Lake Wickaboag Water Quality Management

A Major Qualifying Project

Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
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Degree in Bachelor of Science
in
Civil Engineering by

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Abstract

Lake Wickaboag in West Brookfield, MA is facing the water quality issues of sedimentation and excess phosphorus. For this MQP, water samples from five locations along two tributaries were analyzed and the location along Sucker Brook at Shea Road was selected for a best management practice. A bioretention area and vegetated filter strip were designed to remove sediments before they enter the water system. A 604(b) Grant was explored as a funding option for a future comprehensive watershed analysis.

Acknowledgements

We would like to thank our advisors, Suzanne LePage (CEE) and Chrysanthe Demetry (ME & PW) for their guidance and encouragement throughout the process. We would also like to thank the members of the West Brookfield Stormwater Authority: Chairman Gordon DeWolf (Conservation), Vice-Chairman Johanna Swain (Selectmen's Office), Jim Daley (Highway Department), Bob Benson (Water Department), John Frizzel (Board of Health), Suzanne LePage (Member At-Large), and Tim Morrell (Planning Board). We would like to thank Al Collings of the Lake Wickaboag Preservation Association for his time and knowledge. Lastly, we would like to thank Jane Peirce of the Massachusetts Department of Environmental Protection for taking the time out of her day to interview with Kevin.

Capstone Design Statement

This Major Qualifying Project resulted in the design of a stormwater best management practice along a tributary of Lake Wickaboag in West Brookfield, MA. The town has taken action previously to improve the water quality of the lake by installing an infiltration system at a site to the east of the lake. The town is looking to do more by installing a Best Management Practice (BMP) at another site around the lake that is contributing to the contaminant loads.

The first objective of this MQP was to quantify sediments and phosphorus in water samples collected at various points along the Mill and Sucker Brook tributaries. Water samples were collected at five sites during storm events in the fall of 2015 and tested for total phosphorus and total suspended solids.

The second objective was to identify locations where a stormwater best management practice would be both beneficial and feasible. Criteria such as the proximity of the site to the road, results from the lab analyses, and the ownership of the land were considered when determining the most suitable location.

The third objective was to design a best management practice suitable for the selected site. An iterative process was followed for design. The first set of criteria selected BMPs that fit the site characteristics, removed the appropriate pollutants, and had feasible implementation and maintenance costs and requirements. The second set of criteria analyzed the effectiveness of suspended solids removal, size requirements and specific maintenance requirements. While several options were strongly considered, a bioretention system with a vegetated filter strip pretreatment was the selected BMP type. Vegetation that are local to the area, have a high tolerance to salt and have shallow roots were identified to be included in the bioretention area. The system, when fully operational, will remove an estimated 80% of total suspended solids.

The final objective was to prepare documents that will facilitate the application for a 604b Water Quality Management Grant from the state of Massachusetts. This grant would allow the town to perform more scientifically significant analyses of the Mill and Sucker Brook watersheds. This kind of analysis is necessary for future water management improvements because currently, not enough is known about the sources and quantities of pollution. The

timeline of this type of analysis is beyond the scope of this project, so a professional engineer should be consulted.

This project fulfills the requirements of a major capstone design experience. First, the project includes environmental components as well as health and safety concerns, as the primary topic was the identification and control of total suspended solids and phosphorus in a surface water body used for recreational activities. Second, this project considers sustainability as part of the design by utilizing a low-impact bioretention area to reduce pollutants in the lake. Lastly, manufacturability and economics were taken into consideration in the BMP selection phase.

Professional Licensure

The requirements for achieving Civil or Environmental Engineering licensure vary state-by-state, and Massachusetts has its own requirements as laid out in the Massachusetts General Laws and the Code of Massachusetts Regulations. Particularly, the 250 CMR 2.00: General Provisions, Procedures and Definitions aims to "protect the public health, safety, and welfare by establishing requirements and procedures" by requiring engineers and land surveyors to become licensed before being able to sign off on work.

The first step in the licensure process is to obtain a degree from an ABET-accredited program. Upon graduation, a person can become classified as an Engineer-in-Training (EIT) by taking and passing the Fundamentals of Engineering (FE) exam. This test proves that the person has a thorough understanding of the basics of engineering. There are many resources available to help prospective EITs succeed with this step.

The next step is to gain professional experience, usually by working under a licensed engineer at a firm. The general timeframe for this is four years. During this time, it is important to become familiar with your state's specific requirements for licensure. A detailed application must be submitted that documents this experience.

Finally, the Principles and Practice of Engineering (PE) Exam can be taken. Again, there are many resources available to help people prepare for the PE exam to ensure success.

There are several reasons why it is beneficial to obtain the title of Professional Engineer. With this distinction, future employers are aware of the skill a person possesses and the time that has been invested. Additionally, clients can be assured that the work you provide is sound and reliable. Being licensed is more than just knowing the technical aspects; by taking the PE exam, a person is committing to follow the ethical obligations of the profession, as well.

The National Council of Examiners for Engineering and Surveying (NCEES) stresses that this step in a professional career marks the point where an engineer is solely responsible for the work they put their seal on, and therefore must work hard to uphold the quality of the work.

Authorship

Paper section	**Principal Author**	**Principal Editor**
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1.0 Introduction	Miryam Becker	Miryam Becker
2.0 Background	Both	Both
2.1 Water Quality Issues of Lake Wickaboag	Miryam Becker	Miryam Becker
2.2 Stakeholders in a Healthy Lake System	Miryam Becker	Miryam Becker
2.3 Past Water Quality Projects and Reports	Miryam Becker	Miryam Becker
2.4 Relevant Water Quality Definitions	Kevin Gray	Miryam Becker
2.5 Grant Funding	Kevin Gray	Miryam Becker
3.0 Methodology	Both	Both
3.1 Objective 1	Miryam Becker	Kevin Gray
3.2 Objective 2	Both	Both
3.3 Objective 3	Kevin Gray	Kevin Gray
3.4 Objective 4	Kevin Gray	Kevin Gray
4.0 Results and Analysis	Both	Both
4.1 Analysis of Water Quality	Miryam Becker	Kevin Gray
4.2 Selecting the Design Location	Miryam Becker	Kevin Gray
4.3 Best Management Practices Selection	Kevin Gray	Miryam Becker
4.4 Choice of Best Management Practice	Kevin Gray	Miryam Becker
4.5 Design of Best Management Practice	Miryam Becker	Kevin Gray
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5.0 Conclusion & Recommendation	Kevin Gray	Miryam Becker

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Chapter 1: Introduction

The Town of West Brookfield, Massachusetts, is characterized by the small but charming Lake Wickaboag. Lake Wickaboag is a crucial part of everyday life for the residents of West Brookfield and is the reason many of the residents live there. Recreational activities that take place on the lake include waterskiing, boating and fishing in the summer and ATVing, hockey and ice fishing in the winter.

The first water quality study of the lake happened in 1975 (LWPA, 2015) and since then concerns have been raised about sediment accumulation and excess nutrients entering the relatively small, shallow lake. With decreased water quality and clarity, the recreational activities practiced there may be less attractive for visitors and residents alike. The lake is considered one of the town's greatest assets and for that reason the water quality of the lake is a prevalent issue.

The Town of West Brookfield has completed several successful stormwater and drainage improvement projects around the lake over the 20 years. While these projects have reduced the amount of pollutants in the water, West Brookfield aims to further improve the long-term water quality. One such initiative is a hydraulic dredging project that will tackle sediment accumulation and increase the depth of the lake. The project is planned for the northern end of the lake where Mill Brook, the main tributary, enters Lake Wickaboag.

Unfortunately, the project has run into numerous obstacles due to the cost and extent of the project. While this project will reopen parts of the lake to recreational activities in the short term, it does not ensure water quality in the future as more sediment continues to enter the water system. As such, taking steps to prevent sediment from ever entering the lake reduces the need for another dredging project in the future.

The purpose of this MQP was to assist West Brookfield in maintaining the water quality of Lake Wickaboag by preventing pollutants from entering the lake. To determine the best approach and to avoid repeating work that had already been done, we researched previous water quality studies completed on Lake Wickaboag as well as comparable situations in similar bodies of water. Additionally, water samples were collected at several locations and tested for

total phosphorus and total suspended solids to inform the decision on a location for a stormwater best management practice to be implemented. Sample locations were prioritized by their feasibility and potential impact on pollutant loading, based on criteria developed to consider the environmental, economic and social impacts. The implementation of a structural stormwater best management practice was the primary focus of this study.

