% headroom below the Neponset Baseline. As of 2003-2005 Sharon had sufficient headroom on its Taunton Baseline to allow it to increase pumping of these sources by 41%, and this situation remains largely unchanged. Based on the above, Sharon should not be required to implement any Mitigation.

Sharon also has significant Minimization opportunities. Sharon has experienced very large reductions in demand over the last decade or so through gains in efficiency and better management of UAW, on the order of 20% of total pumping. Nonetheless, as is discussed in greater depth in Chapter 2, significant potential for additional conservation remains. Under the standard MAPC conservation scenario, Sharon can expect a water conservation credit of 0.28 MGD as of 2030.

Sharon has one very significant option for source Optimization; the installation of a new Fowl Meadow well, an idea which Sharon is already pursuing. Sharon has several options for potential interconnections to the MWRA system and at least one existing physical interconnection with an MWRA member town. Such a connection could be used to minimize seasonal impacts at a relatively modest cost. However it is unclear whether MassDEP would require Sharon to consider pursuing such an interconnection if only Minimization rather than Mitigation is required. All these issues are discussed in greater depth in Chapter 4.

Sharon has virtually no sewers and thus few opportunities for sewer system infiltration reduction credits. Conversely, Sharon has the potential for a very sizeable wastewater return credit. However, given that Sharon is not expected to face Mitigation requirements, this potential wastewater credit is of limited usefulness in regulatory terms.

Potential stormwater credits for priority sites in Sharon amount to 0.165 MGD with much higher theoretical maximum potential stormwater credits of 0.95 MGD as discussed further in chapter 5.Lastly, Sharon has modestly elevated UAW, which presents some opportunities for further credit as part of their Minimization plan.

6.4.7 Stoughton

In Stoughton, the presumed permit request volume (i.e. the DCR 65/10 WNF) represents a substantial decrease in existing efficiency levels, and as such, Stoughton may wish to consider requesting a smaller volume in order to avoid Mitigation requirements. To place this in a clearer context, the presumed permit volume for Stoughton would represent a 48% increase over Stoughton's current 2009-2012 use as estimated by the MAPC.

If Stoughton does proceed with requesting the presumed volume, the increase System Baseline would be so large that Stoughton would be required to demonstrate that it has no feasible alternative source which is less environmentally harmful. Given that Stoughton's existing MWRA connection has the capacity to satisfy this volume, it may be difficult for Stoughton to successfully argue that it has no feasible alternative source.

Assuming Stoughton is able to surmount the "no feasible alternative test" it would be required to provide 0.51 MGD of Mitigation. A request of this size would also exceed the combined Major Basin Baselines for both Stoughton's Neponset and Taunton sources. However the System Baseline would control the total amount of Mitigation required. Stoughton would have a variety of options at its disposal for Mitigating such a request if given the opportunity to do so.

Stoughton could expect a water conservation credit of 0.99 MGD under the MAPC 2030 conservation assumptions. At 14% UAW, Stoughton could realize a small additional not reflected above. Options for maximizing these conservation opportunities are discussed in detail in Chapter 2.

Stoughton also has significant opportunities for Mitigation or Minimization through increased stormwater recharge with an estimated credit of 0.127 MGD associated with 34 priority sites and a theoretical maximum potential stormwater recharge credit of 1.27 MGD as discussed further in Chapter 5.

Stoughton would have potential for significant sewer system infiltration reduction credits (0.12 MGD), though their applicability to Mitigation rather than Minimization efforts will be subject to MassDEP's final guidance on I/I credits. Stoughton also still has a significant number of septic systems, which would potentially provide a modest wastewater return credit. These issues are discussed more thoroughly in Chapter 3.

In the context of Minimization, Stoughton has relatively few significant options for source Optimization or Alternate Sources. It would though have an opportunity to substantially reduce existing depletion levels through strategic seasonal use of its MWRA Interconnection on a limited basis and at a relatively modest overall cost. Both of these opportunities are discussed further in Chapter 4.

