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Leicester Water District Analysis

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Leicester Water District Analysis

Massachusetts Water Resource Outreach Center

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Project Sponsors: Leicester Town Manager and the Massachusetts
Department of Environmental Protection

Date: April 28, 2016

Massachusetts Water Resource Outreach Project: Leicester Water District Analysis

An Interactive Qualifying Project

Submitted to the Faculty

Of

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In partial fulfillment of the requirements for the
Degree of Bachelor of Science

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Date of Submission: April 28, 2016

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ABSTRACT

Delivering high quality drinking water to the residents of a town or city necessitates a robust water management system to ensure the health and safety of its residents. Our report investigates the challenges faced by the water supply districts in the Town of Leicester, Massachusetts. By working together with the Massachusetts Department of Environmental Protection and the Town of Leicester, our goal was to analyze the feasibility of incorporating a collaborative water management system in the Town of Leicester to help alleviate issues of water quality and quantity. In our report, we provide recommendations for the Town of Leicester, its water districts and the Moose Hill Commission on how to collaborate to help Leicester with its current and future water needs.

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- Our project advisors, Corey Dehner and Laura Roberts, who guided us throughout our project.
- Our sponsors: Kevin Mizikar, the Town Manager of Leicester, Massachusetts, and Andrea Briggs, Deputy Regional Director of the Massachusetts Department of Environmental Protection.
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- Michelle Buck, the town planner of Leicester.
- Kurt Parliment of the Moose Hill Water Commission.
- Russell Tierney and Eric Burkett of WhiteWater Inc.
- Stephen Estes-Smargiassi of Massachusetts Water Resource Authority.
- Jim Monaco of Worcester Polytechnic Institute's Academic Technology Center.

EXECUTIVE SUMMARY

In July 2010, through Resolution 64/292, the United Nations General Assembly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of human rights (United Nations General Assembly, July 2010). Across the United States, municipalities require water of adequate quality and quantity in order to support residential, commercial, and industrial water demands. This requires the presence of a robust water management system that can ensure these essential conditions are taken care of. Municipalities that encounter issues with water management put their residents at risk of serious health complications. A contemporary example of this is the water crisis in Flint, Michigan that began in April, 2014. As with Flint, numerous towns and cities have been experiencing issues with water management and face the challenge of reforming municipal systems.

In Massachusetts, sixty percent of the lakes, streams, rivers and marine waters that have been tested for contaminants are impaired by various pollutant sources ranging from wastewater treatment plant discharge to storm water runoff (Morris et al, 2007). In addition, “drinking water shortages have become a common occurrence” (Mullin, 2009) all across the United States due to growing population demand. The Town of Leicester, Massachusetts, is suffering from limited economic development due to an inadequate supply of water available for use. Additionally, the water sources that are currently used experience various issues related to contamination. At present, Leicester has three independently operating water districts serving residents of the town (Water & Sewer, n.d.).

From October to December 2015, a student team from Worcester Polytechnic Institute’s (WPI) Massachusetts Water Resource Outreach Center (WROC) worked on a project to investigate possible recommendations to improve the water management system in Leicester (Nivarthi et al, 2016). In the Nivarthi et al report, they recommended that the town move toward water district

consolidation and explore Moose Hill Reservoir as the town's main water source. Aiming to build on these recommendations, the Massachusetts Department of Environmental Protection (MassDEP) and the Leicester Town Manager reached out to our project group.

In collaboration with the Massachusetts Department of Environmental Protection (MassDEP) and Leicester's Town Manager, we analyzed the feasibility of incorporating a collaborative water management system for the Town of Leicester, Massachusetts. Our team explored the viability of functional coordination and resource sharing among each of Leicester's three independently operating water districts, the Town of Leicester and the Moose Hill Commission, to help alleviate issues of water quality and quantity for current and future water needs. In order to achieve this goal, we developed the following six objectives.

1. Identify the state of water management issues in Leicester.
2. Identify towns and cities with existing methods of resource sharing
3. Analyze the feasibility of applying various methods of resource sharing to Leicester
4. Explore and develop approaches for connecting Moose Hill Reservoir and Shaw Pond to the town's collaborative water management system
5. Utilize feedback from sponsors and stakeholder representatives on potential recommendations for Leicester
6. Develop a detailed list of recommendations for Leicester's future water needs

Methodology

To accomplish the objectives mentioned above, we reviewed various consumer confidence drinking water reports, researched other towns and cities that have experienced similar challenges and conducted interviews and focus groups. We interviewed representatives from each of Leicester's three water districts, members of the drinking water department of the MassDEP, water consultants and water wholesalers. Throughout our research, we facilitated several sponsor meetings which functioned as mini focus groups with members of the MassDEP; the Leicester Town Manager,

Kevin Mizikar and the Town Planner, Michelle Buck. Additionally, we conducted a working focus group meeting with attendees from Leicester's water districts, the Town and the Moose Hill Commission.

Findings

A significant portion of Leicester's future economic growth and development rests on a collaborative continuum of resource sharing by each of Leicester's three water districts, the Moose Hill Commission and the Town of Leicester. This continuum of resource sharing would help the Town to develop economically, and increase quality of life for its residents. We categorized our findings into the following themes that essentially looked beyond the tap, for future economic growth by assessing the future water needs in the town.

Existing Methods of Resource Sharing

Other towns and cities similar to Leicester across the United States have explored the idea of resource sharing. Some of the main reasons for increased cooperation are much needed capital upgrades, prevention of further contamination to water sources and providing equitable services. Towns with multiple water districts are very unique. The 19 towns and cities we researched are similar to Leicester in terms of population, number of water districts and number of sewer districts. Figure 1 below illustrates that in Massachusetts, nine out of 351 towns and cities in MA have three or four water districts. This is only 2.5% of all the municipalities in the state.

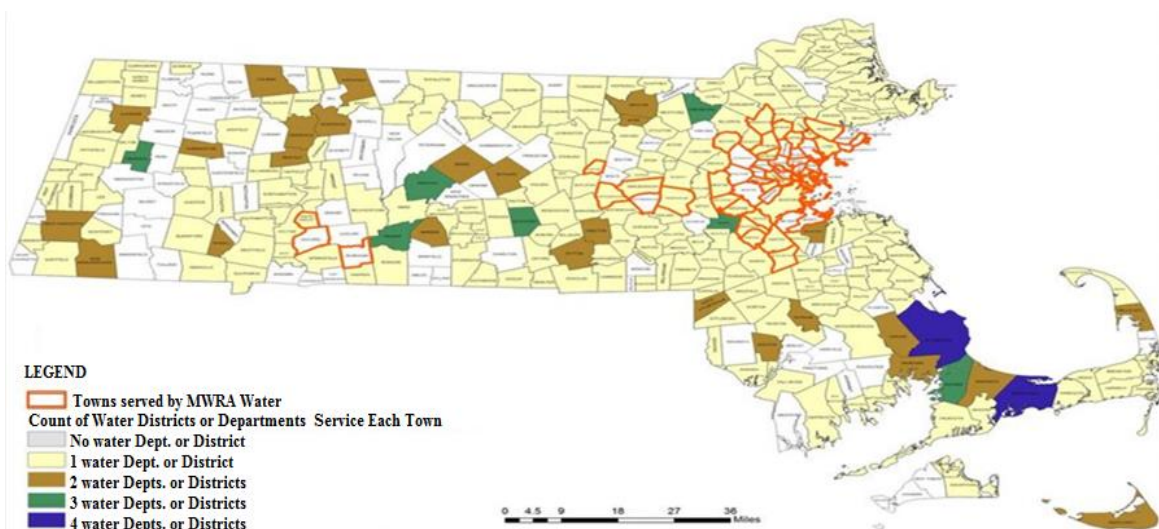


Figure 1: Map Showing Municipalities in Massachusetts and their Water Districts

Capacity

Water availability is becoming a bigger issue for the Town of Leicester. As such, other sources in the town have been assessed for possible use. The Moose Hill Reservoir is a potential drinking water source located in Leicester that has the ability to supply the entire town with water. The reservoir is still untouched and has yet to be capitalized upon. A study conducted in 1966 by SEA Consultants Inc. looked at the feasibility of incorporating Moose Hill Reservoir into the water supply system in Leicester. The study suggested that the reservoir would be able to supply 1.5 million gallons of water per day (Sanitary, 1966), which is approximately 2.5 times more water than the entire town uses at present (Moose Hill, 2008). In an interview with Eric Burkett & Russell Tierney of WhiteWater Inc., it was estimated that the current cost of constructing a new treatment plant at the reservoir is approximately \$18-21 million (Eric Burkett & Russell Tierney, personal communication, April 21, 2016). This is too expensive for any one water district to bear on its own. If the water districts and the town want to utilize this source, they would have to come to an agreement on sharing resources to make it possible. It is important to note that Moose Hill Reservoir cannot be at a standstill for much longer due to increasing costs (Kurt Parliment, focus

group, April 14, 2016). Kurt Parliment, a member of the Moose Hill Commission, urged that water districts work together in some capacity to take advantage of the Reservoir before it is too late.

Distribution System

Additionally, aging infrastructure puts Leicester at a disadvantage for future collaboration with water entities in the town. For water districts that are owned and operated separately from their town, the cost associated with infrastructure upgrades can be too much to incur, without significantly impacting its ratepayers. The piping for the various distribution systems in Leicester can be dated to as far back as the 1890s. These water pipes have a lifespan of anywhere between 120-130 years, and they have exceeded their span (Mike Knox, focus group, April 14, 2016). There is a scale of urgency in the distribution systems in Leicester. For the Cherry Valley & Rochdale Water District alone, it will cost up to \$3.5 million for capital improvements in the district (Mike Knox, focus group, April 14 2016). Each water district in Leicester is currently investing in improving their distribution system by building new treatment plants and laying new water infrastructure among others, however, none of the money from these service upgrades contribute to the improvement of the distribution system.

Funding

Funding for water infrastructure is an essential part of securing a sustainable, high quality water source and distribution system for the Town of Leicester. Various forms of funding exist including the State Revolving Fund for planning and upgrades, the Mass Works grant and creating an earmark in the town's budget. Without proper funding in place, the rate payers are likely to bear the cost of moving forward and this may cause resistance among Leicester residents.

Leicester's Plan

The Town of Leicester, its three water districts and the Moose Hill Commission have to collaborate to create a Leicester Future Plan to propose to regulatory agencies like the MassDEP, in order for these agencies to in turn work with them for the overall betterment of the town. The

MassDEP is willing to work with the Town of Leicester provided that each entity jointly produces a concrete plan for moving forward (Andrea Briggs, focus group, April 14, 2016).

However, the water districts are tentative about putting anything together without a formal commitment from the MassDEP (Kevin Bergin, focus group, April 14, 2016). In order to facilitate communication between parties, the Town Administrator, Kevin Mizikar, agreed to act as the liaison. As liaison, Mr. Mizikar will combine the ideas and thoughts of the Leicester entities and propose a condensed summary to the MassDEP, to help identify exactly what the MassDEP is willing to work with the water districts on.

Education

The residents of each water district need to learn about the town wide water struggles. Because of the separate districts in Leicester, most residents are not aware of the challenges faced by the town (Kevin Bergin, focus group, April 14, 2016). Educating them on these issues could potentially help get them involved. This needs to take place in both the short and long term. Emphasizing the importance of safe drinking water to the residents could spark progress (Kurt Parliment, focus group, April 14, 2016).

Recommendations

Through our research, interviews and participation in focus group discussions, we have formulated several recommendations for the Town of Leicester, the town's three water districts and the Moose Hill Water Commission.

We recommend that the Town of Leicester form a *Water Prioritization Committee* to continue the conversation of functional cooperation with the town, the water districts and the Moose Hill Commission. The committee could consist of officials that are appointed by each water district, the Moose Hill Commission, the town management and planning committees, and an at-large Leicester resident (not a customer of a water district). Also, a subcommittee for education could also be

formed with members of the Leicester Community Action Corporation (LCAC), the Leicester Business Association and a member from each of the Parent Teacher Organizations of Leicester's four schools as representatives. This would insight residents to want to learn more, ask more questions and make inquiries both at town hall and water district meetings.

We recommend that the *Water Prioritization Committee* focus on the following:

Recommendation 1: Conduct weekly meetings to create a Leicester Water Future Plan to discuss with the MassDEP

In the focus group meeting on April 14th, 2016, the Leicester Town Manager, Kevin Mizikar, has agreed to act as a middleman, if necessary, to facilitate open discussions between the commissioners of the water districts and members of the MassDEP so that they can figure out a way to collaborate and help achieve Leicester's goals regarding its water needs.

Recommendation 2: Strengthen the relationship between the Town and the Water districts

The town of Leicester is willing to play a bigger role in helping the water districts provide quality water for their residents. According to an agreement, signed in 2003 between the Leicester Water Supply District and the Board of Selectmen, the Town has agreed to lay down sewer pipes along the west end of Route 9 in Leicester. Town Manager, Kevin Mizikar, expressed that the town would be more than willing to hire consultants to conduct a new feasibility study on the construction of a new treatment plant near Moose Hill Reservoir, so that the water districts do not have to bear this cost (Kevin Mizikar, focus group, April 14, 2016)

Recommendation 3: Development of the Moose Hill Reservoir as a drinking water source

Moose Hill cannot continue in a standstill for much longer. Using Moose Hill would provide the entire town with 1.5 million gallons per day, which allows residents that are currently connected to water district systems to have safe reliable water and it also allows for more residents to have access to public water. This would be aiding the Town's mission for economic growth. We recommend that Moose Hill be developed as a drinking water source.

Recommendation 4: Assist the town with planning for future improvement and implementation of water infrastructure

We recommend that the Town of Leicester and each of its water districts should work collaboratively to invest in town-wide capital improvements that will include replacing aging infrastructure in the town. As part of the Water Priority Committee's role, the committee will oversee that each water district allocates funding towards improvement of their systems, to allow sustain any current and future growth in the town's water demand needs. Additionally, laying new water and sewer infrastructure in underdeveloped areas is recommended. Laying new infrastructure will help to increase the town's tax base by attracting commercial and economic development in smart growth areas.

Recommendation 5: Continually work towards the long term goal of consolidation

Currently, each water district is plagued with similar issues, but all struggle with maintaining compliance. In the long term, we recommend that the water districts combine into one water district. This however, is only achievable through district voting. Becoming one water district with a new enabling act will allow for reduced operational and administrative costs, and would allow for ratepayers funding to be collectively focused on maintaining compliance with drinking water regulations.

Recommendation 6: Assist the Town with Applying for a Mass Works Grant for capital improvements

Proper interconnections between the water districts are necessary so that water from one district can flow to the other districts in times of emergencies and with minimal water loss. However, the water districts are currently using most of their resources to operate the districts and upgrading their infrastructure to keep in compliance with the regulations enforced by the MassDEP. Therefore, we recommend that the Town of Leicester apply for a Mass Works grant in order to pay for these interconnections that can be used not only for emergencies, but on a daily basis. Laying new pipes and improving the existing interconnections would also help to improve Leicester's aging distribution system that was discussed in section 4.4. We believe that the town would have made a

move forward in the right direction as this might foster some cooperation between the town's water entities.

Recommendation 7: Work with various community state holders to education residents of Leicester's water challenge

Each zone managed by each of Leicester's three water districts functions as their "own town" and not as a unified Town of Leicester. As such, many of the residents in the Town of Leicester are unaware of the challenges that each water district faces. Consequently, the residents are unaware of how these challenges directly affect them. Therefore, it should be one of the *Water Prioritization Committee's* top priorities to work jointly with the town, each water district and the Moose Hill Commission to educate the residents of the town. This educational initiative can be done through television programming offered through the Leicester Community Action Corporation (LCAC) television program. Similarly, education can spread through indirect means such as through Parent Teacher Organizations or the Leicester Business Association. These organizations represent residents and businesses in the Town of Leicester who will significantly contribute to Leicester's future development. Through education, these organizations can spark open conversation in the town that will help the *Water Prioritization Committee* to advocate and advertise some of the opportunities the Town of Leicester has, meeting the future water needs in the town.

The Town of Leicester, the three water districts and the Moose Hill Commission, are at a unique time in history when many decisions for the future are being made. Through, cooperation and planning each entity stands to benefit. Therefore, with our recommendations, the Town of Leicester will be able to meet its current and future water needs, while still aligning with the town's vision for economic growth and development.

Water is a vital resource that the Town of Leicester has available; each water supplier in the town has made strides to improve their systems, keep compliant and meet the demands of their residents. There are great opportunities for functional coordination and resource sharing. Currently,

each water district functions as a separate town essentially, however, with the recommendations outlined, it is our hope that each entity sees the gains from working together for the future economic growth and development of the Town of Leicester.