The following chapters present pertinent background information, describe the logic of the methods used, explain the results and form recommendations for the Town of West Brookfield.

Chapter 2: Lake Wickaboag and Stormwater Management Methods

Lake Wickaboag is a key component of the culture and quality of life that characterizes West Brookfield. The importance of the lake is evidenced by the active role that citizens of West Brookfield play in local organizations whose missions are to protect the lake. As a result, several studies and projects have been completed on the surrounding watershed over the past 10 years. Of these projects, two stormwater management best management practices were employed. An overview of common best management practices is included in this chapter.

Additionally, an introduction to the governmental grants available to fund stormwater management projects is presented.

2.1 Water Quality Issues of Lake Wickaboag

Lake Wickaboag covers an area of around 320 acres and is a relatively shallow lake, with an average depth of seven feet and a maximum depth of eleven feet (LWPA, 2015). In certain places, such as the northern cove, sediment accumulation has decreased the depth of the lake to as little as one foot. This is an issue because it limits the potential for recreational activities in those areas.

Additionally, the decreased depth of the lake makes aquatic life more vulnerable to slight changes in the surrounding environment (Qiu, et. al, 2001) because there is not as much of a buffer to the atmosphere. A deeper depth affords space for fish and other wildlife to find refuge from extreme temperatures. The reduced volume that must accompany a decreased depth also results in higher concentrations of pollutants in the water, assuming a stable influent concentration.

The main contributors of sediment-rich stormwater runoff to Lake Wickaboag from the north are Mill and Sucker Brooks. Both tributaries enter the lake at the northernmost point (Figure 1).

FIGURE 1: MILL AND SUCKER BROOKS ENTER LAKE WICKABOAG FROM THE NORTH. IMAGE FROM THE TOWN OF WEST BROOKFIELD, MA, 2016.

The ESS Group Inc., a civil engineering and consulting company occasionally hired by the Town of West Brookfield to assist with stormwater quality projects, attributes an estimated load of 11,500 lbs of sediment per year into the lake through Mill Brook. Comparatively, Sucker Brook contributes an expected load of 13,000 lbs of sediment each year (ESS Group Inc., 2004).

The areas around both tributaries are primarily wetlands and agriculture (MassGIS, 2015), with a high percentage of that agriculture containing livestock (Stormwater Authority, 2016). Agricultural practices that utilize large amounts of fertilizer contribute excess nutrients (Schippers et. al, 2006) to Mill Brook and subsequently to Lake Wickaboag. An excess of nutrients causes algae blooms that can kill off other wildlife in the lake. The health of the lake is important from economic and anthropocentric points of view, as well as biologic, since the lake is the heart of West Brookfield.

2.2 Stakeholders in a Healthy Lake System

As water quality issues have become more apparent, concerned citizens and the Town itself have stepped up to tackle the issues of sedimentation and nutrient overload. Increased development around the lake creates opportunities for polluted runoff to naturally flow into the lake. In 1990, a group of citizens formed an organization called the Lake Wickaboag Preservation Association (LWPA) to help vocalize the very important role the lake plays in the lives of all who live around the lake, in the town of West Brookfield, and in the surrounding areas. Their purpose is to help maintain the ecological health of the lake by supporting programs that work to improve water quality and watershed management (LWPA, 2016). While not responsible for completing projects, their presence and persistence motivates town officials to improve the water quality of the lake.

Within the town government, a committee called the Stormwater Authority (SA) was formed in 2006 to "protect the public health, safety, and welfare by establishing requirements and procedures to manage stormwater runoff and to prevent water pollution from new development and redevelopment" (Town of West Brookfield, 2006). As such, the SA ensures that developments will not cause additional strain to the already-impacted lake system. The LWPA works with the Stormwater Authority to identify and promote stormwater improvement projects around the lake that reduce the amount of non-point source pollutants entering the water.

2.3 Past Water Quality Projects and Reports

The Town of West Brookfield has completed valuable studies and projects addressing the health of the lake that provide a better understanding and address the sources and impacts of sediments and excess nutrients.

As previously mentioned, the first water quality report for Lake Wickaboag, the Lycott Environmental Eutrophic Study of Lake Wickaboag, was published in 1975. Since then, the town government has taken the water quality of the lake very seriously and has taken action to keep the lake healthy. For example, the Board of Health strictly enforces Title V, which regulates septic systems, for properties surrounding the lake (LWPA, 2016). The importance of the lake to the town has resulted in more recent water quality studies, as well.

Also, a group of WPI students completed a study of Lake Wickaboag in 2011 to identify prominent sources of sediment and phosphorus to the lake. After analyzing water samples from various locations around the lake, they determined the Mill Brook area to be the most prevalent source. The team designed a stormwater BMP to be implemented at Shea Road to collect sediment and reduce phosphorous. The project was never constructed for several reasons, including the fact that the design site was located on private land, which would increase difficulty and cost.

While the Stormwater Authority and the Town of West Brookfield itself have been the main players in subsequent water quality management projects as far as design and applying for grants, the Lake Wickaboag Preservation Association has played a role in garnering support from the community and initiating the grant application process. An example of a collaborative stormwater management project was a 2010 drainage improvement project undertaken on Wickaboag Valley Road to improve the existing stormwater runoff system. The engineering firm ESS Group, Inc. was contracted to design and implement StormTech chambers at the site to prevent runoff from Wickaboag Valley Road flowing directly into Lake Wickaboag (Figure 2). That project was estimated to reduce total phosphorus and total suspended solids concentrations by eighty percent.

FIGURE 2: STORMTECH CHAMBERS FOR STORMWATER RUNOFF TREATMENT. PHOTO FROM ALL AROUND LANDSCAPE SUPPLY, 2016.

A second project to improve the water quality of Lake Wickaboag entailed dredging two adjacent ponds located southeast of the lake on either side of Lakeview Ave. These ponds act as catch basins for stormwater runoff that then flows into the lake (Figure 3). The top layer of sediment in the ponds had collected excess nutrients over time, and during storm events was contributing to phosphorus loading. The dredging project removed the top layer of nutrient-saturated sediment and implemented an outlet control mechanism to prevent the flushing of nutrient-rich sediment into the lake (ESS Group, Inc., 2014). This project was a successful collaboration between the LWPA, the Stormwater Authority, a landowner and the engineering firm ESS Group, Inc.

FIGURE 3: TWO DREDGED BASINS OF THE LAKEVIEW AVE. PROJECT. PHOTO FROM ESS GROUP, INC., 2014

Currently, a project is underway to tackle sediment accumulation by dredging the cove where Mill Brook and Sucker Brook enter the northern part of the lake. The cove has acquired so much sediment that certain areas are only one foot deep, affecting normal activities such as boating. The dredging project will assist in reviving past uses of that region of the lake, but without further action to address the sources of sediment, another dredging project will be necessary in the future.

2.4 Relevant Water Quality Definitions

2.4.1 Nonpoint Source Pollution

Nonpoint source pollution encompasses all types of pollution that results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification (US EPA, 2012). Nonpoint source is defined through the Clean Water Act, Section 502(14) as water that does not meet the definition of "point source" pollution. Section 502(14) of the Clean Water Act states:

> "The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture."

The United States Environmental Protection Agency (EPA) reports that nonpoint source pollution is the primary cause of water quality problems. The EPA emphasizes the harmful effects nonpoint source pollution has on drinking water supplies, recreation, fisheries and wildlife (US EPA, 2012). The two major nonpoint source pollution types that affect Lake Wickaboag are total phosphorous (TP) and total suspended solids (TSS) (ESS Group Inc, 2004).

2.4.2 Phosphorous

Phosphorus plays an important role in water quality because it is a limiting nutrient to the growth of algae in aquatic systems (Schippers et. al, 2006). Phosphorus can enter an aquatic system by either point or nonpoint pollution. Phosphorus is a ubiquitous element in fertilizers, causing it to be a common contaminant transported in stormwater runoff. For Lake Wickaboag, the Massachusetts Department of Environmental Protection (DEP) specifies a Total Maximum Daily Load (TMDL) of 729 kg/yr of phosphorus (MA DEP, 2002). The TMDL is a regulatory limit

on the mass of a contaminant that can be released into a water body depending on the water body's specific characteristics. However, the actual amount of loading within Lake Wickaboag is estimated to be 1983 kg/yr, primarily due to stormwater runoff (ESS Group Inc, 2014). Additionally, due to the shallow nature of Lake Wickaboag, sediments play a large role in the concentration of phosphorus. Phosphorus tends to attach to sediments in non-turbulent conditions, but be released when turbulence occurs. This is called internal loading (Søndergaard, 2003). External loading is when phosphorous enters a water body from a tributary of runoff.