6.4.8 Walpole

Walpole has all its sources in the Neponset River Watershed and as such must address only its System Baseline. The project's presumed permit volume request (i.e. the DCR 65/10 WNF) is significantly below Walpole's System Baseline, therefore Walpole is not expected to face any Mitigation requirements. Walpole has numerous options to meet its Minimization requirements.

Walpole's current use is very close to the project's presumed 2030 permit volume, leaving less than 1% headroom, in large part because of Walpole's relatively high (compared to other communities in the study area) RGPCD of 70. During at least the first five years of the permit period, Walpole will have a higher limit as it comes into compliance with the 65 RGPCD requirement, but even so, Walpole should be proactive in more actively managing its demand in order to re-establish a more reasonable level of permit headroom as soon as possible.

Under the MAPC standard conservation scenario, Walpole would receive a water conservation credit of zero MGD, because the MAPC standard conservation scenario does not take into account the greater than average conservation potential that exists in Walpole. For example if Walpole's 2012 RGPCD were at the average 2012 RGPCD for Sharon, Stoughton, Foxborough and DWWD, it would represent an 18% reduction in use by existing homes in Walpole, which would equate to approximately 0.27 MGD of additional capacity (or 13% headroom) within the presumed permit limit. While Walpole currently operates a rebate program, it does not have most of the key water conservation measures such as seasonal restrictions, pricing, and a sustained outreach program, which have proved effective in neighboring communities. In addition, Walpole has the opportunity to achieve a modest improvement in UAW. These issues are discussed in greater depth in Chapter 2.

Walpole has significant opportunity to realize Minimization credit for continued reductions in sewer system infiltration (0.23 MGD). Walpole also has a significant portion of its population served by septic systems and reportedly has few plans to expand sewer service, potentially making it eligible for a significant wastewater credit, though such a credit would have limited regulatory applicability in the absence of a Mitigation requirement. These issues are discussed more thoroughly in Chapter 3.

As discussed in Chapter 5, Walpole has significant Mitigation opportunities in the area of stormwater recharge with potential of 0.33 MGD of additional recharge on priority sites and a theoretical maximum potential stormwater recharge credit of 1.58 MGD.

Walpole has some modest opportunities for source Optimization involving selective pumping of sources further away from streams on a seasonal basis. Walpole also has the potential for an Interconnection to the MWRA system via an existing connection with Norwood, which could be used on a limited basis to substantially reduce seasonal depletion levels. Even though the physical interconnection exists, Walpole is not a member of the MWRA system and it is unclear whether MassDEP would require Walpole to consider this option as part of a Minimization plan. These points are discussed further in Chapter 4.

6.5 Conclusion

As outlined above, each community in the study area finds itself presented with a unique set of circumstances based on the requirements of the SWMI Framework. Each community also finds itself presented with a unique set of tools and opportunities that it may want to consider in responding to those requirements.

Some of the major observations resulting from the project include:

1. It appears fewer communities than initially anticipated will be required to comply with SWMI Mitigation requirement.

2. There remains substantial potential for continued efficiency gains to reduce the volume of water that will be needed by the end of the permit period. Even using moderate conservation assumptions, these efficiency gains are likely to be larger than the added demand from new development for most communities in the study area, thus reducing the amount of Mitigation and Minimization that would otherwise be required.

3. While there is substantial variation in where communities currently stand in terms of efficiency, there are opportunities to implement additional policies and programs to encourage efficiency gains in every community.

4. There appears to be no technical barrier that would prevent the trend of declining water use observed over the last decade from continuing through the 20 year life of the next round of WMA permits for every community in the study area.

5. Even using conservative estimates, I/I reduction efforts have the potential to achieve very significant further Minimization and/or Mitigation benefits in most communities which have

sewer systems. Such benefits can flow both from direct I/I reduction efforts by communities and from introducing new programs to address the problem of I/I entering the public system from private property.