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Executive Summary	Shanel	James
List of Tables	U Shwe	Shanel
List of Figures	U Shwe	Shanel
1.0 Introduction	U Shwe, James, Shanel	James, Shanel
2.0 Background		
2.1 Water Management	James	U Shwe, Shanel
2.2 Water Management Issues	Shanel	U Shwe, James
2.3 Consolidation of Resources	U Shwe	James, Shanel
2.4 The Town of Leicester	Shanel	James, U Shwe
3.0 Methodology	U Shwe	James
3.1 Objective 1	U Shwe, James, Shanel	James, U Shwe
3.2 Objective 2	U Shwe, James, Shanel	James, U Shwe
3.3 Objective 3	U Shwe, James, Shanel	James, U Shwe
3.4 Objective 4	U Shwe, James, Shanel	James, U Shwe
3.5 Objective 5	U Shwe, James, Shanel	James, U Shwe
3.6 Objective 6	U Shwe, James, Shanel	James, U Shwe
4.0 Findings		
4.1 Leicester's Plan	Shanel	James, U Shwe

4.2 Capacity	U Shwe	James
4.3 Tradition	Shanel	James
4.4 Distribution System	U Shwe	James, Shanel
4.5 Real World Examples	Shanel	James, U Shwe
4.6 Governance	Shanel, James	James, U Shwe
4.7 Funding	James	James, U Shwe
4.8 Education	James	James, Shanel
5.0 Leicester's <i>Water Prioritization Committee</i>	Shanel	James
6.0 Conclusion	Shanel	James, U Shwe
7.0 References	Shanel	
8.0 Appendix	U Shwe	

LIST OF TABLES

1. Comparison of the main benefits and costs of the consolidation examples
2. Comparison of the three water districts in Leicester (taken from Leicester, Cherry Valley & Rochdale and Hillcrest Annual Water Quality Reports for 2014)
3. Benefits of functional coordination from existing resource sharing models
4. Prioritization Matrix for the *Water Prioritization Committee*
5. Comparison of the current and future estimated water demands from each water district
6. The list of municipalities that were involved in consolidation
7. Comparison of water rates in each district
8. The water sources used by the Leicester Water Supply district and their status
9. Table showing the water sources used by the Cherry Valley and Rochdale Water district and their status
10. Table showing the water sources used by the Hillcrest Water district and their status

LIST OF FIGURES

1. Municipalities in Massachusetts and their Water Districts
2. The spectrum of management structures in the water utility industry (Dehner, 2011)
3. Vulnerabilities in a water utility supply (Clark and Deininger, 2000)
4. Assessment of rivers and streams in Massachusetts
5. The spectrum of consolidation (EPA, 2007)
6. Modified map of the Town of Leicester, Massachusetts
7. Outline of the project goals
8. Map showing a possible approach to connect Moose Hill Reservoir and the Leicester Water Supply District

TABLE OF CONTENTS

ABSTRACT	i
ACKNOWLEDGEMENTS	ii
EXECUTIVE SUMMARY	iii
Methodology	iv
Findings	v
Recommendations	viii
AUTHORSHIP	xiii
LIST OF TABLES	xv
LIST OF FIGURES	xv
1.0 INTRODUCTION	20
2.0 BACKGROUND	23
2.1 Water Management	24
2.1.1 Water Distribution	24
2.1.2 Water Regulation in the USA	24
2.1.3 Water Regulation in Massachusetts	25
2.1.4 Water Regulation in Towns	26
2.2 Water Management Issues	27
2.2.1 Governance of Local Water Systems	27
2.2.2 Issues of Water Quality	30
2.2.3 Issues of Water Quantity	31
2.3 Consolidation of Resources	34
2.3.1 Consolidation in Practice.....	36
2.4 The Town of Leicester	39
2.4.1 A Comparison of Leicester’s Three Water Districts	40
2.4.2 Challenges Faced by Leicester’s Water Districts	41
2.4.3 The Moose Hill Reservoir	41
3.0 METHODOLOGY	43

3.1 Objective 1: Investigated the State of Water Management Issues in the Leicester Water Districts	44
3.2 Objective 2: Identified existing district methods of resource sharing used by other towns or cities in the United States	45
3.3 Objective 3: Analyzed the costs, benefits and the feasibility of different methods in the continuum of resource sharing identified in Objective 2	46
3.4 Objective 4: Explored and developed approaches for connecting Moose Hill Reservoir and Shaw Pond to the Town’s regionalized water system	47
3.5 Objective 5: Utilized feedback from sponsors and stakeholder representatives on findings to refine our recommendations	48
3.6 Objective 6: Developed recommendations for the Town of Leicester and its water districts on working together for the betterment of the town	49
4.0 FINDINGS- Leicester’s Water Future	50
4.1 Leicester’s Plan	50
Finding 1: The Town of Leicester, its three water districts and the Moose Hill Commission operate independently of each other, with little overlap, making it difficult to work collaboratively with each other and the MassDEP.....	50
Recommendation 1: We recommend that the <i>Water Prioritization Committee</i> conduct weekly working discussion meetings to create a Leicester Water Future Plan for the town to propose to the MassDEP.	51
Finding 2: Each of Leicester’s three water districts has taken many steps to improve the Town of Leicester’s water utilities, but currently, short term plans are being made that hinder long term planning.....	52
Recommendation 2: The Town of Leicester should play a more integral role in helping each water district provide quality water to their residents	53
4.2 Capacity	53
Finding 3: Water needs are becoming a bigger issue for the Town of Leicester and as such other sources in the town have been assessed for possible use	53
Finding 4: The capacity of the water districts to provide water for their customers are limited by their Maximum Daily Withdrawal Limit and aging infrastructure and, at present, water districts in Leicester do not have redundancy supply systems.....	56
Finding 5: The Moose Hill Reservoir is not subject to the Interbasin Transfer Act	57
Recommendation 3: We recommend that Moose Hill Reservoir should be developed as a drinking water source	57
4.3 Tradition	58
Finding 6: Leicester’s three water districts and the Moose Hill Commission have operated separately since their existence.	58

Finding 7: Similarly, to other towns Leicester is rooted in its traditions and as such, many leaders of the water districts seem resistant to change.....	59
4.4 Education	60
Finding 8: The residents of the Town of Leicester may not be fully aware of the town’s water challenges.....	60
Recommendation 4: The Town of Leicester, the Leicester Water Supply District, the Hillcrest Water District, the Cherry Valley & Rochdale Water District, and the Moose Hill Commission should work jointly with the <i>Water Prioritization Committee</i> to educate the Leicester community of the water challenges the town faces	60
4.5 Distribution System	61
Finding 9: Aging infrastructure of each of the water districts puts the Town of Leicester at a disadvantage for future economic growth and development.....	61
Finding 10: The hydraulic pressure in the water systems are not sufficient for fire suppression	62
Recommendation 5: The Town of Leicester should lead efforts to invest in water infrastructure to improve current piping and develop smart growth areas in the Town for economic development.	62
4.6 Existing Models of Resource Sharing	63
Finding 11: Many municipalities have explored and benefited from resource sharing.	63
Finding 12: A continuum of resource sharing in the towns and cities researched, all had varying costs associated with their projects and each had varying degrees of benefits associated.....	65
4.7 Governance	66
Finding 13: Each water district in the Town of Leicester is a governing body run by elected officials.	66
Recommendation 6: We recommend that in the long term, the districts should join into one water district.....	66
4.8 Funding	67
Finding 14: Funding for water infrastructure is an essential part of securing a sustainable, high quality water source and distribution system for the Town of Leicester.....	67
Recommendation 7: We recommend that the Town of Leicester, with the help of the <i>Water Prioritization Committee</i> , apply for funding such as a Mass Works Grant, to provide funding for upgrading the existing interconnections and laying new ones between each district. ...	68
5.0 LEICESTER’S WATER PRIORITIZATION COMMITTEE	69
5.1 Committee Structure	69
5.2 Committee Responsibilities	69
6.0 CONCLUSION	72

7.0 REFERENCES	73
8.0 APPENDICES	78
APPENDIX A: Informed consent form	78
APPENDIX B: Written consent form	81
APPENDIX C: Interview Questions for Andrea Briggs, MassDEP	82
APPENDIX D: Interview Questions for Kevin Mizikar, the Town Manager of Leicester .	83
APPENDIX E: Interview Questions for the water district operator of Cherry Valley & Rochdale Water District	84
APPENDIX F: Interview Questions for the water district operator of Leicester Water Supply District	85
APPENDIX G: Interview Questions for the water district operator Hillcrest Water District	86
APPENDIX H: Probing questions for the <i>Beyond the Tap</i> focus group members	87
APPENDIX I: <i>Beyond the Tap</i> Focus Group Handout	88
APPENDIX J: Interview Questions for Senator Michael Moore	90
APPENDIX K: Interview Questions for Stephen Estes-Smargiassi, MWRA	91
APPENDIX L: Interview Questions for Russell Tierney, WhiteWater Inc.	92
APPENDIX M: Figure showing the spectrum of management structures in the water utilities industry (Dehner, 2011)	93
APPENDIX N: Figure showing the vulnerabilities in a water utility supply (Clark and Deininger, 2000)	94
APPENDIX O: Table showing the current and future estimated water demands from each district (Moose Hill, 2008)	95
APPENDIX P: Table showing the list of municipalities that were involved in consolidation	75
APPENDIX Q: Comparison of the water rates in each water district	78
APPENDIX R: Table showing the water sources used by Leicester Water Supply District and their status	79
APPENDIX S: Table showing the water sources used by Cherry Valley and Rochdale Water District and their status	79
APPENDIX T: Table showing the water sources used by Hillcrest Water District and their status	80

1.0 INTRODUCTION

In July 2010, through Resolution 64/292, the United Nations General Assembly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of human rights (United Nations General Assembly, July 2010). Across the United States, municipalities require water of adequate quality and quantity in order to support residential, commercial, and industrial water demands. This requires the presence of a robust water management system that can ensure these essential conditions are taken care of. Municipalities that encounter issues with water management put their residents at risk of serious health complications. A contemporary example of this is the water crisis in Flint, Michigan. The problem started soon after April, 2014 when Flint, the largest city in Michigan, changed its water source from Detroit Water and Sewage Department to the Flint River (Taylor and Hammell, 2016). The corrosive water of the Flint River caused lead from old pipes to dissolve into the water supply, producing high levels of lead, a possible carcinogen, in the drinking water. It was not until October, 2015 that city officials publicly acknowledged the problem (Taylor and Hammell, 2016). As with Flint, numerous towns and cities have been experiencing issues with water management and face the challenge of reforming municipal systems.

In the 19th century, New England was an industrial region (Weil, 1998). During its industrial age, heavy metals were used; today, these metals continue to contribute to pollution issues. In Massachusetts, sixty percent of the lakes, streams, rivers and marine waters that have been tested for contaminants are impaired by various pollutant sources ranging from wastewater treatment plant discharge to storm water runoff (Morris et al, 2007). In addition, “drinking water shortages have become a common occurrence” (Mullin, 2009) all across the United States due to growing population demand. The Town of Leicester, Massachusetts, is suffering from limited economic development due to an inadequate supply of water available for use. Additionally, based on annual

water quality reports, the water sources that are currently being used experience various issues related to contamination. At present, Leicester has three independently operating water districts serving residents of the town (Water & Sewer, n.d.). This is unusual, especially considering the population of Leicester is only about 11,000 people (Census, n.d.), compared to the adjacent City of Worcester, which has one water district to serve a population of about 180,000 people (Demographics & Census Information, n.d.).

From October to December 2015, a student team from Worcester Polytechnic Institute's (WPI) Massachusetts Water Resource Outreach Center (WROC) worked on a project to investigate possible recommendations to improve the water management system in Leicester. (Nivarthi et al, 2016). In the Nivarthi et al report, they recommended that the town move toward water district consolidation and explore using the Moose Hill Reservoir as the town's main water source. Aiming to build on these recommendations, the Massachusetts Department of Environmental Protection (MassDEP) and Leicester's Town Manager reached out to our project group.

In collaboration with the Massachusetts Department of Environmental Protection (MassDEP) and Leicester's Town Manager, we analyzed the feasibility of incorporating a collaborative water management system for the Town of Leicester, Massachusetts. Our team explored the viability of functional coordination and resource sharing among each of Leicester's three independently operated water districts, the Town of Leicester and the Moose Hill Commission, to help alleviate issues of water quality and quantity for current and future water needs. In order to achieve this goal, we developed six objectives.

We investigated the state of water management issues in each of Leicester's water districts. We identified towns and cities with existing methods of resource sharing and we analyzed the feasibility of applying various methods of resource sharing to Leicester. We explored and developed

approaches for connecting Moose Hill Reservoir and Shaw Pond to the town's collaborative water management system. We sought feedback from sponsors and stakeholder representatives on potential recommendations for Leicester. Lastly, we developed a detailed list of recommendations for Leicester to fulfill its future water needs.

We collaborated with our project sponsors Kevin Mizikar, the Leicester Town Manager, and Andrea Briggs, of MassDEP, as well as other key stakeholders and experts to accomplish our objectives and fulfill our mission. We conducted extensive research of the problem Leicester is currently facing, which is outlined in the Background, Chapter 2. We provided a detailed breakdown of tasks for each objective in the Methodology, Chapter 3. We provided a layout of our findings and recommendations in Chapter 4. Lastly, Chapter 5 describes the *Water Prioritization Committee*, which is a committee we recommend that will ensure Leicester's future water needs are met.

2.0 BACKGROUND

On January 16, 2016, President Barack Obama declared a state of emergency in Flint, Michigan, due to emergency conditions caused by contaminated water in the area (President Obama Signs Michigan Emergency Declaration, 2016). The Flint River's corrosive water caused lead from old pipes to dissolve into the water supply. Lead is detrimental to the body and high lead levels in children can lead to developmental delay and learning difficulties (Lead Poisoning, 2014). In Flint, it is estimated that between 6,000 and 12,000 children were exposed to drinking water contaminated with high levels of lead (Keller, A. 2016, January 18). Flint's 90th percentile lead value reached 25 parts per billion (ppb), well over the allowed level of 15 ppb that is applied to high risk homes (Lead testing results for water sampled by residents, n.d.).

As seen in Flint, poor quality drinking water is a symptom of poor water management. Leicester, a small town in central Massachusetts, is in the midst of a water crisis. They do not have a sufficient quantity of water for their residents. In addition to the shortage, their water contains high levels of contaminants, specifically arsenic, making it difficult to treat for consumption. Arsenic has, "no smell, taste, or color when dissolved in water, even in high concentrations" (Cerutti, 2015), making it hard to detect. Long term arsenic exposure can cause changes to skin color and thickness along with increased risk of various types of cancers (Cerutti, 2015). These health concerns reinforce the need for an effective water management system that will provide safe, clean drinking water for the town.

In this chapter, we elaborate on water management in Section 2.1 and discuss challenges water systems face with water management in Section 2.2. In Section 2.3, we introduce the idea of resource sharing as an antidote to some of these water management challenges. Finally, in Section 2.4 we introduce the town of Leicester and our project.

2.1 Water Management

Water management begins at the source. Water is drawn and then treated for contaminants before it is ready for distribution. The water management system must also maintain and monitor the pipes, chemical levels and conduct water quality tests. If a town has enough usable water, it can accomplish these steps on its own. If not, the town must acquire it from elsewhere, usually by directly purchasing it from a neighboring municipality. To ensure standardized water quality, laws and regulations are enforced by the state environmental agency. These laws exist at the federal level, state level, and local level.

2.1.1 Water Distribution

In the United States, municipalities acquire water in numerous ways. Water can be pumped from surface or groundwater sources, and piped or purchased from neighboring municipalities. Ideally, a town would be able to source and treat its own water; however, this is not always the case. The Cherry Valley and Rochdale water districts in Leicester, Massachusetts is currently considering purchasing water from the neighboring city of Worcester, while the Leicester Water District pipes water in from the nearby Town of Paxton. Worcester's water distribution system can serve as a potential guide for Leicester's future water system.

The City of Worcester has a complex underground water and sewer operation system. The water/sewage division supplies potable water as well as collect sewage and storm-water (City of Worcester, MA, 2016). An average of 24 million gallons of water per day (City of Worcester, MA, 2016) is used in the city and sold to surrounding municipalities. In total, there are ten reservoirs in the Worcester water supply system.

2.1.2 Water Regulation in the USA

There are numerous federal laws and regulations that aim to protect water quality. Of particular importance to this project is the federal Safe Drinking Water Act. Made into law by

Congress in 1974, the Safe Drinking Water Act (SDWA) allows for the establishment of national minimum standards for the quality of drinking water in the 50 states. The United States Environmental Protection Agency (USEPA) identifies major contaminants in water and regulates the permissible amount of contaminants that can be present in drinking water. The SDWA is significant because it mandates the delivery of clean drinking water across the nation. It is important to note that while the USEPA is at the top, each state's Department of Environmental Protection can create stricter requirements for their state. The SDWA requires that all water management systems submit an annual report on the quality of the water supply. These reports are publically available, so consumers may have access to them.

2.1.3 Water Regulation in Massachusetts

In addition to complying with the SDWA, states prescribe stricter requirements for water systems to follow. In Massachusetts, municipalities must adhere to the regulations set forth in the Massachusetts Water Management Act (MWMA). Otherwise they are issued Notices of Non-compliance, a written notice given to a town or district that has failed to comply on any specified occasion with any described requirement(s) (310 CMR 5.00 Administrative Penalty Regulations, 2008). The MWMA limits the amount of water drawn from surface and groundwater sources. It ensures that there will be enough water for the present and the future, as well as for aquatic life (Massachusetts, 1966). The MWMA sets the withdrawal limit at 100,000 gallons of water per day, however, permits may be attained by businesses or individuals who use more than this or nine million gallons of water over a three month period. The business or individuals who surpass the water limit must supply monthly reports detailing their water use. Pursuant to the MWMA, MassDEP holds public water suppliers accountable for any water losses. According to the Alliance for Water Efficiency, water losses typically involve leakage and poor accounting (Water Loss

Control, 2016). Because of this, many water management systems focus on meter installation and maintenance, leak detection, and reducing peak water usage (Massachusetts, 1996).

The Massachusetts Clean Water Trust provides funding to municipalities in the Commonwealth to improve water quality (Massachusetts Clean Water Trust, 1989). Of the extra funding appropriated by the Clean Water Trust, over \$100 million could be put towards construction projects financed by the Massachusetts Department of Environmental Protection (MassDEP). Public health is important to the Drinking Water Intended Use Plan. As of 2015, all Public Water Suppliers in Massachusetts are able to maintain compliance with the SDWA (Final Drinking Water Intended Use Plan, 2015). Funds are put towards municipalities that need capital improvements for an increase in efficiency. This increase in efficiency allows water utilities to provide a higher quality of water to its customers.

2.1.4 Water Regulation in Towns

Beyond the standards set by the SDWA and MWMA, each city or town may have additional rules and regulations. One of the major areas local regulation covers is rates. Megan Mullin, Assistant Professor of Political Science at Temple University, writes that, “Independent special districts play a growing role in providing a wide array of local services” (Mullin, 2009). Special districts perform functions similar to cities and towns (Mullin, 2009). These local districts or departments protect the public’s health by treating drinking water for contaminants. As the population grows and more land becomes developed, competition for freshwater resources increases. Due to lack of funding, municipal governments are forced to focus on projects with an immediate scope rather than finding lasting fixes.

2.2 Water Management Issues

These issues stem from how water is governed in towns and cities across the United States. Management by local governments, and issues of quality and quantity are factors that make water management issues relevant to the future economic growth and development of a town. This section explores these problems and how they affect the New England area.