2.4.3 Total Suspended Solids

The EPA categorizes total suspended solids under the definition of Sediments and Embedded Sediments. The definition states:

> "Suspended and bedded sediments (SABS) are defined by the EPA as particulate organic and inorganic matter that suspend in or are carried by the water, and/or accumulate in a loose, unconsolidated form on the bottom of natural water bodies. This includes the frequently used terms of clean sediment, suspended sediment, total suspended solids, bedload, turbidity, or in common terms, dirt, soils or eroded materials (EPA, 2014)."

Loading imbalance is considered one of the greatest causes of impaired water quality (Berry, 2003). Additionally, sediments are the primary carrier of pollutants. These pollutants range from organic compounds, metals, ammonium ions, phosphates, and toxic organic compounds (EPA Office of Water, 2005). Damage due to sediment pollution in North America has an estimated annual cost of $16 billion (Osterkamp et al., 1998). The damages can be measured physically, chemically, and biologically. Harm to treatment facilities and interference in recreational usage fall under the physical harm category. The storage of nutrients, metals, and pesticides within suspended sediment are all forms of chemical damage. Finally, biological damage equates to any harm or disruption to aquatic habitats (EPA Office of Water, 2005). The loading and movement of sediments within watersheds is a natural process. Therefore, it would

be unrealistic to try to eliminate or control the sedimentation loads. However, the amount of sediments we add in excess to water bodies can and should be controlled to prevent negative effects to the quality of water.

2.4.4 Stormwater Best Management Practices

Best Management Practices (BMPs) refer to specific actions taken to achieve or aid in the achievement of a management measure (EPA Office of Water, 2005). The EPA breaks down BMPs into two basic categories: Nonstructural and Structural.

Nonstructural BMPs can take the form of codes, ordinances, regulations, standards, or rules in order to reduce urban runoff issues. The goal of the nonstructural BMP is to reduce potential pollutants or manage runoff at the source. Furthermore, nonstructural BMPs can be broken down further into two more categories: Land Use Practices and Source Control Practices (EPA Office of Water, 2005).

- Land use practices aim to reduce impacts on water from runoff of new developments by controlling or preventing land use in sensitive watershed areas. Additionally, they can minimize total land use during times of growth accommodation (EPA Office of Water, 2005).

- Source control practices aim to prevent or reduce potential pollutants at the source before they encounter runoff or aquifers. Implemented before or after development, the practices attempt to modify human behavior through education (EPA Office of Water, 2005).

Structural BMPs are engineered or designed to manage flow, velocity, duration, or other characteristics of runoff by physical means (US EPA, 1993). Therefore, one can control stormwater volume as well as peak discharge rates, with the goal of improving water quality (EPA Office of Water, 2005). The Massachusetts DEP outlines five types of structural BMPs in

the Massachusetts Stormwater Handbook. The five categories are: Structural Pretreatment BMPs, Treatment BMPs, Conveyance BMPs, Infiltration BMPs, and Other.

2.5 Funding Opportunities for Stormwater Quality Improvement

Grants are issued on a state level to further the state's policies and goals. The purpose of a grant is to achieve a result with greater impact than what the state could accomplish on its own. Grant funding from the state of Massachusetts has already played an important role in identifying which surface water bodies are impaired throughout the state. Grant funding has provided West Brookfield the opportunity to alleviate some of the issues facing Lake Wickaboag. The following two sections outline two different types of grants offered by the Massachusetts DEP.

2.5.1 Section 319 Nonpoint Source Competitive Grant Program

The Section 319 Nonpoint Source Grant is the primary grant used for West Brookfield's project proposals. The 319 Grant comes from Section 319 of the federal Clean Water Act. The grant is given to projects that "address the prevention, control, and abatement of nonpoint source (NPS) pollution" (MassGov, 2015). In order to achieve the previous requirement, the project must: "…target the major source(s) of nonpoint source pollution within a watershed/sub watershed; contain an appropriate method for evaluating the project results; and must address activities that are identified in the Massachusetts NPS Management Plan" (MassGov, 2015). Additionally, the organization that is receiving the grant must acquire a 40% non-federal match.

West Brookfield has been awarded two 319 Grants, one in 2008 and the other in 2011. The 2008 grant awarded $62,400 from MassDEP and West Brookfield raised $41,600 for the non-federal match. The grant went towards an infiltration BMP design near Wickaboag Valley Road involving the West Brookfield Highway Department, Stormwater Authority, and LWPA. The design is expected to remove approximately 90% of TSS in stormwater runoff from the road. The grant awarded in 2011 funded the dredging of two adjacent ponds near the

southeast region of Lake Wickaboag. The grant awarded $350,000 from MassDEP, and West Brookfield raised $235,000 in non-federal match (ESS Group, Inc., 2014). ESS Group Inc. was hired to design and execute both projects for the Town of West Brookfield.

Since the Stormwater Authority has applied for and received the 319 Grant previously, a further investigation into tactics to improve their application for the grant is unnecessary. Once the template for the grant is compiled, it can be reused for future 319 applications.

2.5.2 604(b) Water Quality Management Planning Grant

Another potential water quality management grant is the 604(b) Water Quality Management Planning Grant. The framework for this grant comes from Section 604(b) of the Clean Water Act. The grant focuses on

> "Watershed or subwatershed based nonpoint source assessment and planning projects leading to the: 1) determination of the nature, extent and causes of water quality problems; 2) assessment of impacts and determination of pollutant loads reductions necessary to meet water quality standards; 3) development of green infrastructure projects that manage wet weather to maintain or restore natural hydrology; 4) development of assessments, preliminary designs and implementation plans that will address water quality impairments in impaired watersheds, and 5) development of regional storm-water utilities in regulated and non-regulated communities" (MassGov, 2015).

Since 1998, The Commonwealth of Massachusetts has awarded over $4 million dollars across eighty-five 604(b) Grants for various watersheds within Massachusetts. The projects have ranged from studies on nitrogen loading on Cape Cod to Chicopee watershed assessments. The grant awards an average of $50,000 to each project. The Chairman of the Stormwater Authority, Gordon DeWolfe, expressed concern about the relative size of Lake Wickaboag's watershed in comparison to the Chicopee or Blackstone watersheds. The concern was that larger watersheds might gain priority over smaller watersheds during the decision

process for awarding grants. Gary Gonyea, Mass DEP contact for the 604(b) Water Quality Planning Grant, relieved these concerns during a BayState Roads conference about grant writing. He expressed that the 604(b) Grant does not account for watershed size when choosing possible award winners but rather focuses on the quality of the project submitted for funding. Therefore, 604(b) Water Quality Planning Grant emerged as the next potential funding source for a stormwater management project.

Chapter 3: Methodology

The goal of this Major Qualifying Project was to improve the water quality and clarity of Lake Wickaboag in West Brookfield, MA by designing a stormwater best management practice to mitigate observed pollutants. To accomplish this goal, four objectives were established:

1. Quantify the amounts of sediments and phosphorus in water samples collected at various points along Mill and Sucker Brooks.
2. Identify locations where a stormwater Best Management Practice (BMP) would be both beneficial and feasible.
3. Design a stormwater BMP to mitigate pollution in the most suitable location, while taking into consideration the physical, social and ecological characteristics of the site.
4. Complete the framework of all the essential elements denoted in a competitive stormwater management grant.

The following chapter explains the steps taken in pursuit of these objectives, and how these objectives helped achieve the goal of this project.

3.1 Objective 1

<u>Quantify the amounts of sediments and phosphorus in water samples collected at various points along Mill and Sucker Brooks.</u>

The purpose of this objective was to identify and collect water samples from informative locations along Mill Brook and Sucker Brook. A comprehensive view of the health of the watershed ensured that the data collected would be pertinent to the issues at hand. Additionally, an understanding of past and current water quality improvement projects in the area ensured that the approach of this project did not repeat past work that is still applicable. In order to achieve this objective, several research questions were pursued:

- What had the town done previously to tackle phosphorus and sediment issues?
- What are the current land uses along Mill and Sucker Brooks and how do they affect water quality?
- What are the current levels of pollutants in the two brooks?