6. Preservation of existing functional septic systems and strategic use of decentralized groundwater discharge plants instead of centralized sewers to meet future sewer needs, can play an important role in minimizing environmental impacts and regulatory entanglements for municipalities.

7. Given the high levels of existing Sub-basin depletion throughout the study area, there were more opportunities to Minimize impacts through source Optimization that originally anticipated, and in a few cases these opportunities are quite significant.

8. There are very few opportunities for communities reduce environmental impacts by developing new sources within their community boundaries.

9. All the communities in the study area, with the possible exception of Foxborough, already have access to MWRA water, have existing physical interconnections with a community that has access to MWRA water or could create such a connection fairly easily. In most of these communities, such Interconnections could be utilized on a limited seasonal basis, to substantially reduce Sub-basin depletion levels, and for most communities the cost of doing so per account on an annual basis would be relatively modest. However, for those who are not already members of the MWRA, it is unclear whether MassDEP will require this option to be evaluated in the absence of a Mitigation requirement.

10. There are substantial opportunities to Minimize and/or Mitigate impacts by encouraging additional recharge of stormwater to the ground. These opportunities can be realized through a combination of policies that require increased levels of recharge for private development and redevelopment projects, and through proactive retrofitting of public and private pavement through a combination of town funds, water bank fees and voluntary education programs. Given that many of these activities will be required anyway under the EPA MS4 permit, they make appealing prospects for SWMI Minimization and Mitigation.

11. Even after more than three years of work, there remain many critical policy details within the SWMI Framework which still need to be clarified and codified through regulations and detailed guidance.

12. The SWMI framework is, perhaps unavoidably, very complex and there is a steep learning curve for anyone who gets involved with SWMI, including both municipal and state agency staff. State agencies could however develop a variety of tools that would greatly simplify the process of evaluating a community's options under SWMI. The work performed as part of this project can potentially help to inform the development of these tools, and EEA should prioritize funding for their development.

13. Because of the complexity of the SWMI Framework, permittees would benefit from a program of concerted outreach regarding the SWMI requirements. It would be both much less aggravating for communities and much more cost effective to use a watershed-based planning process, not unlike the one demonstrated here, to assemble information and conduct a preliminary assessment of alternatives available to communities. Such a process

would help to ensure the consistency and quality of the analysis which must occur across the state, would reduce the compliance burden placed on communities, and would help prevent the very limited MassDEP WMA permitting staff from being totally overwhelmed. It is also highly beneficial to ensure that both permittees and environmental advocates are deeply involved in this type of planning, both to ensure that the best ideas are raised and to encourage greater collaboration in long term implementation. Such a process is however, well beyond the scope of what can be undertaken by MassDEP's WMA staff themselves and therefore it is strongly recommend that EEA find alternative mechanisms to fund this watershed-based planning, perhaps drawing on the resources of regional planning agencies, watershed groups and consulting firms across the state and perhaps dedicating a portion of the SWMI capital funds to this use.

14. In order for the Commonwealth, and the communities it is trying to assist, to realize the full value of its planned investment of SWMI capital funds, the state must find a way to award these funds earlier, and preferably in a way that accommodates multi-year projects, so that there is a reasonable amount of time for applicants to complete their projects. This will become even more critical once revised WMA regulations are completed, and the emphasis shifts from planning to implementation. While it is less than optimal to carry out planning grants with unrealistic timeframes, it will be impossible to implement meaningful water conservation, UAW reduction, stormwater recharge or other implementation projects in three months.

15. While each municipality or district is ultimately responsible for their own jurisdiction, there are a number of areas where ongoing SWMI implementation would benefit from regional cooperation. These particularly include the implementation of water conservation and stormwater management programs, but also take in other possibilities such as coordinated contracting for services such as I/I reduction, leak detection, or even the development of shared sources of supply or Mitigation projects. Such collaboration holds out the possibility of achieving greater progress with fewer dollars, and all project participants are encouraged to consider and pursue such opportunities.