2.2.1 Governance of Local Water Systems

Water systems are governed differently in each state. Water systems can be publicly owned, in the case of a city or town water department, privately owned by third party companies or divided into water districts. In some areas of the United States, like New England, private ownership of water can be defined as domestic wells owned and operated on residential land or owned by a private company. However, a public water system differs from a private system, in that it can either be publicly or privately owned.

Types of water management structures for water resources

Water systems can be owned and operated by public and private entities. Like many states, Massachusetts has water systems that are privatized, fully public, fully private or managed through a public-private partnership, as well as municipally owned and managed. “Throughout history, the Commonwealth has served as a laboratory and model for public water systems throughout the country” (Dehner, 2011). A public water supply system can be defined as a public or privately owned water resource system that provides water to at least 25 people or has a minimum of 15 service connections within its system (NMWD, n.d.). The management of these public systems can be by a private company, a public, town-wide water department or independently owned and operated water districts (see Appendix M, Figure 2 for a spectrum of management structure in the water utility systems).

Collaborative Water Governance

Water governance varies slightly in each state in the New England area. It is broken down into the range of political, socio-economic, environmental and administrative mechanisms designed to handle the development and management of water resources and services (Burchi et al, 2012). Water management issues that exist today show the need for adaptive management that emphasizes the rights, responsibilities and power dynamic among varying levels of management (Huitema, 2009). A unified water department can be considered a type of collaborative water governance system. To effectively govern water resources and water service delivery, there has to be some level of collaboration within the local government (Bouwer, 2000).

Each state in New England faces unique but similar concerns regarding water resources, economy and water governance structure (Managing Water in Connecticut, 2011). These issues vary depending on the types of communities and water resource management problems (Morris et al, 2007). There is a need for water entities to be governed in a way that is accountable, efficient, responsive and sustainable (Bouwer, 2000). There are numerous ways these outcomes can be achieved, once a water management and distribution system is not providing the adequate services to customers. Section 2.3 illustrates possible solutions to help solve these issues.

Aging Infrastructure

Aging infrastructure is a prominent focus in water resource management. The age, capacity and condition of the existing infrastructure have the largest bearing on operation and maintenance costs, as well as the ability of the community to meet both its present and future water needs (Morris et al, 2007). The American Society of Civil Engineers has estimated that a minimum of \$20 billion per year of additional spending is necessary in order for water and wastewater infrastructure in the United States to meet system demands and water quality requirements (Managing Water in Connecticut, 2011). In the American Society of Civil Engineers' infrastructure review for 2013, it is

estimated that up to \$3.6 trillion is needed in infrastructure investments by the year 2020 (Infrastructure Grade, n.d.) with a total investment of \$276.8 billion between 2003 and 2030 (Santora & Wilson, 2008). In North America, there are an estimated 300,000 or more main breaks annually, due to aging pipeline systems (Cohen, 2012). In Massachusetts, there has been a 42.1% increase in expenditure on wastewater and water supply spending between 2000 and 2009 (Cohen, 2012). In 2009, \$1,550,883 was spent on water infrastructure upgrades in Massachusetts alone (Cohen, 2012). For maintenance costs the senior management of a water utility is responsible for formatting a well-organized collection of information that outlines the costs associated with the utility's maintenance (Jordan, 2010). A 'drinking water needs' survey conducted in 2007 and published in 2009, which focused on water needs from 2007 through 2026, highlighted that water systems would need to invest 33.4 billion dollars in drinking water infrastructure improvements over 20 years to comply with drinking water regulations (Haffner & Gennady, 2011). Funding for any type of maintenance and upgrades can be for pipes, treatment facilities and connections. Traditionally, drinking water utility companies use a type of rate based financing to fund any needed improvements to their water systems (Hoffbuhr, 2000). Through preparation of a Water Resource Management Plan, communities can be eligible for financial assistance via the State Revolving Fund (SRF) for the construction of water resource infrastructure projects. Increasingly, the focus of stakeholders in water systems is to "repair and replace water infrastructure that has been in place for decades and will soon fail" (Haffner & Gennady, 2011). However, according to the American Water Works Association, society is at the dawn of the replacement era for infrastructure and there will be growing conflicts between replacement of aged infrastructure and the need for investment in compliance with new regulatory standards (Staff & Ebrary, 2008).

Aging infrastructure can be affected by both physical and chemical challenges. In 2012, a water main broke in Worcester due to the crumbling infrastructure of the water mains (Drici, 2012).

The water main dated back to the 1880s with relining work done about 100 years later in the 1980s (Drici, 2012). For a chemical example, in 2014 Flint's water crisis was caused due to the decomposition of lead from old pipes. This shows the importance of regularly monitoring infrastructure for any damage or maintenance concerns caused by vulnerabilities (see Appendix N, Figure 3 for a list of possible vulnerabilities). In areas like New England where infrastructure is aged, there is a need for funding to upgrade infrastructure and ensure current and future regulatory compliance.

2.2.2 Issues of Water Quality

Water management issues affect the quality of water being supplied to towns and cities. If the water used in homes and businesses is not tested and treated sufficiently, it poses health threats. Laws are set in place to ensure that the water supply reaches an acceptable standard (see section 2.1 above). However, contaminated water sources complicate issues of water quality. Local water management teams are therefore responsible for ensuring safe quality water is supplied to a town or city. Massachusetts' goal is to ensure the availability of sufficient quantity and quality to meet the current and future needs of its residents (Water Conservation Standards, 2006).

Massachusetts Water Quality

The water supplied to our homes comes from multiple sources that contain varying levels of contaminants that, if not properly treated, can lead to devastating health effects. "Contamination is generally viewed as the most serious potential terrorist to water systems" (Voeller, 2014). Many contaminants have no taste, odor or visibility in water. These contaminants are especially dangerous as they can go undetected. It has been, "more than 30 years after the passage of the federal clean water act", yet many water bodies in New England remain polluted (Protecting, 2005). Many of these water bodies are sources that are used to supply water to homes and businesses all over the region, but "at the same time, industrial facilities continue to discharge wastewater directly into water

bodies, adding to water quality woes” (Protecting, 2005). The quality of these water bodies varies, but nevertheless treatment plants must be used to get domestic water to federal and state quality levels. In Massachusetts, water is viewed as a valuable resource. Laws and policies were established to allow for multiple uses, protection of quality and to ensure it meets the legitimate needs of its residents (Water Conservation Standards, 2006). However, sixty percent of the lakes, streams, rivers and marine waters that have been tested in the state for contaminants are impaired by various pollutant sources ranging from wastewater treatment plant discharge to storm water runoff (Morris et al, 2007). In the event that “testing reveals an exceedance of a federal standard, the water supplier is required to notify customers through local news media” (MassDEP FAQ, n.d.). If other contaminants, such as bacteria or chemicals, are above levels that pose threats to human health, the water supply is treated for the removal of the contaminants or taken out of use if the problem cannot be immediately solved. (MassDEP FAQ, n.d.).

2.2.3 Issues of Water Quantity

Quantity is a water management issue that raises concerns of limited supply. Water conservation has become an essential component in efforts to preserve quantity to ensure a sufficient amount is available now and in the future (Water Conservation Standards, 2006). This issue has reached the point where “drinking water shortages have become a common occurrence even in communities that receive abundant rainfall” (Mullin, 2009). This is attributed to the fact that densely populated areas, like Massachusetts, face issues such as significantly low per capita water availability (Water Conservation Standards, 2006). Massachusetts receives approximately 44 inches of precipitation each year, however, rivers and streams within the Commonwealth have inadequate flow for supply (Morris et al, 2007). New sources for water have to be explored. This could mean buying water from other towns, digging more into the ground or building new surface water bodies, to help keep up with the increasing demand, but limited quantity.

Purchasing Water and Digging for More

Water suppliers are experiencing increased difficulty with finding and developing new water sources due to cost, time, regulatory requirements and increasing scarcity of sustainable water sites (Water Conservation Standards, 2006). Water access can be either be an economic or physical water scarcity. Economical water scarcity occurs when clean water resources exist, but they are somewhat unaffordable, while physical scarcity means the actual area of focus has no clean water resources. In either case, finding new sources or purchasing water becomes a necessity. Communities that face these problems are likely to benefit from Integrated Water Resource Planning (IWRP) (Morris et al, 2007) and as such, collaborative water management. An IWRP refers to a comprehensive form of water planning that accounts for water supply, wastewater, storm water, and water quality, and how each relates (Implementing, n.d.).

Assessed Rivers and Streams in Massachusetts

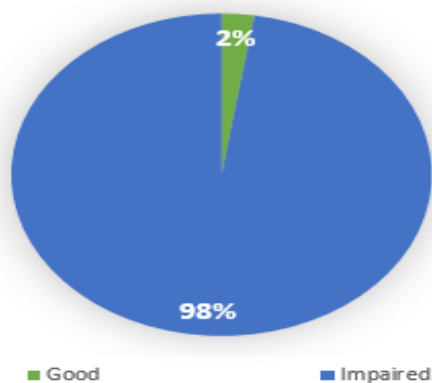


Figure 4: 2012 Assessment of 86,228.5 Acres of Water Sources in Massachusetts

Figure 4 illustrates that in 2012, 86,228.5 acres of lake, reservoirs and ponds in Massachusetts were assessed (Massachusetts Water Quality Assessment Report, n.d.). Of this number, an alarming 97.5% or 84,072.7 were found impaired. This shows a need to acquire more

water from other locations or sources. Water usage varies by community and season, but there is a great opportunity for improved efficiency in water systems (Water Conservation Standards, 2006) as there are not enough quality sources to sustain the current consumption in Massachusetts.

New Surface Water Bodies

Poor water management is a growing issue in the United States that has led to numerous new surface water systems to allow for better quality and quantity of water. Observation shows that this has led to increasing demands for clean water, a reduction in available water resources and issues of pollution, causing concerns about the management of water resources (Zhuang & Zhang, 2014). Problems of water quantity are a reflection of its management. Quantity concerns are expected to increase in coming years as the “demand for water is projected to outstrip supply by a staggering 40 percent by 2030” (Godelnik, 2013). This may be due to overuse, waste and growing population demand, but this will especially be an issue for smaller towns that have to battle quality issues due to contaminated groundwater. This limits the quantity of water that is available to towns and many towns have implemented new surface water bodies to combat the issue of quantity for their water supply.

States such as Texas have begun to focus on the future of water quantity in their state by developing plans to build new reservoirs (Alamaro, 2014). Many areas have either started plans to build new surface water bodies or used existing surface water bodies, such as those used for flood control, as possible reservoir options. In Massachusetts, a comprehensive Water Resource Management Plan allows towns to follow through with any water resource project such as construction of new major wastewater treatment plants, projects for significant interbasin transfers of water or wastewater and the development of any form of large surface water or groundwater

drinking water supplies (Morris et al, 2007). It is nevertheless important to note that these surface supplies can also become contaminated unless properly managed.

Water management issues have the ability to severely hinder towns and cities from achieving their water demand potential. Quality and quantity are then effected due to a lack of collaborative governance in many water systems. In Section 2.3, we explore methods to combat these issues of water management.

2.3 Consolidation of Resources

Small water systems face multiple challenges that hinder their ability to provide reliable, high quality, and affordable water services to their local customers on a regular basis. Some of these challenges include increasing costs due to regulatory compliance, infrastructure renewal needs, or local water resource limitations.

Consolidation is often suggested for addressing these problems (Raucher et al, 2004). Water system consolidation is defined as one community water system being absorbed into, combined with, or served by other systems to gain the resources they lack otherwise (NRC, 1997). There are numerous forms of consolidation; some entail actual physical interconnection or other structural approaches, and others involve non-structural approaches such as shared management arrangements (Raucher et al., 2004). Small water systems can enter into mergers or other cooperative agreements with usually larger systems, or transfer management and/or ownership to another entity (NRC, 1997). Consolidation can allow for cost savings from reduced duplication of services and economies of scale. For example, three different water districts might need to hire three accountants, but if consolidation took place, only one accountant would be needed. This saves money by hiring fewer people to do the same job. Economies of scale is a term used by economists to refer to the situation in which the cost decreases as the volume of output increases (LINFO, n.d.). The consolidated

system can thus make bulk orders for chemicals to treat their water, which will provide supplier discounts.

Regionalization, a subcategory of consolidation, is often seen as a viable solution to address water management problems within small districts by reducing administrative costs. A committee organized by the American Water Works Association (AWWA) defined regionalization as the, “...creation of an appropriate management or contractual administrative organization or a coordinated physical system plan of two or more community water systems in a geographical area for the purpose of utilizing common resources and facilities to their optimum advantage” (Grigg, 1989).

Consolidation can involve cooperation between two or more systems within a region which mutually agree to address a common problem. Each entity would retain its management independence and asset ownership, but the systems would exchange information and technical assistance or develop joint purchasing agreements (Raucher et al, 2004). Full consolidation involves dissolving existing districts to form a new single district. Other types of consolidation can involve the physical interconnection of two or more previously independent entities (e.g., linking water distribution networks to share a common source or treatment facility), and in other cases the systems remain physically independent, but become owned or managed by another water supply entity (e.g., an investor-owned company that imposes centralized management and administration on its portfolio of small systems) (Raucher et al, 2004).

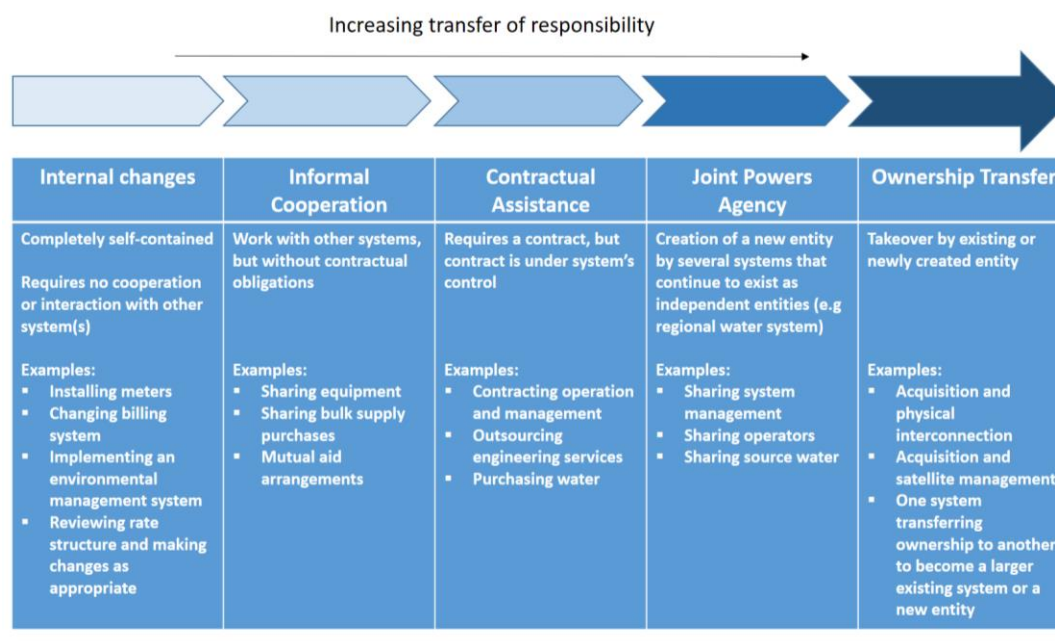


Figure 5: The spectrum of consolidation (EPA, 2007)

2.3.1 Consolidation in Practice

Next, we take a look at the Towns of Clifton and Fine, New York, water districts in Moreau, New York and water districts in Monterey, California that are currently involved in consolidation. From each example, we consider the challenges, the benefits and the costs of consolidation in context to their situation.

Town Consolidation of Clifton and Fine in St. Lawrence, New York

Susan Mende, a bureau reporter for the Watertown Daily Times, explained:

“Since January 2015, two towns in St. Lawrence, New York, have been considering the possibility of consolidating. The merged town would reduce the number of highway superintendents from two to one and there would also be one town supervisor and one town board and possibly other job reductions over time. The two towns already share many services, including some highway services, the Clifton-Fine Hospital and students from both towns attend the Clifton-Fine Central School District. The formation of a combined and shared water district is also on the agenda, regardless of whether the towns consolidate or not. Local officials are optimistic about the financial perks of merging the two neighboring towns in the St. Lawrence County, but they point out that the consolidation study still has several months to go.”

Though the St. Lawrence, New York consolidation does not involve public water systems, it illustrates some of the benefits of consolidated services. The officials of Clifton and Fine are

recommending consolidation because they believe that it will help the towns grow through achieving economies of scale. The consolidated town can also decrease their administration costs by hiring fewer people.

Water district consolidation in the Town of Moreau, New York

In 2013, in the face of state pressure, the Town of Moreau, New York pushed for consolidation of its six water districts and standardization of their rates. The six districts have different water rates, fund balances and use restrictions, which would make for a complicated consolidation (Munks, 2013). The main challenge was how to fairly combine the resources each district has built up (Munks, 2013). The Town Board members moved forward with an asset management study, which looked at each of the six districts and its resources individually, then generated different possibilities for consolidation (Munks, 2013). Consolidation would also help water district one, which will run out of money in a few years as it pays off its water tower and a required hookup to Saratoga County water to create a second source of water (Moore, 2015). Supervisor Jenkins said he was personally in favor of consolidation of water districts in order to simplify things by using the same billing system (Fleury, 2013).

As seen from the previous example, consolidation is an enormous and complex process and regional authorities are sometimes needed to facilitate the consolidation process. If consolidation occurs, the residents of Moreau will be able to benefit from lower standardized water rates and will incur lower administration costs (Fleury J., 2013).