Each of these research questions was answered using various methods that are described in the following sections.

3.1.1 Watershed Analysis: Past and Present

The Town of West Brookfield is well aware of the water quality issues that plague Lake Wickaboag. Various studies and projects have been completed to address the issues, and a thorough understanding of these studies and projects helped form the approach to the problem. The goal of this pursuit was to prevent the team from repeating previous work within the area.

The past MQP regarding the health of Lake Wickaboag (Guerra et. al, 2011) guided this project to focus on the Mill Brook watershed because it was determined to be one of the biggest contributors of pollutants to the lake.

Several site visits were conducted, initially, to identify and collect information about ideal testing locations along Mill and Sucker Brook and later to understand the specific circumstances the selected site for BMP implementation. Site visits were crucial to understanding current land uses and the layout of the area. The dates of all of the site visits were: September 16, October 24, November 9 and November 12 in 2015 and February 25, 2016. Details including weather and exact happenings during these site visits can be found in Appendix B.

In addition to utilizing written reports and site visits, communication was established with the president of the Lake Wickaboag Preservation Association, Al Collings. Mr. Collings was able to provide the most up-to-date information regarding the state of health of the lake because he orchestrates water quality improvement efforts, such as the proposed dredging

project in the northern part of the lake (LWPA, 2016). On a site visit on September 16th, 2015, Mr. Collings presented the two proposed locations for disposal of dredged material from the lake as well as the quarry along Mill Brook. The quarry is thought to be a source of sediments to Mill Brook. The experience of seeing these locations first-hand influenced our later BMP designs to be more realistic and feasible.

While on the September 16th visit, Mr. Collings brought the team on a boat tour of the lake. This tour provided an opportunity to discuss the specific effects of excess nutrients and sedimentation on the lake and the initiatives that the Lake Wickaboag Preservation Association has supported to mitigate those effects.

Finally, attendance at several West Brookfield Stormwater Authority meetings offered the opportunity to collect input from a variety of stakeholders. The first meeting attended was on October 7th, 2015, when the proposal for this MQP was presented. Information regarding the impacts and planning of previous water quality improvement projects was documented so that this project did not pursue solutions that had already been attempted. The other Stormwater Authority meetings the team attended occurred on November 4th, 2015, December 2nd, 2015 and February 3rd, 2016. While this method uncovered information not readily available on the Internet, other methods gave the bulk of information that informed later decisions.

3.1.2 Characterizing Land Uses

In an effort to comprehensively understand the land uses within the Mill Brook watershed, the geographic information system, or GIS, was utilized. ESRI's ArcMap GIS software provided a graphical representation of the area, while displaying various factors of interest like slopes, contours, drainage basins and, of particular use for the first research question, land uses. The land use layer in GIS uses a color scheme to separate the different land uses of an area. Manipulation of this layer illustrated land usage along both streams that are suspected to compromise water quality. Information on land uses obtained from MassGIS was used to determine locations along each brook that contribute the most non-point source pollution and thus would benefit from a stormwater BMP. The GIS land use layer procured by the team was

created in 2005 (MassGIS, 2015) and may have been out-of-date by the time this project took place. To corroborate the GIS land-uses layer with more recently updated information, aerial images from both MassGIS and Google Maps were examined. Additionally, site visits contributed first hand familiarization with the landscapes around Lake Wickaboag.

3.1.3 Identifying Pollutants in Mill Brook and Sucker Brook

Sampling locations were selected based off information from various site visits, past reports, and GIS data layers. Mill Brook constitutes the main input into Lake Wickaboag, so a focus on the Mill Brook watershed was understood to be critical in addressing water quality issues of the lake. For example, the northern basin of Lake Wickaboag is experiencing significant sedimentation, therefore this project aimed to identify and mitigate the sources of sediments entering from Mill Brook. Sucker Brook was not originally considered for sampling, but upon further investigation into past water quality reports it became a larger focus due to the reportedly high concentrations of pollutants detected in Sucker Brook. Many of the properties north of Lake Wickaboag are farmland, which are known to be sources of nutrients and sediments. Additionally, there are several quarries north of Lake Wickaboag that may affect the water quality of both Mill and Sucker Brooks.

However, the most critical factor guiding sample location selection was accessibility to the waterways from the road. Much of the land on either side of Mill Brook is private land, severely restricting access to locations away from the public road. Additionally, no immediate benefit could be seen for selecting locations lacking easy access from the road. Due to the accessibility criteria, only five sites were suitable along both Mill and Sucker Brook within West Brookfield town limits. These locations can be seen on Figure 3, below:

1) Mill Brook at Wickaboag Valley Road

2) Sucker Brook at West Brookfield State Forest

3) Mill Brook at Shea Road

4) Mill Brook at Tyler Road

5) Sucker Brook at Shea Road

Three different roads within town limits intersect Mill Brook. These roads, ordered south to north moving away from Lake Wickaboag, are: Wickaboag Valley Road, Shea Road, and Tyler Road (Locations 1, 3 and 4). Sucker Brook, which comes from the north east of Lake Wickaboag, is intersected by West Brookfield State Forest Road and again by Shea Road (Locations 2 and 5).

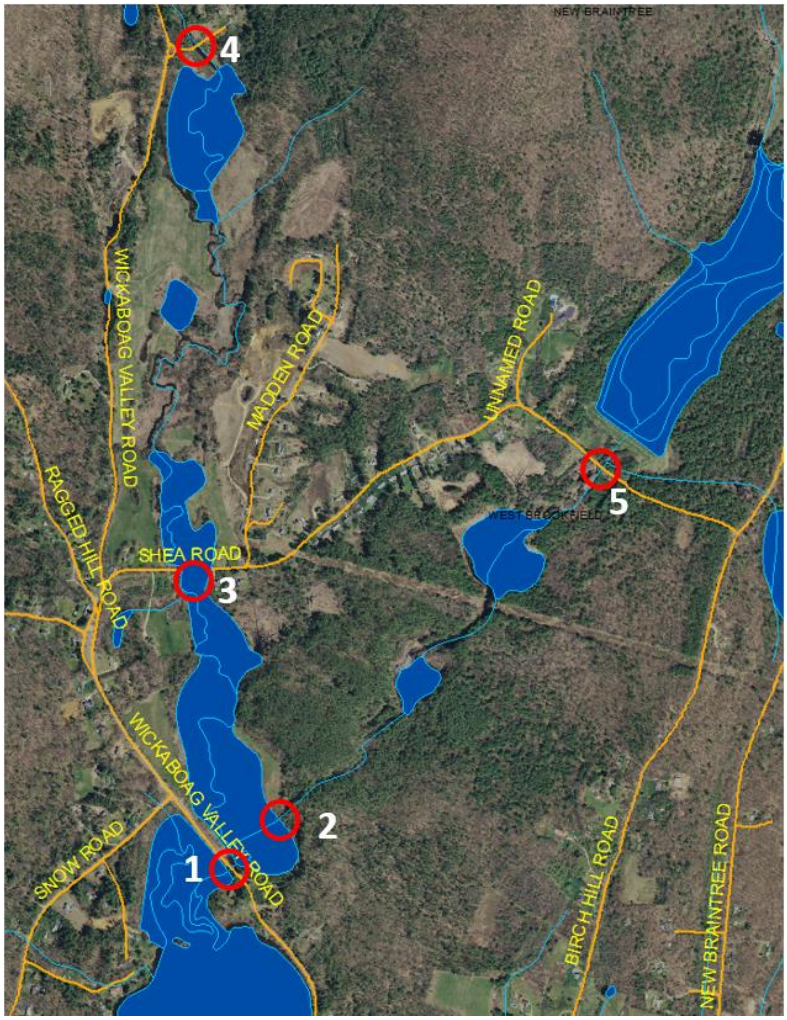


FIGURE 4: SAMPLING LOCATIONS ALONG MILL AND SUCKER BROOKS

Water samples from the five locations were collected from the middle of the stream to ensure a representative sample and stored in 250-mL and 1-L plastic sample bottles. Each bottle was prepared beforehand by washing it with a nitric acid solution to reduce previous contamination and then rinsed three times with laboratory grade (E-Pure) water. Following

methods from the MA Department of Environmental Protection Standard Operating Procedure for Stormwater Gathering, samples were collected in both wet and dry weather conditions within the weeks of 10/27/2015 through 12/17/2015 to observe the levels of pollution. The total rainfall for West Brookfield was determined using a Rain Collector II rain gauge, model #7857, set up on a nearby property in West Brookfield. The collection of samples from various locations provided an understanding of the watershed as a whole while identifying specific locations that may contribute more pollutants than others.