Water district consolidation in Monterey, California

Another example of the consolidation process is the formation of the Monterey Peninsula Water Management District (MPWMD) in California, a government organization specifically formed to ensure an adequate water supply for residents in the Monterey Peninsula. In Monterey, the

California-American Water Company (Cal-Am) supplies 80% of the water (Smith, 1981). The rest is supplied by the 14 mutual water companies, two small private companies, 400 private wells and a publicly owned water system – the Seaside Municipal (Smith, 1981). A district was formed with the intention of bringing “integrated management” to a fragmented water situation (Smith, 1981). Sociological studies indicate that the formation of formal organizations is preceded by the formation of an informal group of influential individuals who are activists or key communicators at some level of society (Smith, 1981). The formation of MPWMD was no exception; assembly persons, county supervisors, the Monterey Mayor, former director of the California Department of Water Resources and a businessman were at the center of this group (Smith, 1981).

Regionalization is often recommended to help solve a public water distribution system’s problems but it faces many barriers. One barrier is the complex cost structure of water supply systems (Grigg, 1989). Also, action at the local level can be impeded by political considerations, hence cooperation can be considered on a case by case basis (Grigg, 1989). Loss of autonomy is a complicated political issue that generates deep feelings and reactions to proposals for regionalization (Grigg, 1989). Generally, regionalization is not favored by the small water districts because “it involves the redistribution of power” (Grigg, 1989) and this political element can serve as a barrier to moving consolidation forward.

Case	Benefits	Challenges and Costs
Town consolidation of Clifton and Fine, St. Lawrence, New York	<ul style="list-style-type: none"> • Reduced duplication of services 	<ul style="list-style-type: none"> • Possible opposition from town residents • Feasibility study • Infrastructure upgrades
Water district consolidation in the Town of Moreau, New York	<ul style="list-style-type: none"> • Standardized water rates • Lower administrative costs • Coordinated management of the districts • Economies of scale • Attract more businesses 	<ul style="list-style-type: none"> • Fund balance difference not shared equally • Feasibility study
Water district consolidation in Monterey, California	<ul style="list-style-type: none"> • Ensure adequate water supply • Integrated and coordinated water management 	<ul style="list-style-type: none"> • Investment in new infrastructure

Table 1: A Comparison of the Main Benefits and the Costs of the Consolidation Examples

2.4 The Town of Leicester

Leicester is a small town in Worcester County, Massachusetts, with a population of approximately 11,000 people. Leicester is mainly open land, however, smart growth projects and economic development projects have been hindered by the limited supply of water in the town (Nivarthi et al, 2016). Currently, Leicester’s water supply system is operated under three physically disconnected and independently operated water districts: Leicester Water Supply District (LWSD), Cherry Valley & Rochdale Water District (CVRWD) and Hillcrest Water Supply District (HWSD). Below, Figure 4 shows how the three water districts are situated in the town. The areas that are not highlighted represent the parts of town with privately owned wells.

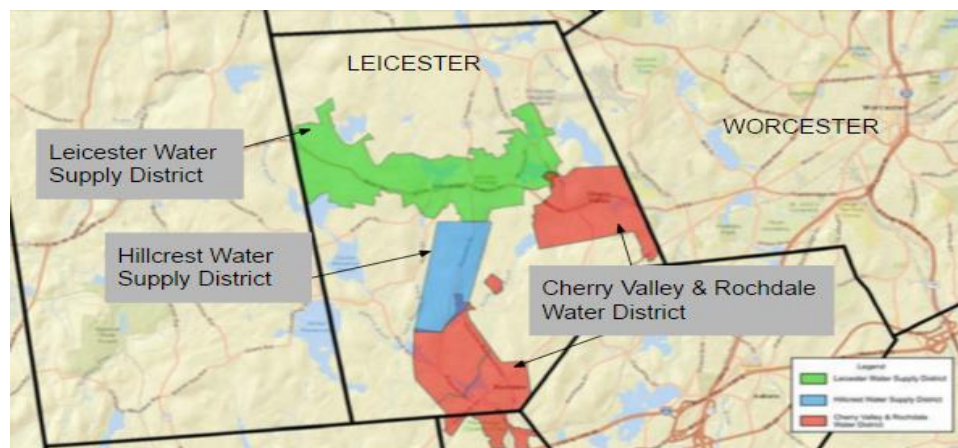


Figure 6: A Modified Map of the Town of Leicester's, Three Water Districts (Nivarthi et al, 2016)

2.4.1 A Comparison of Leicester's Three Water Districts

Each water district in Leicester maintains and manages its own water sources and faces similar challenges when treating their water before it is supplied to the residents. Below, Table 2 shows a comparison of the number of residents served, water sources used, contaminants treated for and the susceptibility rating of each district. The information in Table 2 was obtained from each water district's annual water quality report for 2014.

Water District	Leicester Water Supply	Cherry Valley & Rochdale Water	Hillcrest Water Supply
No. of residents served	~3,300	~4,400	~350
Water Sources	Whittemore Street Well Rawson Street Well Paxton Well Field	Henshaw Pond Grindstone Well	Lehigh Road Well
Contaminants tested for in the water sources	Microbial, lead, copper radon, iron, manganese, uranium, radionuclides, arsenic	Microbial, sediment, algae, bacteria, lead, copper, radon, uranium, radionuclides, arsenic	Microbial, uranium, radionuclides, arsenic
Susceptibility Rating	Moderate	High	Moderate

Table 2: Showing a comparison of the three water districts in Leicester

(Taken from Leicester, Cherry Valley & Rochdale and Hillcrest Annual Water Quality Reports for 2014)

From the comparison in Table 2, each district serves a different number of residents in Leicester, with the CVRWD serving the largest percentage of residents. Another difference is that each district uses different sources for their water supply, with each source being tested and treated

for similar contaminants such as arsenic, but other dissimilar contaminants as well. Lastly, the susceptibility rating of each water source at risk for contamination varied, with Cherry Valley and Rochdale having a high susceptibility rating while LWSD and HWSD had moderate ratings.

2.4.2 Challenges Faced by Leicester's Water Districts

Each water district faces challenges of water quality and quantity. As of 2016, each of Leicester's three water districts had at least one notice of non-compliance issued within the past two years. For the LWSD, the Whittmore Street well was temporarily closed until the water from the well could be properly treated for uranium and arsenic (Leicester, 2014). For the CVRWD, MassDEP required that the district come into compliance, so they proceeded with an interconnection process to purchase water from the City of Worcester (Cherry Valley, 2014). For the HWSD, the district has one source water tank that cannot supply adequate safe drinking water to its customers. As such, Hillcrest buys water from the Leicester water supply district during the summer time (Central, 2010).

These districts are not physically connected and are managed separately. Each is continually challenged with quantity issues and issues of non-compliance. Through collaboration, the districts may be able to alleviate issues of water quality and quantity in the Town of Leicester, and the use of sources such as the Moose Hill Reservoir, can help.

2.4.3 The Moose Hill Reservoir

The Moose Hill Reservoir is a surface water body located in the northwest corner of Leicester. It was an artificial reservoir constructed in the 1980s as a flood control project (Water and Wastewater, n.d.). In November 1987, the reservoir was designated as a drinking water source through the state Department of Environmental Quality Engineering (Water and Wastewater, n.d.). A feasibility evaluation was conducted on the reservoir in 2008 by the Moose Hill Commission, but through 2016, the reservoir still had not been used as a drinking water source (Moose Hill, 2008).

The Moose Hill Reservoir Feasibility Evaluation was slated to “evaluate the feasibility of re-certifying the reservoir as a new source of public water supply... and to create a timeline for the process of permitting the reservoir” (Moose Hill, 2008). The water currently present in the reservoir has to be treated if the reservoir was ever to be a proper drinking water source. No water treatment facility exists for the reservoir, however, in 1966, a Report on Municipal Water Supply Storage for the Proposed Shaw Brook Flood Control Reservoir (now known as Moose Hill Reservoir) outlines proposed steps for water treatment at the reservoir. This report, however, is approximately fifty years old. Nevertheless, even fifty years ago, there was a need for Leicester to get more out of its water systems and sources. “At some future date, should a regional water supply plan of sufficient magnitude to include Leicester be proposed, Leicester should certainly examine the [reservoir’s] role therein” (Sanitary, 1966). Leicester’s water districts have continually found it difficult to supply of proper quality and quantity to its residents. With the introduction of consolidation and using Moose Hill as the town’s main water source, Leicester will be able to reduce these issues that plague the town.

Given the challenges the Town of Leicester faces, the town and the MassDEP reached out to us to investigate the problem further. In the next chapter we explore our methodological approach to accomplishing the project goal.

3.0 METHODOLOGY

Working in collaboration with the Massachusetts Department of Environmental Protection (MassDEP) and Leicester's Town Manager, our team explored the viability of functional coordination and resource sharing among each of Leicester's three independently operated water districts, the Town of Leicester and the Moose Hill Commission, to help alleviate issues of water quality and quantity for current and future water needs in Leicester. In addition, we analyzed the feasibility of incorporating a collaborative water management system to help address these water problems. Next we discuss our objectives and the tasks we completed in order to achieve them.

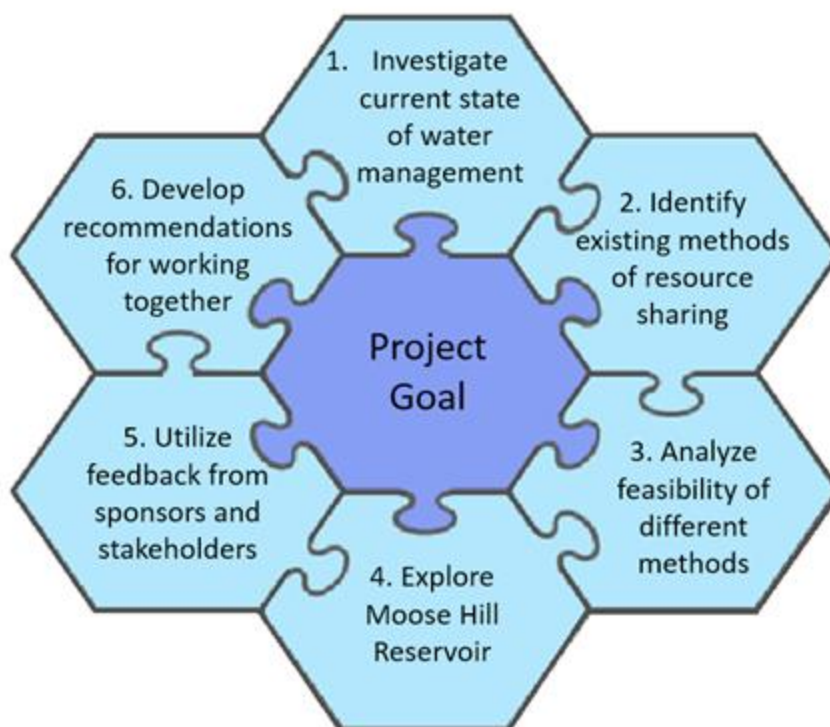


Figure 7: Outline of the Project Objectives

3.1 Objective 1: Investigated the State of Water Management Issues in the Leicester Water Districts

The water distribution system in Leicester is unique. It is separated into three independently owned and managed water and sewer districts: Cherry Valley & Rochdale Water District and Cherry Valley Sewer District; Leicester Water Supply District and Hillcrest Water District. The previous Worcester Polytechnic Institute (WPI) student group found that each district faces different challenges related to the quantity and quality of water that they can supply to their customers. In order to accomplish this objective, we analyzed the research and findings of the 2016 study conducted by a WPI student team that worked in Leicester, analyzed the three districts' annual water quality reports for the years 2014 and 2015 and interviewed the current districts' superintendents and water commissioners.

To begin, we analyzed the previous student team's 2016 report titled "Massachusetts Water Resource Outreach Center: Water Management in Leicester". We read and analyzed the content of the report focusing on the methodology, findings and recommendations chapters. We took notes on what we thought would be useful to our project. We also looked at who they contacted, in case we needed to contact them as well. We conducted an informal interview with Tim Berube, one of the students who worked on the aforementioned project, and asked him questions regarding the report. From this, we gained a basic understanding of the state of water management for each district in Leicester.

We conducted three separate in-depth interviews with the representatives of each district to find out more about the districts. We interviewed Don Lennerton, Chairman of the Board of Commissioners of the Leicester Water Supply District; Michael F. Knox, Superintendent of Cherry Valley & Rochdale Water District; and Joseph Wood, representing the Hillcrest Water Supply District (see Appendix E, F and G for a comprehensive list of the interview questions). We interviewed them because of their extensive experience and leadership roles within their respective

districts. From these interviews, we learned more about the current state and the challenges of each district. We also learned about their vision for their own districts and the possible challenges they might face, as well as their perspective on the other water districts.

We conducted two informational interviews with our project sponsors: Kevin Mizikar, the Leicester Town Manager, and Andrea Briggs, the Deputy Regional Director of the MassDEP (See Appendix C and D for a comprehensive list of the interview questions). From these informational interviews, we learned our sponsors' opinions and reservations regarding the current state of water management. We also learned their vision for the future of the water districts and information about the water issues facing the Town of Leicester.

3.2 Objective 2: Identified existing district methods of resource sharing used by other towns or cities in the United States

In order to continue with the next phase of the Massachusetts Water Resource Outreach Center Project: Water Management in Leicester, MA, our project group analyzed several different municipal approaches to collaboration and sharing resources. A continuum of resource sharing shows how the water systems operate under conditions of functional coordination, with regards to how the resources are shared and who makes the decisions on how the districts operate. This spectrum of resource sharing ranged from partial consolidation, where the districts would share resources but still remain independent; to full consolidation, where multiple districts would merge to form one water district and no longer operate independently.

We cast the net wide and conducted case studies of 50 municipalities that have coordinated water systems within their town or city. We researched municipalities across the United States by using the Google search engine on the internet. We narrowed it down to 19 towns and cities with a population size between 5,000 and 25,000 that are located in the United States. We selected these towns because they shared a similar geographical location and population to the town of Leicester. For each municipality we examined their approach to functional coordination, including the costs

and benefits of working together in some capacity, how resources are shared and the timeframe in which formal agreements were first made and implemented.

We also interviewed Russell Tierney, Northeast Regional Water Operations Manager, of WhiteWater Inc. that participated in the models of resource sharing found in Task 2.1 (See Appendix L for a comprehensive list of the questions for the interview). These interviews helped us to understand how municipalities shared their resources and the costs and challenges associated with working together. We also used snowball sampling to find other municipalities that have jointly cooperated that these experts have worked with before.

3.3 Objective 3: Analyzed the costs, benefits and the feasibility of different methods in the continuum of resource sharing identified in Objective 2

For the next phase of our project, we analyzed the benefits, costs and challenges of different existing models of resource sharing. We sought assistance from Juliet Swigor, the GIS Regional Coordinator for the Central Region Office of MassDEP, and created maps showing the spatial arrangement of the water pipes, treatment facilities and land owned by each water district in Leicester using Geographical Information System (GIS) software. This provided visual aid to help us understand how resource sharing could be structured in the town.

From the information gathered on the different methods of resource sharing in Objective 2 and the maps, we developed several approaches the water districts in Leicester could take to share their resources. We also recorded the respective cost benefit analysis and SWOT analysis of the methods used by other municipalities. Cost benefit analysis is a technique used to analyze the costs and benefits of implementing a project by comparing against each other in terms of their assigned monetary values (Investopedia, 2006). SWOT analysis is a technique used to analyze the strengths and weaknesses of a project and assess the opportunities and threats that the project might bring (Investopedia, 2005).

We gathered information from the interviews with industry experts in Objective 2 and they gave us both qualitative and quantitative data. We compared the costs incurred and the benefits gained from water districts sharing resources from each example using the quantitative data. Using the qualitative data, we developed a matrix highlighting the strengths, weakness, opportunities and threats of each method of sharing resources.

By comparing the information from both methods of analysis, we determined which models were the most economically and technically feasible and viable for Leicester. An economically viable project is one which can finance itself. Technically viable means the project is implementable. There are certain set costs associated with functional coordination, such as laying pipes or constructing a new building and/or new treatment facilities, so it was important to know whether districts and the town can cover these costs. For viability, the potential success of different methods of sharing resources in the Town of Leicester was also dependent on existing infrastructural relationships, such as with the sewer systems.

3.4 Objective 4: Explored and developed approaches for connecting Moose Hill Reservoir and Shaw Pond to the Town's regionalized water system

The Moose Hill Reservoir is a surface water body located in the northwest part of Leicester. Many feasibility studies were conducted on Moose Hill Reservoir, and it was deemed as a high quality water source for the town. The Moose Hill reservoir is capable of providing 1.5 million gallons per day (MGD) of water and is large enough to be used as the only water sources for the town of Leicester. The Moose Hill Water Commission is planning on investigating Shaw Pond, another surface body water source near the Moose Hill Reservoir, to see if it could be used as another water source for the town (Kurt Parliment, personal communication, January 26, 2016).

We investigated the possibility of utilizing Moose Hill Reservoir and Shaw Pond by doing online research and reviewing documents provided by the MassDEP. From this research, we gathered information on the costs, legalities and necessary infrastructure upgrades required to use

the reservoir as a water source. We developed GIS maps of the Moose Hill Reservoir which showed the ownership of land surrounding the reservoir as well as the water pipes that are either associated with, or located near the reservoir. We did this so that we can find a way to integrate these water sources into the hypothetical regionalized water system.

3.5 Objective 5: Utilized feedback from sponsors and stakeholder representatives on findings to refine our recommendations

We reported our progress and findings through weekly focus group meetings, held at the MassDEP office, with our sponsors, Andrea Briggs and Kevin Mizikar, members of MassDEP (Robert Bostwick, Paula Caron, Juliet Swigor, Marielle Stone and Stella Tamul) and the Leicester town planner, Michelle Buck. We used these weekly meetings to guide and validate our research, as well as to draw on the expertise of the MassDEP staff members. Their experience helped make a multifaceted discussion at the table and helped us broaden or narrow our approaches to the project as needed. The feedback we received from the meetings was extremely useful. It helped us determine the direction in which our project should move. This feedback also helped strengthen our resolve and see the bigger picture of our project.

In addition, we conducted a focus group meeting with representatives from the Moose Hill Water Commission and the water districts in Leicester, the town planner, our sponsors, one of our advisors and a moderator from the Central Massachusetts Regional Planning Commission (CMRPC). The attendants were Kurt Parliment, Chair of Moose Hill Water Commission, Michael Knox and Kevin Bergin, of Cherry Valley and Rochdale Water District, Michelle Buck, the Town planner, Kevin Mizikar, the Town Manager, Andrea Briggs, of MassDEP, Corey Dehner, our advisor and Trish Settles, of the CMRPC. The meeting started with a brief presentation on our findings. Then we moved on to an interactive discussion section where we discussed the possible opportunities that the water districts could capitalize upon if they shared their resources and worked together. We considered the challenges the water districts face and how functional coordination will

help them tackle their problems. We also proposed plans for how the water districts could work together to utilize Moose Hill Reservoir as their main source of water for the town, using the GIS models that we developed. This allowed us to evaluate which plans the district representatives either preferred or disliked and to what capacity they could work with each other.

The information we collected from the focus group meeting helped shape our recommendations for cooperation among the water districts and the town in order to achieve the goals set by the Board of Selectmen in 2015. Using the information from the focus group, we came up with a more detailed and refined proposal for a continuum of resource sharing among the water districts and the town of Leicester.

3.6 Objective 6: Developed recommendations for the Town of Leicester and its water districts on working together for the betterment of the town

Our main deliverable was to provide a detailed list of recommendations on how the Town of Leicester and its water districts can collaborate to improve the town's water quality and quantity so that Leicester can continue to grow and develop. We analyzed existing methods of sharing resources employed by other municipalities in the United States and formed a personalized continuum of resource sharing for Leicester, using the feedback we collected from our research, interviews and the focus group meeting. We organized our findings from Objectives 4 and 5 into specific categories, followed by our recommendations. For example, we listed all our findings pertaining to capacity issues under Section 4.2 Capacity, followed by our recommendation in regards to improving the capacity issue of the water districts.

In the following chapter, we outlined our findings and provided our recommendations based on all the information that we gathered.

4.0 FINDINGS- Leicester's Water Future

A significant portion of Leicester's future economic growth and development rests on the separate entities embracing a continuum of resource sharing. These entities include: each of Leicester's three water districts, the Moose Hill Commission and the Town of Leicester. Resource sharing will help the Town develop economically, and increase quality of life for its residents, and continually improve in the future. In this chapter, we outlined various key themes that contribute to Leicester's functional coordination for the town to assess the future water needs in the town. In this chapter, we discuss some of the challenges the Town of Leicester, each of its three water districts and the Moose Hill Commission face. We provide our recommendations for addressing these issues as well. In addition, we provide a breakdown of an uber group called the *Water Prioritization Committee* and a prioritization matrix to aid the group with project timelines.

4.1 Leicester's Plan

Finding 1: The Town of Leicester, its three water districts and the Moose Hill Commission operate independently of each other, with little overlap, making it difficult to work collaboratively with each other and the MassDEP

The Town of Leicester reached out to Worcester Polytechnic Institute (WPI) for assistance with research on methods to help Leicester continue to grow and develop, particularly with regard to their water needs. Leicester has a well-planned vision for its future that will only be achievable if the current and future water needs in the town are met. In 2015, the Leicester Board of Selectman established a vision for the town. The vision contained the following goals:

- Bolster the Town's tax base by enabling commercial and residential development
- Enhance communication with residents and stakeholders to help ensure insight into the operations of the Town, aid in community involvement and continue to build productive relationships

- Develop the infrastructure and services of the Town to improve the quality of life of residents and enable desired development
- Continually assess and improve the operations of the Town to ensure the most effective, efficient and modern practices are used in the delivery of services to residents and stakeholders (Leicester Annual Report, 2016).

In a focus group meeting we conducted, titled *Beyond the Tap: Delivering Leicester's Future*, with members from the Cherry Valley and Rochdale Water District, Moose Hill Water Commission, the Town Manager, the Town Planner and the MassDEP present, we discovered that each water entity in the town was willing to work together towards a future for Leicester. However, according to Kevin Bergin, Chairman of the Board of Commissioners for the Cherry Valley and Rochdale Water District, it is very difficult for the water districts to both keep addressing its current non-compliance issues and still be onboard with setting funds aside for any future infrastructure investments (Kevin Bergin, focus group, April 14 2016). This is due to regulatory compliance issues and necessary demands from regulatory agencies like the MassDEP. Other aspects of this challenge includes time and money that will be discussed later in this chapter.

Recommendation 1: We recommend that the *Water Prioritization Committee* conduct weekly working discussion meetings to create a Leicester Water Future Plan for the town to propose to the MassDEP.

In the focus group meeting on April 14th, 2016, the Leicester Town Manager, Kevin Mizikar, agreed to act as a middleman, to facilitate open discussions between the commissioners of the water districts and members of the MassDEP so that they can figure out a way to collaborate and help achieve Leicester's goals regarding its water needs.

We recommend that a special committee, called the *Water Prioritization Committee*, be formed to act as the main body in Leicester that oversees its water needs and ensures both present and future water needs are taken care of. This committee will ideally consist of a nominated representative from each water district, a representative from the Moose Hill Water Commission, the town manager and the town planner. This committee will have weekly working discussion

meetings with members of the MassDEP. Each week's action items and deadlines will be assigned to ensure that agreements and changes are made in an efficient and orderly manner. We recommend that the committee prioritize their focus on making a plan to conduct a feasibility study on Moose Hill Reservoir to see if Moose Hill is still an adequate source of water for the town. The committee could then follow up on another study weighing the costs and benefits on building a new treatment plant with shared resources at Moose Hill Reservoir against the costs and benefits of having two separate treatment plants

Finding 2: Each of Leicester's three water districts has taken many steps to improve the Town of Leicester's water utilities, but currently, short term plans are being made that hinder long term planning.

The Cherry Valley and Rochdale Water District is currently negotiating with the Worcester Water Department to contract them as Cherry Valley's water supplier. Permanent interconnections between the City of Worcester and the Cherry Valley & Rochdale Water district were slated to run from March 2015 to May 2017 (CVRWD, 2015). This will help the Cherry Valley & Rochdale Water District address its water quantity problem. The Cherry Valley & Rochdale Water District has put aside \$3.5 million to upgrade their existing infrastructure to address the noncompliance issues (Mike Knox, focus group, April 14, 2016). Leicester Water Supply District is in the process of getting approval from the MassDEP for the construction of a new treatment plant. According to Mike Knox, Cherry Valley & Rochdale Water District had been looking at constructing a full treatment facility that would cost between \$9-10 million. That is going to be an added problem as Cherry Valley needs the ability to deliver to their existing customer base and to accommodate future growth and this requires more clean water (Kevin Bergin, focus group, April 14, 2016).

Most of the officials of the focus group meeting agreed that their resources are not being used in the most efficient way possible and that cooperation between the districts was a necessary

step forward in the right direction. The Cherry Valley and Rochdale Water District suggested that a written formalized agreement between the town and the districts would help facilitate cooperation (Kevin Bergin, Focus group, April 14th 2016).

Recommendation 2: The Town of Leicester should play a more integral role in helping each water district provide quality water to their residents

The town of Leicester is willing to play a bigger role in helping the water districts provide quality water for their residents. According to an agreement signed in 2003 between the Leicester Water Supply District and the Board of Selectmen, the Town has agreed to lay down sewer pipes along the west end of Route 9 in Leicester. The Town has also built a new water booster station near Route 9 on a piece of land owned by the Leicester Water Supply District. At the focus group meeting, the Town Manager, Kevin Mizikar, expressed that the town would be more than willing to hire consultants to conduct a new feasibility study on the construction of a new treatment plant near Moose Hill Reservoir, so that the water districts do not have to bear this cost (Kevin Mizikar, focus group, April 14, 2016). The offer was contingent upon the water districts agreeing to work together.

We recommend that the group focus on recommendations 1 and 2 as their first priority. Meetings should begin by July 2016, with biweekly meetings to keep conversations active and impactful. This is an instrumental step forward in securing Leicester's future water needs. The increasing costs of utilizing Moose Hill Reservoir also dictates this urgency.

4.2 Capacity

Finding 3: Water needs are becoming a bigger issue for the Town of Leicester and as such other sources in the town have been assessed for possible use

Leicester, "like many other communities, is finding it difficult to supply the demand for water created by an increase in population combined with an increase per capita water consumption" (Sanitary, 1966). A study conducted in 1966 by SEA Consultants Inc. looked at the feasibility of incorporating Moose Hill Reservoir into the water supply system in Leicester. The study suggested that the reservoir would be able to supply approximately 1.5 million gallons of water

per day (Sanitary, 1966), which is approximately 2.5 times more water than the entire town uses at present (Moose Hill, 2008). In 1966, the estimated cost of building a new treatment plant at the source location was \$1.1 million. The current cost of building the new treatment plant, capable of treating 1.5 million gallons of water per day, and the necessary infrastructure to pump the water from Moose Hill Reservoir is estimated to be at least \$18 million (Russell Tierney, WhiteWater Inc., personal communication, April 21, 2016). The Moose Hill Water Commission is proposing the construction of a water treatment facility, water transmission and storage facilities at the Moose Hill Reservoir in Leicester. The treated water from Moose Hill Reservoir can be used by the three water districts within the Town of Leicester (Richard H. Thibedeau, personal communication, January 4, 1990). The extra water would help attract more residents and businesses into the town and help Leicester achieve its vision of economic growth and subsequently growing its tax base.

The Moose Hill Reservoir is still untouched and has yet to be capitalized upon. In 2008, the cost of constructing a new treatment plant there was estimated to be \$3.6 million (Moose Hill, 2008), which was too expensive for any one water district to bear on its own. If the water districts and the town want to utilize this source, they would have to come to an agreement on sharing resources to make it possible. Additionally, from using Geographical Imaging Software (GIS) provided by the MassDEP, 1 mile of piping would be required to connect Moose Hill to the Leicester Water Supply District, as shown in Figure 8.

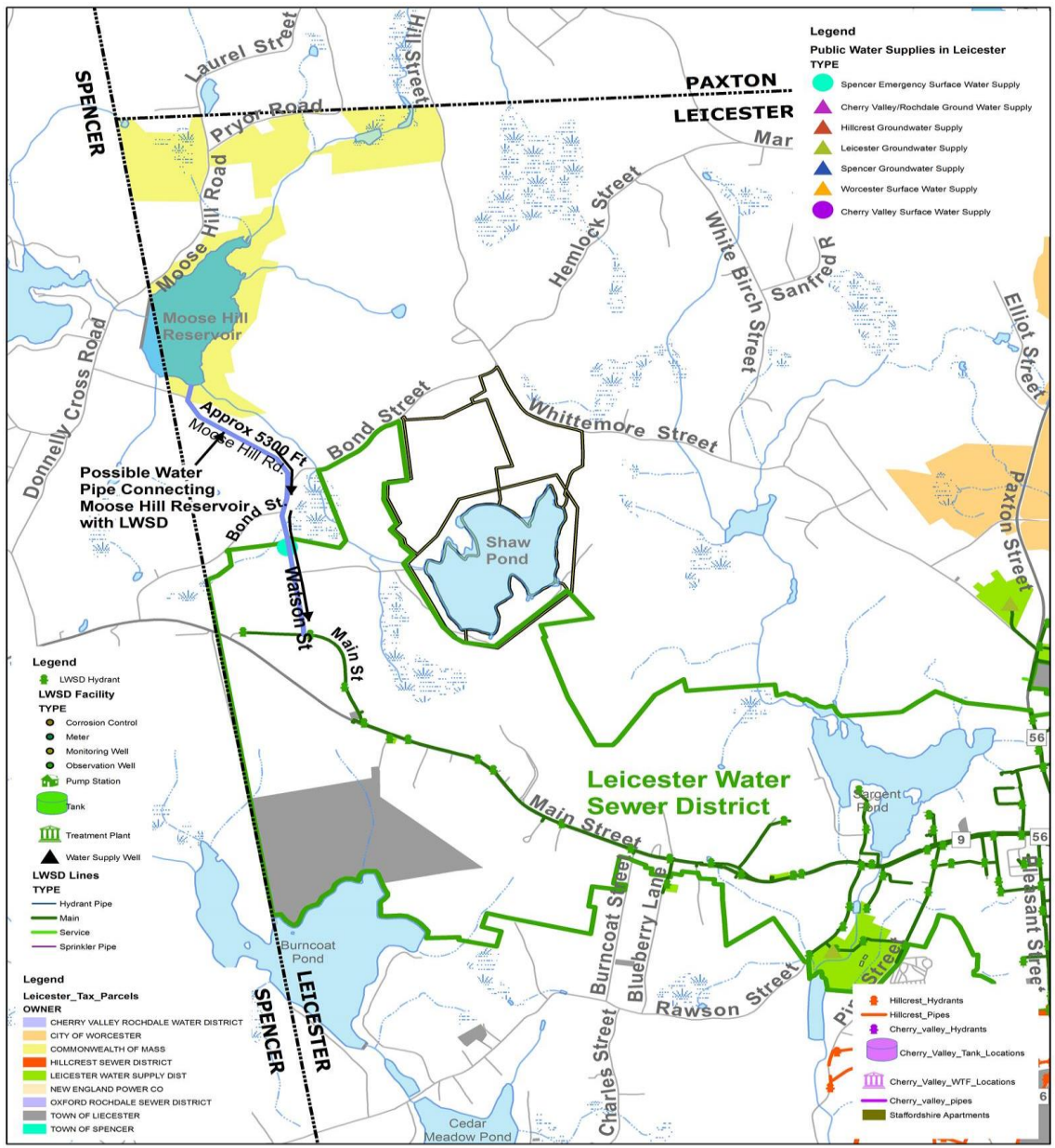


Figure 8: Map showing a possible way to connect Moose Hill Reservoir and the Leicester Water Supply District.

It is important to note that Moose Hill Reservoir cannot be at a standstill for much longer due to increasing costs of construction materials and services (Kurt Parliament, focus group, April 14, 2016). Kurt Parliament, a commissioner of the Moose Hill Water Commission, urged that water districts work together in some capacity to take advantage of the situation before it is too late.

Finding 4: The capacity of the water districts to provide water for their customers are limited by their Maximum Daily Withdrawal Limit and aging infrastructure and, at present, water districts in Leicester do not have redundancy supply systems

Cherry Valley and Rochdale Water District are at their registered water withdrawal limit volume and to supply more water they would need to apply to increase their limit. According to the December 2015 WPI student report, the Cherry Valley & Rochdale Water District is currently pumping out 262,000 gallons per day out of their permitted 270,000 gallons per day (Nivarthi et al, 2016). This is 97% of their maximum daily withdrawal limit. However, they believe that very little would be gained for the financial expenditure to increase their volume. As a result, the Cherry Valley & Rochdale Water District has looked into purchasing water from Worcester as a short term solution to accommodate their customer's' daily water needs.

The Leicester Water Supply District's permitted volumes allows for quite a bit of expansion, but they have issues with their aging water distribution infrastructure which limits their pumping capacity. The Leicester Water Supply District is currently able to pump about 221,000 gallons per day. This is only 53% of their 416,000 gallons per day limit.

Leicester Water Supply District is considering constructing a \$9 million treatment plant on Route 156. However, constructing the new plant will not address the delivery system issues that the Leicester Water Supply District has. Hillcrest Water District withdraws 60,000 gallons per day from their maximum daily withdrawal limit of 86,000 gallons per day. They are also limited by their pumping capacity. As a result, they have to buy water from the Leicester Water Supply District.

Currently, each of Leicester's three water districts do not have redundant water supply systems. Redundant supplies are additional water sources used as a backup or emergency supply (Water Supply, n.d.). Emergency connections do exist for each water district, but each district in town does not have enough capacity to supply water for their own customers as well as serve as a redundant supply for a neighboring district (Michael F. Knox, focus group, April 14, 2016).

Finding 5: The Moose Hill Reservoir is not subject to the Interbasin Transfer Act

Based on a 1990 Report, the Moose Hill Reservoir is not subject to the Interbasin Transfer Act and will not require approval of the Water Resources Commission. This determination is based on the following rationale:

1. Section 8B of the Act (MGL, CH 21, ss. 8B-8D) states: “If a city or town partially situated within a river basin takes water from that basin, extension of the water services to a portion of the same city or town outside the basin shall not be deemed an interbasin transfer of water.” Therefore, the portion of the project within the town of Leicester is exempt under the Act.
2. There is no increase in the hydraulic capacity of the transmission lines to the town of Spencer.

Recommendation 3: We recommend that Moose Hill Reservoir should be developed as a drinking water source

Moose Hill cannot continue in a standstill for much longer due to foreseeable cost increases in construction materials and services. Using Moose Hill Reservoir would provide the entire town with 1.5 million gallons of water per day, which allows residents that are currently connected to water district systems to have sufficient safe, reliable water. The water districts would also be able to accommodate new residents who currently do to have access to public water. This would aid the Town’s mission for economic growth. We recommend that Moose Hill be developed as a drinking water source. A shared water source, such as Moose Hill Reservoir, could alleviate those concerns pertaining to water quality and quantity. Each district could continue using their best sources, stop using the ones that are more prone to contamination, and instead draw from Moose Hill Reservoir. If the town could somehow acquire Shaw Pond from the Town of Spencer, it could also be used in conjunction with Moose Hill Reservoir. Between the 1.5 million gallons of water per day from Moose Hill (Sanitary, 1996) and the 300,000 gallons per day from Shaw Pond (Town of Spencer, 2012), the town could supply itself with enough drinking water, as well as increase developmental areas.

The *Water Prioritization Committee*, described in Recommendation 1, would be in charge of hiring a consultant to prepare a feasibility study on developing Moose Hill Reservoir as a drinking water source. The feasibility study should include:

1. Cost breakdown of building one treatment plant from Moose Hill vs the Leicester Water Supply District and the Cherry Valley Rochdale District each building their own separate treatment plants.
2. A comparison of current water operations in the town that cannot provide adequate quantity for the town in the future.
3. Cost breakdown and timeline for the development of Moose Hill Reservoir as a drinking water source.
4. Cost for capital improvements that is need for each water system and that is needed for joining Moose Hill into the current system.
5. Using Moose Hill as the main source of water for the town versus the town developing Moose Hill and selling water to each district.