There is much that can be learned about water quality using appropriate chemical analyses in a lab. For this project, water samples were tested for total suspended solids and total phosphorus because those two contaminants had been identified in previous water quality reports.

3.1.3.1 Total Suspended Solids Testing

A gravimetric method approved by the EPA was used to determine total suspended solids in the samples. Filters were dried in crucibles in the oven for one hour and then weighed. A volume of 1 L of samples was forced through each filter using a vacuum pump. The filters were then removed from the filtration apparatus and placed back in a dish to be dried in the oven at 104° C for one hour. After drying, the filter was weighed again and the value recorded.

The following equation to calculate the total suspended solids:

$$non - filterable\ residue\ (mg/L)\ =\ (A - B)/C \qquad \text{(Equation 2)}$$

Where,

A= Weight of filter (or filter and crucible) + residue (mg)

B= Weight of filter (or filter and crucible) (mg)

C= Liters of sample filtered

(EPA, 1971)

This method of obtaining the amount of total suspended solids allowed a comparison of the locations based on the amount of sediment in the water. A comparison of this sort helped identify where sources of sediment pollution might be and which of the sampled locations had the most sediment.

3.1.3 Simple Method to Calculate Pollutant Loading

The Simple Method is a technique used by civil and environmental engineers to estimate the annual loading, in pounds, that will run off from certain areas during storm events. For this project, the Simple Method was applied to estimate the amount of pollutants that enter Mill Brook and Sucker Brook. The equation for the simple method is as follows:

$$L = 0.227 \times P \times P_j \times R_v \times C \times A \qquad \text{(Equation 1)}$$

Where,

L= Annual Loading (pounds)

P= Annual Rainfall (inches)

P_j= Fraction of annual rainfall events that produce runoff

C= Pollutant concentration (mg/L)

A= Area (acres)

Runoff Coefficient = $R_v = 0.05 + (0.9 \times i)$

Where,

i = Site imperviousness

(Rutgers University, 2015)

The values of these variables were obtained from several sources. The value of the average rainfall depth for West Brookfield was obtained from the NOAA Centers for Environmental Information website, which provided a map of total rainfalls for each of the last 100 years, and an average of all of these totals.

The site imperviousness was calculated using a GIS imperviousness layer from MassGIS. The MassGIS layer generates blocks onto the map that are either given a value of 0 or 1. Zero indicates an area that is permeable by water and is illustrated as such by appearing in black. One indicates an area that is impervious and is illustrated as the color white. The area-measuring tool was used to measure the white shapes within the desired watersheds and summed to form the total impervious area.

The fraction of annual rainfall events that produce runoff is suggested by most sources, including the Minnesota Stormwater Handbook, to be 0.9 to reflect the approximately 10% of storms that occur each year are relatively small and do not provide enough water to produce runoff. The water from these storms gets caught on leaves or shallow depressions and evaporates. The value of 0.9 was chosen after confirmation from the advisor of this project, Professor Suzanne LePage.

The pollutant concentrations were determined by the completed lab analyses and corroborated by the 2004 ESS report. Lab analyses reported total levels of suspended solids and phosphorus, but the comparison to a professional report on the area provided assurance that the calculated numbers were valid, despite the fact that they only reflect one storm event. Contributing areas were ascertained by measuring sections of the pre-defined drainage subbasins within MassGIS.

3.1.3.2 Total Phosphorus Testing

Knowing the total amount of phosphorus entering Lake Wickaboag through Mill and Sucker Brooks provides insight into the current algal blooms and invasive weeds affecting Lake Wickaboag. More information about the issues algae and phosphorous play on lake systems can be found in the background.

Three steps were followed when testing for total phosphorous in the water samples:

1. Standards prepared by the WPI environmental engineering lab manager were used to calibrate the machine
2. The aqueous samples were digested
3. DR/3000 Color Spectrophotometer analysis was performed.

First, the standards were digested and subsequently analyzed in the Color Spectrophotometer to produce a calibration curve of the absorbances of the standards to compare to the results from the collected samples.

The next step was to digest the sample solutions so they have the right characteristics to be analyzed in the Spectrophotometer. Sulphuric acid-nitric acid digestion and a Hach DR/3000 Color Spectrophotometer were used to measure the phosphorus in the water samples collected. The water samples were digested using nitric and sulphuric acids. First, 25 mL of sample solution was poured into a beaker. Then, 5 mL of concentrated nitric acid and 1 mL of concentrated sulfuric acid were added to the beaker. This solution was heated and reduced to a volume of about 1 mL. After cooling, the reduced sample was transferred to a sample cell.

Finally, the actual analysis of the samples was conducted. One drop of phenolphthalein indicator was added to each sample cell. Then, 5N NaOH was added to the cell until the solution turned a light pink color. E-pure water was added to the cell to reach a volume of 25 mL. An additional 1 mL of Molybdovanadate was added. The cells rested for three minutes to account for reaction time, and then were placed in the Color Spectrophotometer. The Spectrophotometer was set to a wavelength of 400 nm absorbance. A calibration curve was created using standards with known concentrations of total phosphorus. The calibration curve was compared to the results of the water samples to determine the amount of total phosphorus within each sample. For this analysis, a methodology prepared by Hugying Wen and Don Pellegrino was followed. The complete methodology can be found in Appendix C.

Phosphorus had been identified by previous water quality reports to be the cause of algae blooms in Lake Wickaboag that affect wildlife and lake usage. Analyzing samples from various locations gave us insight into where this phosphorus might be entering the water system.

3.2 Objective 2

Identify locations where a stormwater Best Management Practice (BMP) would be both beneficial and feasible.

The placement of a BMP is crucial to its value in reducing the amount of pollutants that enter a watershed. If a BMP can tackle pollutants at the source, it mitigates the need to deal with pollutants downstream. In order to identify which site was best suited for BMP implementation, the team adapted several factors from Volume 2 Chapter 1 of the Massachusetts Stormwater Handbook that reflect the site location's current environmental state and may affect the construction of the BMP. The factors chosen to identify the best site location were:

- Is the property privately owned?
- What are the existing conditions of the location?
    - Does the location already have a BMP in place?
    - Do the natural contours and slope of the site present challenges for design and construction?
- Can the negative effects of construction be quickly and efficiently controlled?

The answers for these questions placed each location on a spectrum from most feasible location to least. Development on private property requires the permission and cooperation of the owner, and may require the potentially expensive acquisition of the property through outright purchase or eminent domain proceedings. Sites located on private property were lowered to the bottom of the priority list, while sites on public land were given more consideration.

The existing conditions of the site were analyzed with another set of criteria. Any site with a BMP currently in place or in development was placed lower on the priority list. This was done to prevent the repetition of work for West Brookfield and to provide new information and possibilities to improve the water quality of Lake Wickaboag. When discussing construction

disturbances, the sites with convenient road access, as well as lower through traffic, were prioritized higher than locations with limited road access or high traffic. This factor was prioritized to minimize disturbance to residents and facilitate construction.

Finally, the contours of the sites were identified in GIS and confirmed during the site visits. Sites with mild changes in elevation were prioritized higher than sites with steep slopes so that the natural contours would not have to be changed as much during construction. This reduces design challenges and construction costs.

After reviewing all the previous information, two locations were presented to the Stormwater Authority. The subsequent discussion focused primarily on the feasibility of construction of the BMP, and one site was ultimately selected. Site selection was approached in this manner to give the most useful recommendations to the stakeholders within the town.

3.3 Objective 3

Design a stormwater BMP to mitigate pollution in the most suitable location, while taking into consideration the physical, social and ecological characteristics of the site.

The purpose of this objective was to learn about the process of design in fulfillment of the Capstone Design requirements for the MQP. An iterative process was followed to select an appropriate type of BMP, and then sized for compatibility with the proposed location. The first set of criteria disqualified certain categories of BMPs based on the type of pollutant it removes or mitigating function it performs. The second set of criteria facilitated a finer assessment of the options with regard to a specific location.

3.3.1 Initial Criteria for BMP Selection

No single BMP is equally effective for all project sites because different types of BMPs have varying dimensions and levels of efficiency. In order to narrow the range for possible BMP designs the project team outlined three simple criteria:

- Compatibility with site location
- Ability to remove pollutants
- Implementation and maintenance costs

BMPs were chosen based on their suitability with the physical characteristics of the selected location. The information gathered from GIS, the Simple Method, and water sample analyses allowed the team to qualify which stormwater BMP would be most effective. Some BMPs are simply for conveyance or drainage, so only BMPs with the ability to remove pollutants such as sediments and phosphorus were considered for the primary BMP. Finally, BMPs with costs for materials, construction and yearly maintenance greater than $65,000 were excluded. This amount was chosen because previous BMP implementations completed by West Brookfield have cost less than $65,000. After the initial rounds of selection, the BMPs that qualified were identified in section 4.3. These BMPs then were further analyzed and refined using more specific criteria.

3.3.2 Refining Criteria for BMP Selection

In order to refine the options with regard to the site selected, the project team defined explicit criteria to narrow the selection further:

- Amount of disruption to the property
- Efficiency and efficacy of pollutant removal
- Drainage area, size requirements, and construction considerations
- Maintenance requirements

The information used to create these criteria came from input from the West Brookfield Stormwater Authority, the Department of Environmental Protection Stormwater Handbook (MA DEP, 2001), and the Chesapeake Bay Program's BMP Workshop (CBP, 2003). These sources outlined specifications for BMPs in the following categories: structural, treatment, conveyance and other. From these criteria, ten potential BMPs were identified.

All of the previously collected data influenced the iterative process described in Section 3.3.1, which led to the selection of a BMP for the location deemed most feasible.

3.3.3 Design Methods

Designing the BMP started with a return site visit to the proposed location. The detailed description of the visit can be found in Appendix C.

3.3.3.1 Rational Method

The Rational Method was used to determine the peak discharge rate for the desired drainage basin runoff. As denoted in Chapter 8 of the MassHighway Design Guide, the equation for the Rational Method is as follows:

$$Q = CiA \qquad \text{(Equation 3)}$$

Where,

Q= Peak discharge rate (cubic feet per second)

C= Rational Method runoff coefficient

i = Rainfall intensity (inches per hour)

A= Drainage area (acres)

To define the drainage basin, the contours layer of GIS was overlaid upon aerial images of the desired site location.

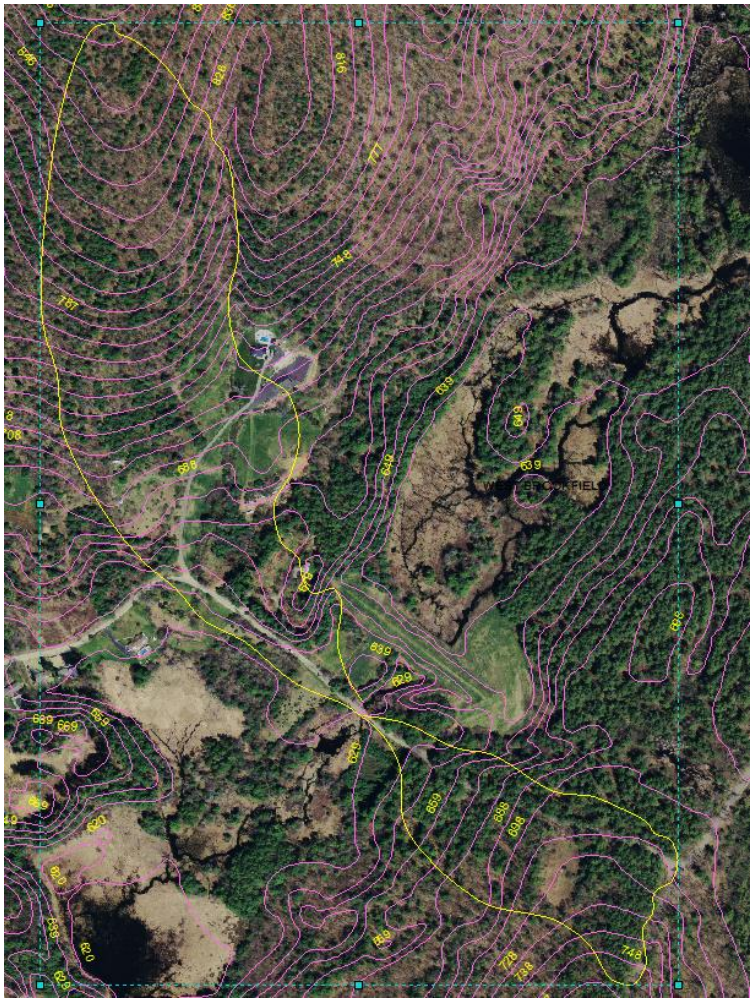


FIGURE 5: CONTOURS SHOWN IN PINK AND DRAINAGE AREAS IN YELLOW. PHOTO FROM MASSGIS, 2016.

Contours that led towards the site location or toward a road that leads to the site location provided the foundation for outlining the drainage area. The value for the drainage area was determined using the GIS measuring tool.

Rainfall intensity was taken from Intensity-Duration-Frequency Curves for Worcester-MA (MassHighway, 2006). The curves denoted storm events for 2, 5, 10, 25, 50, and 100-year events. The 100-year storm event was chosen as the desired storm event because designing to that level ensures that the BMP will be sufficient to treat runoff from nearly any storm event. It has been projected that average annual rainfalls are increasing in the Northeastern US as climate change occurs (Hayhoe et. al, 2007), so designing for a larger storm event reflects that fact. The Rational Method runoff coefficient was chosen from the Recommended Runoff

Coefficients for Rational Method (By Overall Character of the Area) denoted as Exhibit 8-8 in the Massachusetts Highway Design Guide.

3.3.3.2 Determining Required Design Volumes

The Massachusetts DEP requires that a stormwater report be submitted by the developer to document that the BMP complies with the Stormwater Management Handbook Standards. There are eight Standards in the SMH that must be considered during the design phase. For designing an infiltration or treatment BMP, the two major standards required for sizing the BMP are Standards 3 and 4 from Volume 3, Chapter 1 of the Massachusetts Stormwater Handbook. These Standards provide criteria to determine the necessary design volume for both stormwater recharge and water quality treatment. The target depth factor (D) is the same depth as the BMP design depth. Once both volumes were calculated, the larger of the two volumes was used in order to account for both groundwater recharge and water quality treatment with this BMP system.

To calculate the Required Recharge Volume, the following formulas were used for the Simple Dynamic Method from Standard 3:

$$V = A\ x\ D \qquad \text{(Equation 4)}$$

$$\text{Where, } A = \frac{R_v}{D+K}$$

$$\text{Where, } R_v = F \times i$$

Where,

V= Storage Volume (cubic feet)

A= Minimum required surface area of the infiltration structure (square feet)

D= Depth of the infiltration (feet) *chosen by design team as the maximum depth for a bioretention area.

K= Saturated hydraulic conductivity (Rawls Rate) (inches/hour)

T= Allowable drawdown during the peak of the storm (assumed 2 hours)

R_v= Required Recharge Volume (cubic feet)

F= Target depth factor of each Hydrologic Soil Group (feet)

i = Impervious area

The Simple Dynamic Method for soils with a rapid infiltration rate was followed when sizing the BMP for recharge because the site we chose contained soils that fall under the category of having rapid infiltration rates. First, the National Resources Conservation Service web soil survey was reviewed to identify the different soil types and Hydrologic Soil Groups associated within the desired design location. A site visit corroborated whether the soil composition was as reported, or was altered in any way that would affect natural drainage of the site. A field hand test was conducted on site to check the soil composition. The target depth factor ***(F)*** depends on the Hydrologic Soil Group, and the majority of the soils in the selected area are classified as Soil Group B. Volume 3 of the Massachusetts Stormwater Handbook outlines target depth factors for specific soil groups.