We recommend that this study be completed by the summer of 2017, so that the *Water Prioritization Committee*, mentioned in Recommendation 1, can decide on next steps for developing Moose Hill. This recommendation should be of high priority, as there is an opportunity in the town now for the districts to collaborate and pool resources together in bringing Moose Hill online instead of Cherry Valley and Rochdale Water District and Leicester Water Supply District spending \$18-20 million collectively on two different treatment plants.

4.3 Tradition

Finding 6: Leicester's three water districts and the Moose Hill Commission have operated separately since their existence.

The Town of Leicester, is divided into three distinct villages: Leicester Center, Cherry Valley and Rochdale. These villages do not seem to have any official significance, but it is evident that members in the town identify more strongly with their village than with their town (Leicester, MA Explained, n.d.). In addition to villages, Leicester is also divided by its water districts. There are three separately operating water districts in Leicester: Leicester Water Supply District, Hillcrest Water

District and Cherry Valley & Rochdale Water District. These districts have operated separately since their existence. The Leicester Water District began operations in 1888 with the hope of eventually being the Town of Leicester's main water supplier (Don Lennerton, personal communication, March 29, 2016). The Cherry Valley & Rochdale Water District began operations in 1910 (CVRWD, 2015) and the Hillcrest Water District began operations, to mainly provide water for the Leicester Country Club's golf course in 1950 (Hillcrest, 2000).

The Leicester Water Supply District and the Cherry Valley & Rochdale Water District are connected by an emergency interconnection, however, the Cherry Valley & Rochdale Water District and Hillcrest Water District do not have an interconnection between them. The Moose Hill Reservoir could provide a yield of 1.5 million gallons of water per day (Sanitary, 1996), which is more than the 0.55 million gallons of water per day the Town of Leicester uses (Kevin Mizikar, Leicester Town Manager, 2016). Nevertheless, because each water district and the Moose Hill reservoir have all operated separately since their existence, there is little desire to work jointly. Currently, Leicester is experiencing a water crisis, and only through functional coordination of each water district, the town and the Moose Hill Commission, will the Town of Leicester be able to meet its current and future water needs.

Finding 7: Similarly, to other towns Leicester is rooted in its traditions and as such, many leaders of the water districts seem resistant to change

Functional coordination among the three water districts, the Town of Leicester and the Moose Hill Commission can only be achieved if there is a willingness to cooperate. As it stands currently, there is a desire for more cooperation between each entity, however, due to tradition and the strong personalities that exist among each entity and the residents in the Town of Leicester, there may be resistance to change. To move beyond tradition, the residents of Leicester, need to become aware of the water situation their districts and the entire town is up against. Education on the water situation in Leicester is discussed further in the chapter in section 4.8. The phrase "it has

always been this way” will not suffice for the current and future water needs in Leicester. The *Water Prioritization Committee*, from Recommendation 1, will be responsible for educating the residents of Leicester, to change this mind set.

4.4 Education

Finding 8: The residents of the Town of Leicester may not be fully aware of the town's water challenges.

Most residents of the Town of Leicester are unaware of the water challenges faced by the town. Educating them on these issues could potentially help get them involved. This needs to take place in both the short and long term. The rate payers in a district would need to vote on any action to undo the enabling legislation for the district. Due to the history of the town, some residents are hesitant to embrace change in many aspects of the town, including water. Emphasizing the importance of safe drinking water to the residents could spark progress. Another group to focus on is the Leicester Business Association. The assurance of clean water can help attract new residents, which means the businesses could attract new customers.

Recommendation 4: The Town of Leicester, the Leicester Water Supply District, the Hillcrest Water District, the Cherry Valley & Rochdale Water District, and the Moose Hill Commission should work jointly with the Water Prioritization Committee to educate the Leicester community of the water challenges the town faces

Each zone managed by each of Leicester's three water districts functions as their “own town” and not as a unified Town of Leicester. As such, many of the residents in the Town of Leicester are unaware of the challenges that each water district faces. Consequently, the residents are unaware of how these challenges directly affect them. Therefore, it should be one of the *Water Prioritization Committee's* top priorities to work jointly with the town, each water district and the Moose Hill Commission to educate the residents of the town. This educational initiative can be done directly through television programing offered through the Leicester Community Action Corporation (LCAC) television program. Similarly, education can spread through indirect means such as through Parent Teacher Organizations or the Leicester Business Association. These

organizations represent residents and businesses in the Town of Leicester who will significantly contribute to Leicester's future development. Through education, these organizations can spark open conversation in the town that will help the *Water Prioritization Committee* to advocate and advertise some of the opportunities the Town of Leicester has, meeting the future water needs in the town.

The Town of Leicester, the three water districts and the Moose Hill Commission, are at a unique time in history when many decisions for the future are being made. Each entity stands to benefit from cooperation and planning. Therefore, with our recommendations, the Town of Leicester will be able to meet its current and future water needs, while still aligning with the town's vision for economic growth and development.

4.5 Distribution System

Finding 9: Aging infrastructure of each of the water districts puts the Town of Leicester at a disadvantage for future economic growth and development

Aging water infrastructure is a challenge that is faced by every town and city in the United States. The United States Environmental Protection Agency projects it will cost \$384 billion over 20 years to maintain the nation's existing drinking water infrastructure, but in Massachusetts it is estimated that the cost of maintaining water infrastructure is approximately \$7.7 billion, which includes \$5.6 billion to maintain the transmission and distribution network. (Drinking Water Needs Survey, 2013).

For water districts that are owned and operated separately from their town, this cost can be too much to incur, without significantly impacting its ratepayers. According to Mike Knox, operator and superintendent of the Cherry Valley & Rochdale Water District the piping for the various distribution systems in Leicester can be dated to as far back as the 1890s. These water pipes have a lifespan of anywhere between 120-130 years, and they have more than exceed their span (Mike Knox, focus group, April 14, 2016). During our working focus group meeting, it was highlighted

that there is a scale of urgency in the distribution systems in Leicester. For the Cherry Valley & Rochdale Water District alone, it will cost up to \$3.5 million for capital improvements in the district (Mike Knox, focus group, April 14, 2016).

If the Town, water districts and Moose Hill truly want to achieve the Board of Selectmen's mission for the Town, then the issue of aging water infrastructure must be addressed. There needs to be a water delivery system that is able to sustain both the current customers served as well as accommodate any future growth within the town. Each water district in Leicester is currently investing in infrastructure improvements such as building new treatment plants, however, none of these improvements address the aging distribution system (Mike Knox, focus group, April 14, 2016).

Finding 10: The hydraulic pressure in the water systems are not sufficient for fire suppression

In 2013, a public water system sanitary survey was conducted on Cherry Valley and Rochdale Water District (CVRWD). In the report, the chief operator of CVRWD reported that in two locations (with about 30 interconnections) in the distribution system, have a low pressure approaching 20 pounds per square inch.

According to the Public Water System Sanitary Survey Evaluation Report of CVRWD, the ideal working pressures in the water distribution system should be approximately 60-80 PSI and not less than 35 PSI. The report emphasizes the importance of properly operating hydrants by stating that they are essential for fire protection and insurance purposes. In addition, a water system may be held liable if hydrants do not operate properly in emergency situations (Public Water System Sanitary Survey Evaluation, 2013).

Recommendation 5: The Town of Leicester should lead efforts to invest in water infrastructure to improve current piping and develop smart growth areas in the Town for economic development.

We recommend that the Town of Leicester and each of its water districts invest in capital improvements that will include replacing aging infrastructure in the town. As part of the Water

Priority Committee's role, the committee will oversee that each water district allocates funding towards improvement of their systems, to allow sustain any current and future growth in the town's water demand needs.

Based on the number of residents served by each water district (see Table 2 for a comparison of number of residents served by each district), approximately 27% of Leicester's 11,000 residents are on well water. This is concerning, as Leicester lies on Central Massachusetts' naturally occurring arsenic belt. The regulations on water quality for families on well water is not as stringent as public water supply systems. Therefore, we recommend that the town should look into laying new water and sewer infrastructure in these areas. Laying new infrastructure will help to increase the town's tax base by attracting commercial and economic development in smart growth areas.

In addition to laying new water and sewer infrastructure, the town should work with the Bylaw Committee to establish a bylaw that states that those within a certain range of newly laid infrastructure be mandated to connect to the infrastructure. It should be mandated that connection is required for any infrastructure laid after the year 2016, in an effort to align with the town's future development goals.

4.6 Existing Models of Resource Sharing

Finding 11: Many municipalities have explored and benefited from resource sharing.

When moving towards a continuum of resource sharing for water districts, some of the main reasons are much needed capital upgrades, prevention of further contamination by substances, such as nitrates and arsenic and providing equitable services, such as billing. In an informal phone interview with Peter Rezka, of the Erie County Water Authority (ECWA), many of the towns that they have worked with in Upstate New York had infrastructure that needed many upgrades. These towns and villages, however, were required to conduct their own upgrades in order to be compliant with the ECWA's standards. In this interview, he also expressed that the municipalities that he has worked with all had varying outcomes with resource sharing, but nevertheless, all benefited in some

way. Of the 19 towns explored, 100% of the towns needed infrastructure upgrades to each of their water districts in order to either plan or follow through with a continuum of resource sharing.

Towns with multiple water districts are very unique. In many of the cases we identified, the towns were similar to Leicester in terms of population size, number of water districts and number of sewer districts. The populations ranged from 5000-15000 residents, 2-8 water districts and 2-7 sewer districts; and the water districts were publicly operated municipal systems. Of the 19 towns that we assessed, all faced challenges similar to Leicester. Some of these challenges included increasing rates, building of new facilities such as treatment plants and placement of new capital equipment such as water mains.

Town	Benefits	No. of water districts
Ballston, NY (combined, 2016)	<i>Rates:</i> Standardized rates, standardized fees, equitable billing	1, 9 extensions
Monterey, CA		2
Champlain, NY (in progress)		6
Chelmsford, MA	Sharing of resources and facilities	3
Moreau, NY (in progress)	Sharing of expertise, Working with ECWA	6
Blasdell, NY		8
Ballston, NY (combined, 2016)		1, 9 extensions
Moreau, NY (in progress)	Economies of scale,	6
Stillwater, NY (combined, 2013)	Economical and reliable supply	3, 1 extension

Table 3: Benefits from functional Coordination from Existing Resource Sharing Models

We decided to look more closely at Massachusetts and as shown in Figure 9, **only nine out of 351 towns and cities in MA have 3 or 4 water district.** This is about 2.5% of municipalities in the state.

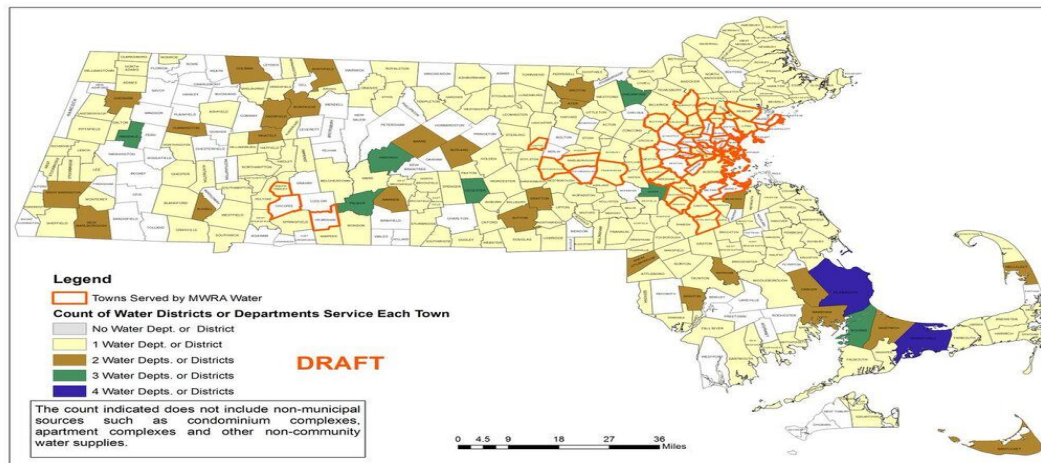


Figure 9: The Municipalities in Massachusetts and their Water Districts

Finding 12: A continuum of resource sharing in the towns and cities researched, all had varying costs associated with their projects and each had varying degrees of benefits associated.

In order to follow through with a continuum of resource sharing, each of the towns and cities that were assessed looked at feasibility studies of whether to continue operating as normal or to participate in some sort of collaborative working effort. A feasibility plan can cost between \$10,000 and \$55,000. However, the cost is heavily dependent on the amount of capital upgrades needed and the size and number of districts. Proceeding with the most extensive type of resource sharing, full consolidation, can cost anywhere from \$300,000 to \$7 million.

Capital is needed in the event that some degree of functional coordination is pursued in order to lay pipes for interconnections, build new treatment facilities for both water and sewage, and upgrade current facilities and infrastructure. Across all towns that were involved with some degree of resource sharing, the benefits received were standardized rates across all districts, sharing of resources, reduced duplication of services and reduced administrative costs. In some cases, a third party may get involved and even take over completely, or act as the overseer. The Erie County Water Authority is the entity in Upstate New York that manages many consolidated water districts. Similarly, in Massachusetts, the Massachusetts Water Resource Authority acts as a water wholesaler and water services provider for towns, mainly in Eastern Massachusetts.

4.7 Governance

Finding 13: Each water district in the Town of Leicester is a governing body run by elected officials.

In legislation, water districts have an enabling act which allows them to operate as governing bodies with elected officials, do contracts, collect taxes and fees, access to betterment, borrow money and the power of Eminent Domain. According to Joe Cove, Leicester's Town Counsel, the Enabling Act of each water district determines whether or not the water districts can decide to freely give their assets to the Town of Leicester. If the three water districts in Leicester were to consolidate and form a town-wide water district, a new enabling legislature would be needed. If consolidation is pursued, the town would incur all the loans (SRFs) and bond payments that the districts have outstanding. For future funding, there would have to be a vote whether to apply for funding, as that would be a debt that the town would have to repay. Therefore, the existing loans of water districts would have to be refinanced and transferred to the Town of Leicester.

Having access to water could make Leicester more attractive for businesses and residents moving to Leicester. Therefore, allowing for economic growth and development in the town. Permissive Referendum Questioning is the act of gauging the public's feelings for an idea in a non-binding way. After they are further along in the process, the town could use this to see how the residents feel about a consolidated water system.

Recommendation 6: We recommend that in the long term, the districts should join into one water district.

Currently, each water district is plagued with similar issues, particularly maintaining compliance with the federal Safe Drinking Water Act and its implementing regulations. In the long term, we therefore recommend that the water districts combine into one water district. This, however, is only achievable through district voting. Since each water district is a governing entity, dissolving each district and the reforming of one water district with a new enabling act will allow for

reduced operational and administrative costs, as well as a focus on having one district become compliant, rather than three.

4.8 Funding

Finding 14: Funding for water infrastructure is an essential part of securing a sustainable, high quality water source and distribution system for the Town of Leicester.

If each district agreed to cooperate and jointly explore the idea of working as one water district, the new joint venture could explore different funding sources, including a town earmark, State Revolving Fund Loan, Mass Works Grant or water rate adjustments.

Through a town wide vote, funding could be reallocated in order to create an earmark in the Town of Leicester's budget to fund this venture (Senator Moore, informal communication, April 5, 2016). Other types of grants and loans are also available to aid towns with future planning and improvement of their water systems.

The State Revolving Funding (SRF) is one such federal government loan that can be granted to each water district. Currently, each water district has at least one outstanding SRF loan. SRF loans fund wastewater and drinking water needs. The SRF starts with public health and moves to environmental concerns after. In an informal interview with Stella Tamul of the MassDEP, we learned that approximately 10% of money in the SRF budget is set aside for smaller communities. SRF funding can also be used for planning purposes, including funding a feasibility study (Stella Tamul, informal communication, March 30, 2016).

Another type of funding the Town of Leicester can apply for is a *Mass Works Grant*. During our weekly mini focus group meetings with members of the MassDEP, Paula Caron, from the MassDEP Drinking Water Program, informed us that this grant can be used to fund projects that help with the betterment of the town, such as laying pipes for interconnections between districts (Paula Caron, personal communication, March 30, 2016). This would be covered by the town, meaning the water districts would not be responsible for laying pipes. This would be one of the first

steps toward the districts working together in some capacity, as it would provide interconnections that act as more than emergency backups. This would increase cooperation between districts, as well as provide an in-town backup for any of the districts in the case that they encounter a problem.

Water rate restructuring is also a possible way to do improvements without each water district sharing the cost. Like with the Town of Ballston, NY, the water district that required the most upgrades incurred the higher rate increase. In the case of Leicester, each district would only be responsible for paying for the infrastructure upgrades they need. If the water district had already done some upgrades, exempling installing new pipes, then that water district would be exempt from paying for pipe upgrades in the other districts. This would be reflected in the rates paid by customers. Once each district had reached the same point in upgrading their systems, one standard rate could be applied to all residents being served by each water district. This would allow for residents to see that the water districts have been working together in some capacity.

Recommendation 7: We recommend that the Town of Leicester, with the help of the *Water Prioritization Committee*, apply for funding such as a Mass Works Grant, to provide funding for upgrading the existing interconnections and laying new ones between each district.

Proper interconnections between the water districts are necessary so that water from one district can flow to the other districts in times of emergencies and with minimal water loss. However, the water districts are currently using most of their resources to operate the districts and upgrading their infrastructure to keep in compliance with the regulations enforced by the MassDEP.

Therefore, we recommend that the Town of Leicester apply for a Mass Works grant in order to pay for these interconnections that can be used not only for emergencies, but on a daily basis. Laying new pipes and improving the existing interconnections would also help to improve Leicester's aging distribution system as discussed in section 4.4. We believe that the town would move in the right direction as this might foster some cooperation between the town's water entities.

5.0 LEICESTER'S WATER PRIORITIZATION COMMITTEE

We recommend that a *Water Prioritization Committee* is formed to assist the Town of Leicester to continually strive to develop and grow economically, in regards to the town's water needs. In this chapter, the structure of the committee, its responsibilities and its main priorities are outlined.

5.1 Committee Structure

The *Water Prioritization Committee*, described in the recommendations above, could consist of officials that are appointed by the Leicester Water Supply District, Hillcrest Water District, Cherry Valley & Rochdale Water District, Moose Hill Commission, Town Manager, Town Planner and an at-large Leicester resident (not a customer of a water district). The two representatives from each district, should be individuals that are knowledgeable of technical water operations and also works closely with the water systems. The Town Administration and the Town Planner should appoint two representatives who are knowledgeable about where the Town as a whole wants to be in the future. The *Water Prioritization Committee*, will also be responsible for appointing a subcommittee that focuses on water education. We recommend that the subcommittee consist of representatives from the Leicester Community Action Corporation (LCAC), the Leicester Business Association (LBA) and a member from each of the Parent Teacher Organizations of Leicester's four schools. The main responsibility of the subcommittee is providing education about Leicester's water situation to the residents. This would entice residents to learn more, ask more questions and make inquiries both at town hall and water district meetings. Lastly, the committee should meet once a week, starting the first week of June 2016.

5.2 Committee Responsibilities

We recommend that the *Water Prioritization Committee's* responsibilities include:

1. Creating a consent order that each water district agrees with and then present the consent order to the MassDEP.

2. Hiring a consultant to conduct a town wide water feasibility study
3. Working to bring Moose Hill Reservoir online
4. Educating Leicester's residents on the town's water challenge
5. Working with the Town to apply for grants and other types of funding for capital improvements
6. Continuously analyzing and capitalizing on the town's main water priorities and opportunities for future economic growth and development. Below is a prioritization matrix for the *Water Prioritization Committee*. The dates represent the deadline for the tasks to be completed by.

	Urgent (Within the next 2 years)	Foreseeable Future (Within the next 5-10 years)
High Priority	Water Feasibility Study (Oct. 2016)	Develop Moose Hill (May 2025)
	Interconnections (Dec. 2016)	Laying new water infrastructure
Low Priority	Educating residents	Merging districts into one water district for the entire town (Dec. 2025)
		mandating residents on wells to connect to public system (for pipes laid after 2020)

Table 4: Prioritization Matrix for the *Water Prioritization Committee*

Leicester's Future Water Action Plan

The *Water Prioritization Committee* is responsible for creating a *Future Water Action Plan*, to present to the MassDEP. We recommend that this plan illustrate the town, each water district and the Moose Hill Commission's strategies in regards to Leicester's future water needs. The plan needs to be agreed up and signed by the Leicester Water Supply District, the Cherry Valley & Rochdale Water District, the Hillcrest Water District, the Town of Leicester and the Moose Hill Commission and then presented to the MassDEP with Kevin Mizikar as the liaison. This is because each entity is its own governing body and by showing that each entity agrees with the plans to move forward, the MassDEP can then reassess previous consent orders that were issued. If the MassDEP agrees with the terms of the plan, then the MassDEP would issue a new consent order that supersedes any

previous consent orders the water districts were issued. We recommend that *Future Water Action Plan* should be created and signed by July 31, 2016. We recommend that the *Future Water Action Plan* state the following:

1. The Town of Leicester, the Moose Hill Commission and each water district, will jointly work in association with the *Water Prioritization Committee* to conduct a feasibility study on Moose Hill Reservoir, to be completed by October 2016 and to bring Moose Hill online.
2. The Town of Leicester, the Moose Hill Commission and each water district, will jointly work in association with the *Water Prioritization Committee* to lay new water mains and sewer mains in smart growth areas for residential and economic development
 - 2.1. The *Water Prioritization Committee* should work with the Town of Leicester's Bylaw Committee to mandate that any residents or businesses in close proximity to new laid water and sewer infrastructure laid after 2020, have to be connected to the infrastructure and not to privately owned wells.
3. The Cherry Valley & Rochdale Water District will temporarily buy water from the City of Worcester, until Moose Hill Reservoir is brought online.
4. One mile of piping will be laid from Moose Hill Reservoir to the Leicester Water Supply District and each district will be connected through functional interconnections.
5. The Leicester Water Supply District will not follow through with their previous consent order with the MassDEP regarding the building of a new a treatment plant.
6. The Leicester Water Supply District, the Cherry Valley & Rochdale Water District and the Hillcrest Water District will jointly invest in one treatment plant to treat water from a developed Moose Hill Reservoir.

With the help of the *Water Prioritization Committee* the Town of Leicester will be able to achieve its future goals for economic growth and development.

6.0 CONCLUSION

Water is a vital resource that the Town of Leicester has available; each water supplier in the town has made strides to improve their systems, keep compliant and meet the demands of their residents. Water plays a significant role in Leicester's future economic growth and development. There are great opportunities for functional coordination among the town, its three water districts and the Moose Hill Commission to meet the current and future water needs in Leicester. We outlined potential options in which each entity can work together capitalize on these opportunities. These options range from short term recommendations to improve the existing interconnections between each district to long term recommendations that involve the districts using the Moose Hill Reservoir as the Town's main water source,. Currently, each water district functions as a separate town for water distribution. However, with the recommendations we outlined, it is our hope that each entity will see the gains that the town can realize by all three districts working together for the future economic growth and development of the Town of Leicester.

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8.0 APPENDICES

APPENDIX A: Informed consent form

Informed Consent Agreement for Participation in a Research Study

Investigators: Shanel Chisholm, James Commisso, U Shwe Thein

Contact Information:

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Title of Research Study: Leicester Water District Analysis

Sponsors: Massachusetts Department of Environmental Protection (MassDEP) & the Town of Leicester

Introduction:

You are being asked to participate in a research study but before you agree/disagree, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:

The purpose of this study is to identify the challenges the Town of Leicester's three water districts are facing and the potential improvements that can be made to the water districts through resource sharing. We will prepare a comparative analysis for each available option that will help Leicester

alleviate its water quality and quantity problems, in order to meet its current and future water demands.

Procedures to be followed:

Before each interview or focus group, we will have each of the participants sign a written consent form. During this process, one member of our group will also read our prepared preamble to introduce the participants to the purpose of the activity. Once we have gained permission to continue our research activity from each participant who is willing to participate, we would begin the interview or focus group with any initial questions or brief overview of completed research. The main goal of these interviews and focus groups is to obtain their input and answers. If, for any reason, the participants are unwilling to answer a specific question, they would be free to do so and we would not continue on that subject.

Risks to study participants:

If we uncover any incidental findings that may lead to enforcement action by the MassDEP, these findings may prove to be detrimental to the subject's reputation. Depending on the subject's connection to these findings, risks may include loss of reputation for the subject, the subject's place of work, the Town of Leicester due to any enforcement actions or any other actions to address the situation as the MassDEP sees fit.

Benefits to research participants and others:

Participants in our research will not receive any individual benefits. The Town of Leicester can expect to have solution(s) to choose from when implementing a new water system in their town. These solutions would have the goal of improving system compliance with regulations, and increase the water supplied to the town.

Record keeping and confidentiality:

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and

have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you. If we, the investigators, wish to use your name in our publication or presentation, we will ask for your written consent to do so, which you retain the right to allow or deny.

Compensation or treatment in the event of injury:

This research does not involve any risk of physical injury or harm to the participant. You do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

WPI IRB Chair, Professor Kent Rissmiller: Tel. 508-831-5019, Email: kjr@wpi.edu

University Compliance Officer, Jon Bartelson: Tel. 508-831-5725, Email: jonb@wpi.edu

For contact information of the Investigators, please refer to the top of this document

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the research activities at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____

Study Participant Signature

Study Participant Name (Please print)

_____ Date: _____

Signature of Person who explained this study

APPENDIX B: Written consent form**Written Consent Form**

I, _____, give my permission for the Leicester Water District Analysis project group to identify me by name and position title in their final project report. I reserve the right to withdraw this permission at any time via written and verbal communication with the project investigators.

_____ Date: _____

Study Participant Signature

Study Participant Name (Please print)

APPENDIX C: Interview Questions for Andrea Briggs, MassDEP

Preamble:

We are conducting this interview in order to learn more about the current water management issues in the Town of Leicester. By participating in this interview, our project group hopes to understand the challenges of water quality and quantity each of the three water districts in Leicester encounter.

Your participation is completely voluntary and you can choose to end the interview at any point.

1. How long has Leicester been having water problems? When did it start to draw attention?
2. What are some violations/issues of non-compliance that Leicester has? Can we acquire those documents?
3. Where do you think the problem arises from?
4. What has MassDEP done to deal with this problem in the past?
5. Do you have exact data on the concentration of the contaminants that are present in the water supply?
6. Are there any towns in MA with situation similar to Leicester (i.e. many districts in in one town)? If so, how did they try to solve it?
7. What are your thoughts on how Leicester should tackle this problem?
8. What are your thoughts on consolidating the water districts to solve the water issue? What are the possible advantages and disadvantages of consolidating?
9. Any alternatives to consolidation?
10. Any models of consolidation that you have in mind for Leicester?
11. What are other consolidation models that you have worked with/seen?
12. Is there any legislation that we should be aware of when working on the project?
13. What data does MassDEP have on Moose Hill Reservoir? Is it possible for us to get access to this data?
14. Do you have the binder from the previous group?
15. What resources can the MassDEP provide to help us with the project?
 - a. Is there anyone versed on water legislature at the MassDEP that can help with understanding the legislative steps behind consolidation?
16. Could you describe the dynamic among the district commissioners?
17. In your experience with interacting with the district managers, do you have recommendations on how to conduct our meetings with them?

APPENDIX D: Interview Questions for Kevin Mizikar, the Town Manager of Leicester

Preamble:

We are conducting this interview in order to learn more about the current water management issues in the Town of Leicester. By participating in this interview, our project group hopes to understand the challenges of water quality and quantity each of the three water districts in Leicester encounter.

Your participation is completely voluntary and you can choose to end the interview at any point.

1. How long has Leicester been having water problems? When did it start to draw attention?
2. Where do you think the problem arises from?
3. Are there any towns in MA with situation similar to Leicester (i.e. many districts in in one town)? If so, how did they try to solve it?
4. What are your thoughts on how Leicester should tackle this problem?
5. What are your thoughts on consolidating the water districts to solve the water issue?
6. Any models of consolidation that you have in mind for Leicester?
7. Is there any legislation that we should be aware of when working on the project?
8. Could you describe the dynamic among the district commissioners?
9. In your experience with interacting with the district managers, do you have recommendations on how to conduct our meetings with them?

APPENDIX E: Interview Questions for the water district operator of Cherry Valley & Rochdale Water District

Preamble:

We are a student group from Worcester Polytechnic Institute (WPI) working on a project together with the Leicester Town Manager and Massachusetts Department of Environmental Protection. We are conducting interviews in order to learn more about the current water management issues in the Town of Leicester. By participating in this interview, our project group hopes to understand the challenges of water quality and quantity each of the three water districts in Leicester encounter. Your participation is completely voluntary and you can choose to end the interview at any point. If you would like, we can also provide you with our final project report.

1. What is your role in the Cherry Valley and Rochdale Water District?
2. What are the some of the current challenges that your water district faces?
3. How has the Cherry Valley and Rochdale water district tackled these challenges?
4. What are the future issues the water district may encounter?
5. How does your district plan to handle these issues?
6. Do you anticipate any changes in the Cherry Valley and Rochdale water rates due to handling any of these issues? If, so what are the projected changes in rates that you anticipate?
7. What is the annual budget breakdown for your water district?
8. What are the costs associated with short term fixes vs long term ones?
9. What are the current challenges that the other two water districts might be facing?
10. What are the future challenges that the other two water districts may encounter?
11. Do you have any concerns with the possibility of having all the districts connected?
12. Where do you see the future of water management for the Town of Leicester?
13. Would you like to see the water districts unified in some way?

APPENDIX F: Interview Questions for the water district operator of Leicester Water Supply District

Preamble:

We are a student group from Worcester Polytechnic Institute (WPI) working on a project together with the Leicester Town Manager and Massachusetts Department of Environmental Protection. We are conducting interviews in order to learn more about the current water management issues in the Town of Leicester. By participating in this interview, our project group hopes to understand the challenges of water quality and quantity each of the three water districts in Leicester encounter. Your participation is completely voluntary and you can choose to end the interview at any point. If you would like, we can also provide you with our final project report.

1. What is your role in the Leicester Water Supply District?
2. What are the some of the current challenges that your water district faces?
3. How has the Leicester Water Supply District tackled these challenges?
4. What are the future issues the water district may encounter?
5. How does your district plan to handle these issues?
6. Do you anticipate any changes in the Leicester Water Supply District rates due to handling any of these issues? If, so what are the projected changes in rates that you anticipate?
7. What is the annual budget breakdown for your water district?
8. What are the costs associated with short term fixes vs long term ones?
9. What are the current challenges that the other two water districts might be facing?
10. What are the future challenges that the other two water districts may encounter?
11. Do you have any concerns with the possibility of having all the districts connected?
12. Where do you see the future of water management for the Town of Leicester?
13. Would you like to see the water districts unified in some way?

APPENDIX G: Interview Questions for the water district operator Hillcrest Water District

Preamble:

We are a student group from Worcester Polytechnic Institute (WPI) working on a project together with the Leicester Town Manager and Massachusetts Department of Environmental Protection. We are conducting interviews in order to learn more about the current water management issues in the Town of Leicester. By participating in this interview, our project group hopes to understand the challenges of water quality and quantity each of the three water districts in Leicester encounter. Your participation is completely voluntary and you can choose to end the interview at any point. If you would like, we can also provide you with our final project report.

1. What is your role in the Hillcrest Water District?
2. What are the some of the current challenges that your water district faces?
3. How has the Hillcrest Water District tackled these challenges?
4. What are the future issues the water district may encounter?
5. How does your district plan to handle these issues?
6. Do you anticipate any changes in the Hillcrest water rates due to handling any of these issues? If, so what are the projected changes in rates that you anticipate?
7. What is the annual budget breakdown for your water district?
8. What are the costs associated with short term fixes vs long term ones?
9. What are the current challenges that the other two water districts might be facing?
10. What are the future challenges that the other two water districts may encounter?
11. Do you have any concerns with the possibility of having all the districts connected?
12. Where do you see the future of water management for the Town of Leicester?
13. Would you like to see the water districts unified in some way?

APPENDIX H: Probing questions for the *Beyond the Tap* focus group members

Preamble:

We are an independent student study group from Worcester Polytechnic Institute's Worcester Community Project Center working together with the Leicester Town Manager and Massachusetts Department of Environmental Protection. The town of Leicester reached out to WPI for assistance with research on methods to help Leicester continue to develop and grow, particularly with regard to their water needs. We are conducting this focus group meeting today in order to learn about how the water districts and the town can cooperate and in what capacity. We would like to thank you all for your participation in this discussion. Before we move forward with the meeting, we would like you to know that your participation in this meeting is voluntary and that we are happy to keep your identity confidential if you would like. At the end of our project, we will be publishing our report. Please let us know if you are comfortable with us using your name and/or position in our project report. Please review the informed consent handout and let us know if you have any questions before we proceed.

1. The town is willing to obtain funding laying pipes to connect each district for redundancy or emergency connections? We would love to hear your thoughts on this.
2. Would developing areas in town with little to no water infrastructure be something that the town can do to help develop areas as well as attract new businesses and families?
3. What are your plans to improve water quality?
4. Many people have referenced the Moose Hill Reservoir as a potential solution to the town's capacity issues. Would all of you be comfortable with exploring this possibility jointly?
5. What do you think about jointly exploring Shaw Pond as an additional source of water for the town?
6. Would conducting a feasibility study through applying for a SRF loan for planning be something that you would want to undertake?
7. We learned that for some resources all of the districts likely pay more by hiring someone separately. If there is an expert in the field that has worked with something like quality control, what are your thoughts on hiring one town consultant that is then shared among all entities?
8. What are your thoughts on exploring opportunities to save on billing costs, by sharing available resources related to this administrative function?
9. What do you think about reducing the cost of supply purchase for water treatment plants through bulk ordering?

APPENDIX I: *Beyond the Tap* Focus Group Handout

Beyond the Tap: Delivering Leicester's Future

04/14/2016

A working group to discuss strategies for the Town of Leicester's future economic growth and development, as it pertains to current and future water needs.



Contact Information:

Water Resource Outreach Center Project Team

Names: Shanel Chisholm, James Commisso, U Shwe Thein

Email: wrocpaperscissors@wpi.edu

The Town of Leicester, MA

Leicester's Mission, as outlined by the Board of Selectmen

- “bolster [Leicester’s] tax base by enabling commercial and residential development”
- “develop the infrastructure and services of [Leicester] to improve the quality of life of the residents”
- “continually assess and improve the operations of [Leicester] to ensure... effective, efficient and modern practices are used in the delivery of services”

Improvements made by Leicester's entities

<i>Water Districts</i>	<i>Town of Leicester</i>	<i>Moose Hill Commission</i>
Laying new pipes and sewer	Laying new pipes	Feasibility study
Infrastructure upgrades	Infrastructure upgrades	Desire to investigate Shaw Pond
New Facilities	New Facilities	

Table 1: Improvements made towards Leicester's mission

Current Challenges in Leicester

Capacity

- Moose Hill
- Fire suppression
- Smart growth: water infrastructure

Quality

- Naturally occurring Arsenic belt
- Upgrades to treatment facilities
- Reassessment of water sources

Compliance

- Notices of non-compliance

Rate increases

Challenges faced by similar towns

No. of Towns and Cities: 19

No. of Water Districts: 2-8

No. of Sewer Districts: 2-7

Challenges

- Needed upgrades to capital
- Building new facilities
- Limited capacity
- Risks of contamination and quality issues
- Rate increases

Town	Benefits	No. of water districts
Ballston, NY (combined, 2016)	Rates: Standardized rates, standardized fees, equitable billing	1, 9 extensions
Monterey, CA		2
Champlain, NY (in progress)		6
Chelmsford, MA	Sharing of resources and facilities	3
Moreau, NY (in progress)	Sharing of expertise, Working with ECWA	6
Blasdell, NY		8
Ballston, NY (combined, 2016)		1, 9 extensions
Moreau, NY (in progress)	Economies of scale	6
Stillwater, NY (combined, 2013)	Economical and reliable supply	3, 1 extension

Table 2: Benefits from functional coordination

Functional Coordination and Potential Options for Leicester's Future

Resource Sharing Options

- Shared billing system: involves the water districts to employ a common billing system and cycle
- Sharing expertise: involves sharing technical knowledge between the water district operators
- Interconnections: involves placing permanent physical interconnections between all the water districts
- Tiered and standardized rates: *In the short run*, the districts could charge a tiered water rate where the water rates reflect the districts spending on infrastructure upgrades. *In the long run*, the districts, after agreeing to use a common billing system, could charging customers the same rates for the same volume of water used across all the districts.
- Sharing consultants: involves districts sharing the cost of hiring consultants for feasibility studies
- Economies of scale: the advantages that water districts can gain by working together. i.e. making bulk purchasing orders for chemicals used to treat the water.
- Using a common source: involves the water districts and also the town sharing the aggregate cost of acquiring the necessary equipment and building facilities to utilize a common water source.