The Simple Dynamic Method calls for the use of a Rawls Rate value in place of the saturated hydraulic conductivity (K) when the K value is above 2.4 inches/hour. According to the Web Soil Survey, the soil in our selected area is classified as having a high K value, and thus a rapid infiltration rate (NRCS, 2016). In this case, a Rawls Rate value of 1.02 was used.

As previously discussed, GIS was used to calculate the impervious areas on the project site. These areas were then used to calculate the Required Recharge Volume and Required Water Quality Volumes.

To calculate the Required Water Quality Volume for water quality treatment outlined in Standard 4, the following equation was utilized:

$$V_{wq} = (D_{wq} \div 12\ inches/ft) \times (A_{imp} \times 43{,}560\ sq\ ft/acre) \qquad \text{(Equation 5)}$$

Where,

V_{wq}= Required Water Quality Volume (cubic feet)

D_{wq}= Water quality depth (inches) *denoted in the Mass Stormwater handbook as 1 inch.

A_{imp}= Impervious area (acres)

3.4 Objective 4

Complete the framework of all the essential elements denoted in a competitive stormwater management grant.

To begin this objective, open discussion with the Stormwater Authority narrowed down the short term, medium term, and long-term outcome for possible future project. To do so the following questions were discussed:

- What do we need to know about Lake Wickaboag and its surrounding watersheds?
- What are the current concerns from the residents of West Brookfield?
- What should be the next big project done by West Brookfield?
- How can we find funding for this project idea?

Thus began a process of narrowing down the main issues facing Lake Wickaboag and identifying the absolutely essential information needed to start the next phase in the Stormwater Authority's goal in addressing water quality issues within West Brookfield. These discussions led to the agreement to pursue gathering information on the 604b water quality management grant awarded by the Massachusetts Department of Environmental Protection.

In order to gain a better understanding of the requirements for the 604b grant a meeting with Jane Peirce of the Massachusetts Department of Environmental Protection was scheduled. Worcester Polytechnic Institute provides a document outlining the key features required in performing the initial liaison interviews for students about to start their Interactive Qualifying Project. This document can be found in appendix D and was adapted to provide a format for the interview process with Jane Peirce. The first principle element outlined in appendix D is to conduct background research. This was accomplished through review of the information provided on the Massachusetts Department of Environmental Engineering website.

Next, the interview questions were created and refined in several iterations using feedback from Professors LePage and Demetry as well as the Stormwater Authority. The approved questions were emailed to Jane Peirce to allow for ample preparation before the scheduled interview. The questions were as follows:

1. When are the applications for the 604(b) grant usually due?
    a. The Mass.gov website expresses January and February deadlines. Are these deadlines repeated annually?
2. What does a grant reviewer look for in municipal applications?
    a. From what I understand about research grants, most reviewers want to be sold on why the research is important. Usually this entails writing a grant for research the reviewer is personally interested in when reviewing the grant.
3. When writing the grant, are there any phrases or actions I should avoid?
4. Are there any differences in writing a grant for the 604(b) as opposed to the 319?
    a. Other than the obvious difference that the 604(b) is a planning grant, and the 319 deals with constructed projects.
5. Besides my professors, are there other sources that should to review my grant before submission?
    a. I understand my grant wouldn't be submitted without the Stormwater Authority reviewing it first, but I mean in future endeavors who else would be a good source of feedback.

The interview was recorded using the recorder application on a Samsung Galaxy S6 active. The recording was used later to make sure the information expressed during the interview was as accurate as possible. The interview was not transcribed for this document due to being asked to keep the specifics expressed during the interview private. However, the general information obtained during the interview is provided in Section 4.7.

A BayState Roads grant writing workshop was attended on March 21, 2016 after being recommended by Jane Peirce during the interview. The purpose of the workshop was to clarify the process for writing proposals for cleaner water in the state of Massachusetts. The workshop was attended to gain an understanding of the grant review process from speakers who sit on grant review boards. These speakers were Steve McCurdy (MassDEP), Pam DiBona (Mass Bay National Estuary Program), Diana Payne (University of Connecticut), Carol Baldassari (Endicott College), Jane Peirce (MassDEP), and William Hinkley (Mass Environmental Trust). The

workshop addressed how to write a competitive proposal, the importance of project mapping, budgets and deliverables, and how the reviewer interprets a proposal.

A deliverables was established between the Stormwater Authority and the project team. The deliverable was an accumulation of all information and data gathered through research, interviews, and workshops. This accumulation, found in section 4.6, provides a streamlined source of valuable information such as other funding organizations in addition to the MassDEP, a summary of the interview and workshop information gathered throughout the year. Additionally, a template outlining a specific request for responses for the town of West Brookfield can be found in Appendix F.

Chapter 4: Results & Analysis

The findings of the watershed water quality analysis and the preliminary selection of BMP options are presented in this section. Specifically, a bioretention area was chosen as the primary BMP design with a vegetated filter strip offering pretreatment and conveyance of the runoff. The reasoning behind the design choices is outlined within this chapter.

4.1 Analysis of Water Quality at Selected Sites

Stormwater samples were collected on three days between the months of October and November 2015. The samples were analyzed for total suspended solids and phosphorous levels. Flow rates at each site were collected, but were inconclusive due to the extremely mild conditions during collection times. Annual rainfall and intensity data was acquired from the NOAA website (NOAA, 2010). Finally, Drainage area and impervious area were calculated using MassGIS. The comprehensive data for pollution are shown in Table 1. As shown in the table, the highest total suspended solids results are at Mill Brook on Tyler Road and Shea Brook on West Brookfield State Forest. For total phosphorus, Wickaboag Valley Road (Location 1) had the highest contamination level recorded on November 16, 2015.

TABLE 1: COMPREHENSIVE DATA TABLE FOR EACH SAMPLE TAKEN DURING THE FALL OF 2015.

Location (number)	Date collected	TSS (mg/L)	Total Phosphorus (PO4^-3) (ppm)	Turbidity	Flow Rate (m/s)
Wickaboag Valley Road (1)	10/24/2015	0.3	0.279 (10/30/15) ; 0.472 (11/16/15)	2.7	
	11/12/2015	invalid			0.11
	11/12/2015	7.2			0.07
MB @ Shea Road (3)	10/24/2015	invalid	0.268 (10/30/15)	2.25	
	11/12/2015	0			0.22
	11/12/2015	invalid			0.22
MB @ Tyler Road (4)	10/24/2015	43.69	0.052 (10/30/15)	8.24	
	11/12/2015	2.26			0.03
	11/12/2015	invalid			0.03
SB @ WBSF (2)	11/9/2015		0.2 (11/16/15)		
	11/12/2015	19.4			0.33
	11/12/2015	12.2			0.25
SB @ Shea Road (5)	11/9/2015	0.3	0.325 (11/16/15)		
	11/12/2015	1.1			0.14
	11/12/2015	invalid			0.14

4.1.1 Sedimentation

To better understand the sedimentation problem facing Lake Wickaboag, the Simple Method was utilized to estimate annual loading (Rutgers, 2015). Table 2 illustrates the annual loading amounts for the five site locations. The highest loading concentrations originate from Sucker Brook with the Shea Road location contributing an estimated 14,513 lbs of sediments per year. This loading amount is similar to the 2004 ESS report which stated that Sucker Brook was contributing an estimated 13,000lbs per year (ESS 2004). However, the Mill brook locations do not match the 2004 ESS report, which estimated an annual loading of 11,400lbs per year. Due to the data collected in the fall of 2015 being a very small sample of the true nature of the sampling sites, further testing will be required by a professional engineering staff to better understand the pollution issue affecting Lake Wickaboag and its associated watersheds.

TABLE 2: SIMPLE METHOD RESULTS FOR EACH SAMPLING LOCATION.