Potential options for Leicester's future

Leicester's role/ plans

- Interconnection, laying pipes from moose hill and Shaw pond to LWSD
- Lay pipes and sewers to areas with little to no water infrastructure

Cooperation among water districts`

- Share personnel and expertise
- Jointly looking into a feasibility study
- Shared billing system
- Tiered rate distribution

Funding options

- SRF for planning
- SRF for upgrades
- Mass Works Grant for upgrades
- Equitable rate breakdown

Potential water sources

- Bring Moose Hill online
- Acquire Shaw Pond

Treatment facilities and services

- Ordering chemicals in bulk
- New treatment plant

Additional Comments

APPENDIX J: Interview Questions for Senator Michael Moore

Preamble:

We are a student group from Worcester Polytechnic Institute (WPI) working on a project together with the Leicester Town Manager and Massachusetts Department of Environmental Protection to help alleviate the issues of water quality and quantity in the Town of Leicester. We are conducting this interview to learn more about legislation involved with consolidation of water districts. Hence, we thought that it might be a good idea to talk to a senator. Your participation is completely voluntary and you can choose to end the interview at any point. If you would like, we can also provide you with our final project report.

1. As the senate representative of the residents in Leicester, MA, what can you tell us about your understanding of the current water situation in Leicester?
2. How have residents in Leicester responded, if at all about their current water supply?
3. What is being done to address these problems with the water supply?
4. If water district consolidation were to occur, what do you foresee as some hurdles to overcome?
5. What does it take to move/ create special legislature?
6. Do you know of anyone we may be able to contact to talk further about water district legislation?
7. Are you aware of any funding that Leicester would be able to gain access to or be granted in order to finance consolidation or at the very least, a feasibility study?

APPENDIX K: Interview Questions for Stephen Estes-Smargiassi, MWRA

Preamble:

We are a student group from Worcester Polytechnic Institute (WPI) working on a project together with the Leicester Town Manager and Massachusetts Department of Environmental Protection to help alleviate the issues of water quality and quantity in the Town of Leicester. We are conducting this interview because we thought Leicester can look into joining the MWRA as a short term solution to alleviate their water problems. Hence, we thought that it might be a good idea to talk to someone from the Massachusetts Water Resource Authority (MWRA). By participating in this interview, we hope to understand more about how the MWRA and its communities operate. Your participation is completely voluntary and you can choose to end the interview at any point. If you would like, we can also provide you with our final project report.

1. What were some of the challenges the towns that had joined the MWRA faced?
 - a. How did the MWRA help the towns solve these problems?
2. What are some of the main issues or legislation involved in trying to become a water wholesaler?
3. How can towns become members of the MWRA? Are there any membership fees involved?
4. We know that Worcester has an emergency water connection to the MWRA. If possible, could you tell us what the annual fees Worcester pays to the MWRA is being spent on?
5. If a town has the means to join the MWRA, who is going to bear the costs?
6. We know that the Town of Lynnfield in Massachusetts has two water districts and only one of the districts is connected to the MWRA. Obviously, some fees were paid to the MWRA by this water district. If the other water district wants to join the MWRA, does it still need to pay for the membership fee?
7. The Town of Leicester is looking for sources of water and one of its water districts is trying to purchase water from Worcester. Assuming Leicester becomes a member of the MWRA, how soon can it start buying water from the MWRA?
8. Is it okay for a town or a water district to connect to the MWRA with the intention of solving its short term water needs until the town can begin to use its own sources?

APPENDIX L: Interview Questions for Russell Tierney, WhiteWater Inc.Preamble:

We are a student group from Worcester Polytechnic Institute (WPI) working on a project together with the Leicester Town Manager and Massachusetts Department of Environmental Protection to help alleviate the issues of water quality and quantity in the Town of Leicester. We are conducting this interview because WhiteWater Inc. is well known water consultant company in Massachusetts and we wanted expert opinion on some water management issues in Leicester. By participating in this interview, we hope to understand more about how WhiteWater Inc. functions and how it helps its clients. Your participation is completely voluntary and you can choose to end the interview at any point. If you would like, we can also provide you with our final project report.

1. What is your role at your corporation?
2. Do you know of other towns and cities that have consolidated before?
3. What are some of the monetary costs that might be associated with consolidation?
4. What are some of the external costs that might be associated with consolidation?
5. What are some of the challenges associated with consolidation of multiple districts?
6. What are some of the legislative challenges associated with consolidating water district?
7. What are some of the benefits and shortcomings of the town or city that consolidated, experienced since its consolidation of its water districts?
8. What are some other possible solutions besides consolidation?
9. What are some of the environmental concerns that one might have about consolidation?

APPENDIX M: Figure showing the spectrum of management structures in the water utilities industry (Dehner, 2011)

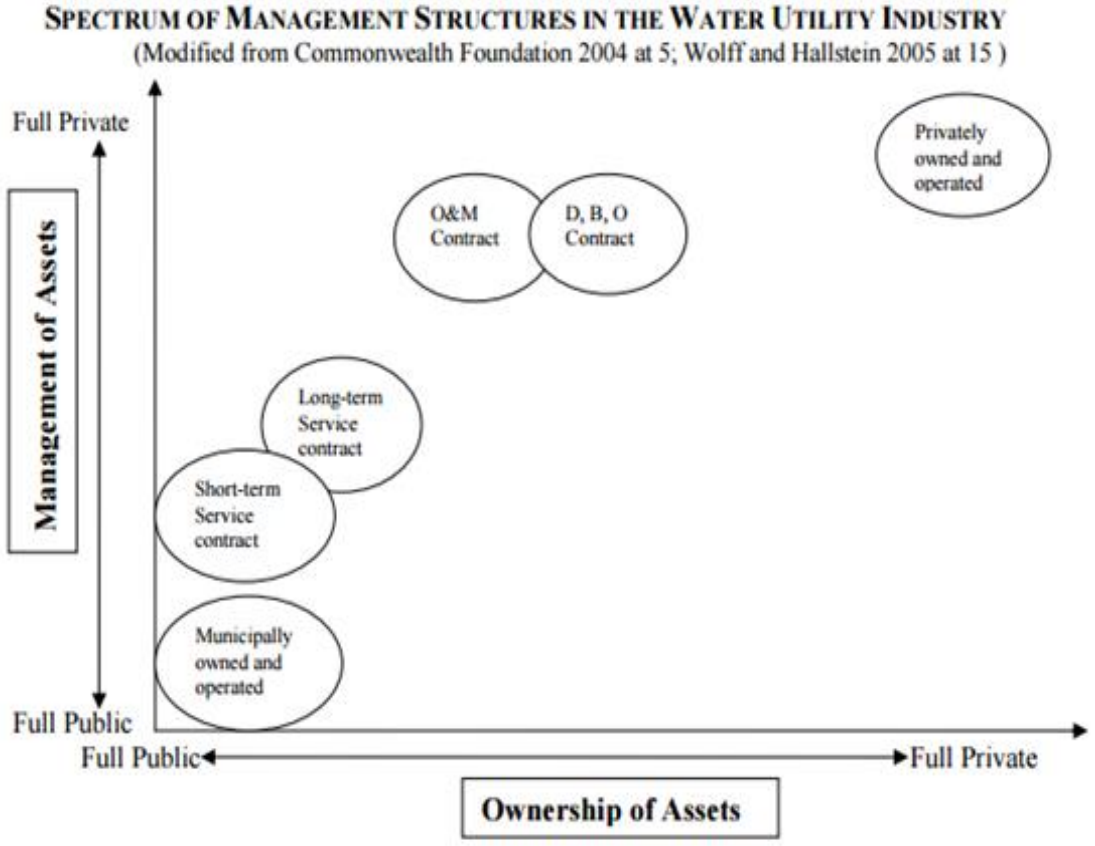


Figure 2: Spectrum of Management structures in the water utility industry (Dehner, 2011)

APPENDIX N: Figure showing the vulnerabilities in a water utility supply (Clark and Deininger, 2000)

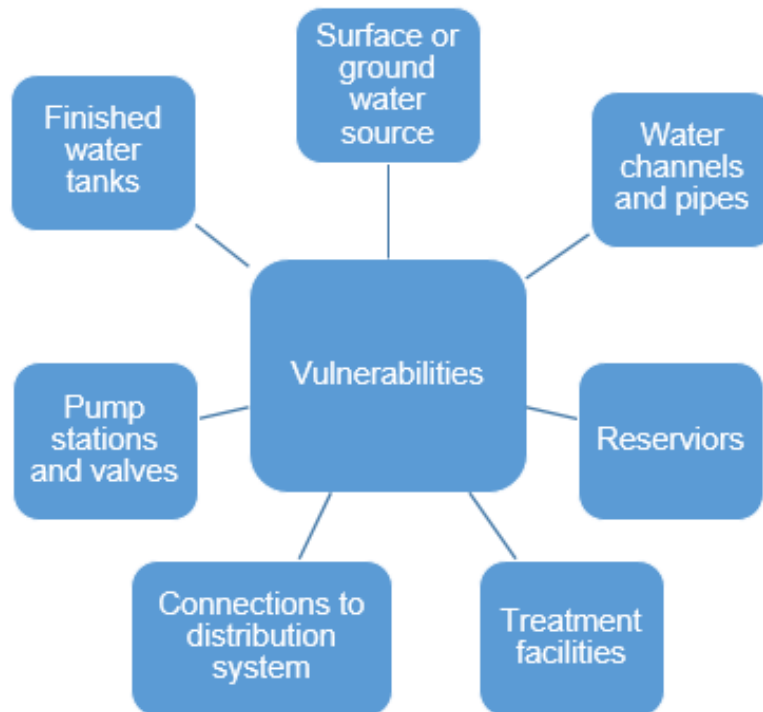


Figure 3: The most vulnerable system elements of a water utility supply (Clark & Deininger, 2000)

APPENDIX O: Table showing the current and future estimated water demands from each district (Moose Hill, 2008)

Water district	Current Avg. daily demand	Current Max daily demand	Future Avg. daily demand	Future Max daily demand
LWSD	250,000	395,000	625,000	987,500
CVRWD	256,000	533,500	398,000	829,400
HWD	65,000	167,500	65,000	167,500
Total	571,000	1,096,000	1,088,000	1,984,400

Table 5: A comparison of the current and future average daily demand of water in each water district

*LWSD future avg. demand based on projected potential growth in residential, commercial and industrial wastewater flows to 2025

APPENDIX P: Table showing the list of municipalities that were involved in consolidation

Town/ Village	Other Towns/ Villages Involved	Organizations involved	Status of Consolidation	Cost	What was consolidated	Benefits/ Why/ Challenges
Town of Ballston	N/A	C.T. Male Associates	In Progress	\$ 7,500.00	Burnt Hills-Ballston Lake Water District #2 and its nine district extensions into one district	more streamlined billing and municipal debt repayment
Town of Dryden	N/A	N/A	In Progress	\$ 12,500.00	Six water districts and seven sewer districts into one water district, and one sewer district	greater efficiency in management and long range planning
Town of North Elba	Village of Lake Placid	CGR, Patrick Smith	Completed	\$ 54,724.00	Two Highway Departments and the Village Water Department	2 Parks Departments; and restructure financing of shared services, align fiscal years, create a central purchasing office and equalize water and sewer rates
Village of Blasdell	N/A	N/A	Completed	\$ 400,000.00	Eight individual water districts and transferred ownership of its water system to the Erie County Water Authority (ECWA)	N/A
Village of Cayuga	Town of Aurelius	N/A	In Progress	\$ 292,545.00	Operation and maintenance of their municipal sewer and water systems	to help streamline administrative and billing services, and help develop a new joint asset management plan for the systems. The Village and Town will also replace all of the existing water meters with a new remote, radio-read meters
Town of Denmark	Village of Copenhagen	N/A	In Progress	\$ 400,000.00	Water systems	The new system will utilize the same water meter reading system, water supply, water storage facilities, water distribution system, and automated control system.

Town of Eden	N/A	Erie County Water Authority	In Progress	\$ 25,000.00	Water services	This planning project will identify and quantify redundancies in services and then determine a means of eliminating duplication to the benefit of taxpayers.
Village of Elbridge	Village of Jordan, Town of Elbridge	N/A	90% Complete	\$ 600,000.00	Public water services through the construction of a consolidated water treatment facility and a new water treatment line	N/A
City of Mechanicville	Village of Stillwater	N/A	Completed	\$ 399,935.00	Evaluated consolidation of their municipal water supply and distribution systems	N/A
Town of Nichols	Village of Nichols, Town and Village of Owego	N/A	Completed	\$ 43,470.00	Identified opportunities for efficiencies and cost savings through shared services and/or consolidation of their respective wastewater treatment plants	N/A
Village of Williamsville	N/A	ECWA	In Progress	\$ 400,000.00	Water supply services and transfer system ownership to the ECWA	This consolidation will require a significant capital investment on the part of the Village to bring the System up to current ECWA standards
Village of Sleepy Hollow	Village of Tarrytown, Village of Briarcliff Manor	N/A	In Progress	\$ 26,000.00	Three water departments into a single entity.	N/A
Town of Plattsburgh	Town of Schuyler	N/A	In Progress	\$ 371,000.00	Schuyler's Morrisonville Water District into Town of Plattsburgh consolidated water district	N/A
Moreau, CA	N/A	Tim Burley (Engineer)	In Progress	\$ 600,000.00	Consolidate six water districts	Standardized water rates, money is to enter and fund to help renovate the districts

Monterey, CA	Markfield, Sacramento		In Progress	-	Consolidated Markfield and Sacramento district, size of the larger Sacramento district to be used for bulk of revenue acquisition	Standardizing rates
Monterey, CA	Monterey County Health Department	David P. Stevenson	In Progress	-	Water districts	Recommend publicly or privately consolidation of water systems to ensure proper water quality, mentioned arsenic
Berlin, MA	N/A	Mayor Rachel Rochette	-	-	Water Control District, Kensington Fire District, Worthington Fire District	Reduce duplication of services
Chelmsford, MA	N/A	Paul Cohen (Town Manager)	Completed (did not follow through)	\$ 15,000,000.00	Chelmsford Water District, North Chelmsford Water District, East Chelmsford Water District	save water bills, reduce duplication of services, 2 multi-million-dollar treatment plants, approximate costs, costs incurred by residents for 2 plants, was too high

Table 6: Comparison of the list of municipalities that were involved in consolidation

APPENDIX Q: Comparison of the water rates in each water district

Leicester Water Supply District		Cherry Valley and Rochdale Water District		Hillcrest Water District	
Base rate (per quarter)	\$45.00	Base rate (TBD)	\$50.00	Base rate (per quarter)	\$65.00
1 st step (1-4,000 CF)	\$2.57/100CF	1 st step (236-1,000 CF)	\$11.50/100CF	1 st step (1000-3000 CF)	\$3.65/100CF
2 nd step (4,001 – 12000 CF)	\$4.13/100CF	2 nd step (1,001-1,500 CF)	\$12.50/100CF	2 nd step (Over 3001CF)	\$7.84/100CF
3 rd step (over 12,000 CF)	\$6.86/100CF	3 rd step (1,501-2,000CF)	\$13.50/100CF		
Cross connection testing (semi-annual)	\$50.00	4 th step (over 2,000CF)	\$14.50/100CF		
Connection fee	\$2,500	Connection fee	\$5,850	Connection fee	\$3,000

Table 7: Comparison of the current water rates in each water district

APPENDIX R: Table showing the water sources used by Leicester Water Supply District and their status

PWS ID	Source ID	Source Name	Status	Well Type	Pollution Sources
2151000	2151000-01G	Rock Well #1	Inactive	Bedrock Well	Surface drain, Stream
2151000	2151000-02G	Rock Well #2	Active	Bedrock Well	Surface drain, Residential properties, Septic, Road
2151000	2151000-03G	Rock Well #3	Active	Bedrock Well	Surface drain, Stream
2151000	2151000-04G	Jim Dandy Well	Inactive	Dug Well	Wetlands
2151000	2151000-05G	Rock Well #4	Inactive	Bedrock Well	Road, Residential properties
2151000	2151000-06G	Rock Well #5	Active	Bedrock Well	Road, Residences, Sewer lines, Stream
2151000	2151000-07G	Pierce Spring	Active	Dug Well	Road, Stream, Wetlands

Table 8: Water sources used by the Leicester Water Supply District and their status

APPENDIX S: Table showing the water sources used by Cherry Valley and Rochdale Water District and their status

PWS ID	Source ID	Source Name	Status	Well Type	Pollution Sources
2151001	2151001-01G	Grindstone Well	Active	Bedrock Well	-
2151001	2151001-02S	Henshaw Pond	Active	Bedrock Well	-

Table 9: Water sources used by the Cherry Valley and Rochdale Water District and their status

APPENDIX T: Table showing the water sources used by Hillcrest Water District and their status

PWS ID	Source ID	Source Name	Status	Well Type	Pollution Sources
2151002	2151002-01G	Rock Well #1	Active	Bedrock Well	Residential properties, Lawn care, Road, Septic, Sewer lines
2151002	2151002-02P	LWSD Interconnection	Active	-	-
2151002	2151002-03G	Rock Well #2	Inactive	Bedrock Well	Residential

Table 10: Water sources used by the Hillcrest Water District and their status