Location (number)	Drainage area (A) (acres)	Rainfall depth per year (P) (in)	Fraction of events with runoff (Pj)	Runoff coefficient (Rv)	Site imperviousness (i)	Conc. of pollutant in runoff (C) (mg/L)	**Loading (L) (lbs)**
Wickaboag Valley Road (1)	284.5	47.7	0.9	0.11	0.071	7.2	**2264**
MB @ Shea Road (3)	513.6	47.7	0.9	0.086	0.041	5	**2163**
MB @ Tyler Road (4)	602.8	47.7	0.9	0.063	0.015	2.26	**837**
SB @ WBSF (2)	366.9	47.7	0.9	0.060	0.011	15.8	**3375**
SB @ Shea Rd (5)	867.0	47.7	0.9	0.072	0.024	24	**14513**

4.1.2 Phosphorous Levels

The phosphate levels at each location were calculated and are shown in Figure 6. Wickaboag Valley Road had the highest levels of phosphate at 0.47mg/L. The high level of phosphate at Wickaboag Valley Road could be due to Mill Brook and Sucker Brook merging right before this location. The other locations have rather similar values with Mill Brook at Shea Road having 0.27mg/L of phosphate, Sucker Brook at Shea Road having 0.33mg/L of phosphate, and Sucker Brook at West Brookfield State Forest having 0.2 mg/L of phosphate. These values are all higher than the regulated Total Maximum Daily Load (TMDL) of 0.02 mg/L (Guerra, 2011). Furthermore, this data is from samples taken during a dry event. The values could increase or decrease based off of previous stormwater activity. Therefore, a more comprehensive study of the phosphorous concentrations entering Lake Wickaboag should be conducted by a professional engineer.

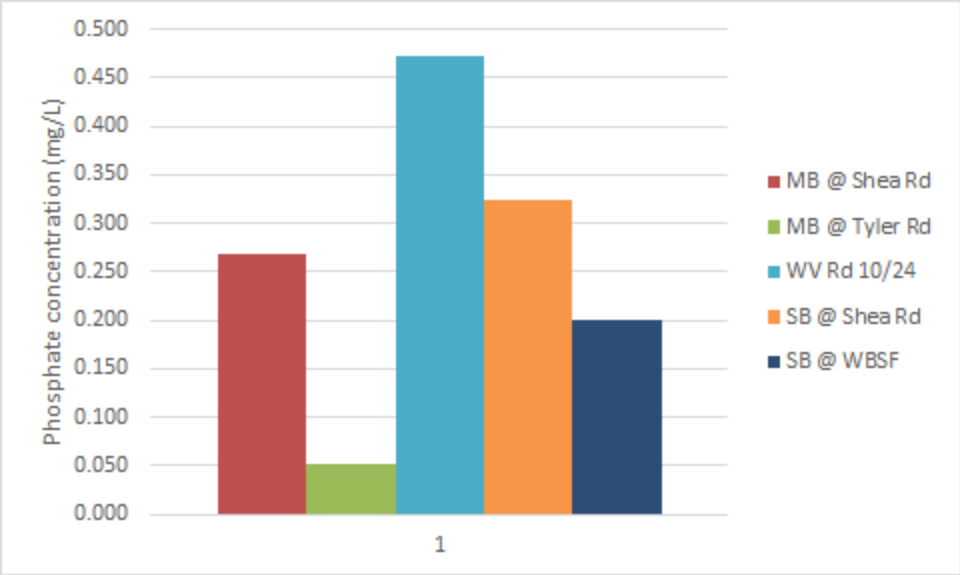


FIGURE 6: DRY PHOSPHATE CONCENTRATIONS FROM THE FIVE SITE LOCATIONS IN MG/L

4.1.3 Data Limitations and the Focus on Sediments

The data collected represents only a small sampling of weather conditions affecting certain locations along Mill and Sucker Brook. None of the samples were collected at the point in a storm event where sufficient quantities of runoff were being produced, therefore conclusions cannot be reasonably drawn about the pollutants entering Lake Wickaboag from the Mill and Sucker Brook watershed. A comprehensive study of the Mill Brook watershed completed by a professional would provide more reliable data on all of the levels and types of pollutants affecting water quality.

Consequently, the deficiencies within the phosphorous data led to the focus of the BMP design to become the reduction of sediments. This decision was reached based on the level of sedimentation observed in the northern basin of Lake Wickaboag where Mill and Sucker Brook merge to enter the lake. Those sediments can be directly attributed to the water coming in from both brooks. Phosphorus in the lake has been tied with other sources around the lake, including septic systems, and cannot be associated solely with the inlet at Mill Brook. Additionally, as was noted in Section 2.3, phosphorus tends to bind to sediments but can be released back into the water under certain conditions (Søndergaard, 2003). Therefore the

removal of sediments inherently reduces the amount of phosphorus entering the lake. For these reasons, total suspended solids were identified as the pollutant of interest for this study.

4.2 Selecting the Design Location

Sucker Brook at Shea Road is the location that we chose for BMP implementation because there is ample and relatively flat land to the east and west of Sucker Brook, which reduces the amount of grading necessary for construction. Additionally, the water table at these locations is at a depth where it will not interfere with the BMP (NRCS, 2016). There are no previous in-depth studies into the effect that a stormwater BMP may have on this area, so this project chose to focus our efforts there. This Sucker Brook location was chosen over that on West Brookfield State Forest Road because that road is more accessible at the Shea Road location.

4.3 Best Management Practices Selection

In order to narrow down the initial search for an appropriate BMP, each one of the five categories of BMPs within the Massachusetts Stormwater Handbook was analyzed against our initial criteria of site location compatibility (Scale of 1 (very applicable) - 5 (not very applicable)), ability to remove TSS (based off average TSS removal), and implementation and operational costs (Table 3).

TABLE 3: BMP CATEGORIES COMPARED TO INITIAL CRITERIA FOR BMP SELECTION.

BMP Category	Pretreatment BMP	Treatment BMP	Conveyance BMP	Infiltration BMP	Other
Compatibility	1	1	3	1	5
TSS removal	Average 25% TSS Removal	Average 80% TSS Removal	Average 50% TSS Removal	Average 80% TSS Removal	Limited to no TSS removal
Costs [1]	~$56,000	~$50,000	~$44,000	~$65,000	N/A

[1] Data based per impervious acre treated from University of Maryland Center for Environmental Science.

Compatibility was quantified through site visits as well as feasibility to construct the specific types of BMP within each category. Other received a category of 5 because the types of BMPs within other (porous pavement, green roofs, rain barrels, and dry detention basins) do not appropriately match up with the characteristics of the site location. Conveyance BMPs, which contain water quality swales, biofilter swales, and drainage channels, received a rank of 3 because, individually, the purpose differs from the goals of our project. A conveyance BMP's primary function is as an alternative to curbs and gutter systems. However, in conjunction with another form of BMP, a conveyance BMP can be a great pretreatment alternative. The last three categories -- pretreatment, treatment, and infiltration -- all received a rank of 1 because they all contain BMP types that match the site characteristics. A majority of the BMPs within these categories can be built alongside roads and have efficient TSS removal rates. However, pretreatment BMPs, much like conveyance options, serve better when in conjunction with another BMP system. Therefore, treatment and infiltration became the two main categories for primary BMP options.

In order to narrow down the types of BMPs within our two primary categories a new set of criteria was created:

- Disruption to State Forest property
- Efficiency and efficacy of TSS removal
- Drainage area, size requirements, and construction considerations
- Maintenance requirements

The new criteria focused on the location at Shea Road primarily in regards to disruption control and efficiency of TSS removal. There are six possible BMP designs within the category of treatment BMP and five possible BMP designs within the infiltration BMP category providing eleven possible BMP options.

From these eleven possible BMPs six were chosen, three from each category, and analyzed as the primary candidates for BMP design. Dry wells and infiltration trenches were removed as possible infiltration BMPs. Dry wells were removed due to their primary function being non-metal roof runoff control, a function that doesn't fit the State Forest property. Infiltration trenches were removed due to their design requiring open stone upon the surface, detracting from the State Forest property and the likelihood of clogging due to excess sediments. However, infiltration basins were retained because the design utilizes grass as a cover, which is more compatible with the State Forest's natural state. From the treatment BMP category extended dry detention basins, proprietary media filters and sand & organic filters were removed. Extended dry detention basins were removed due to their need for a large land area. Proprietary Media Filters were removed due to their varied TSS removal percentage based on the filter material. Sand and Organic filters were removed due to the high groundwater level within the Shea Road site location.

4.4 Choice of Best Management Practice

Following the iterative process for BMP selection, a bioretention area was determined to be the most applicable for the location along Sucker Brook at Shea Road. Bioretention areas have a high TSS removal of 80% with proper pretreatment, and it is a low-impact development option so the rural nature of the area can be maintained. The requirements for design do not extend beyond the limitations of the site. Volume 2, Chapter 2 of the Massachusetts

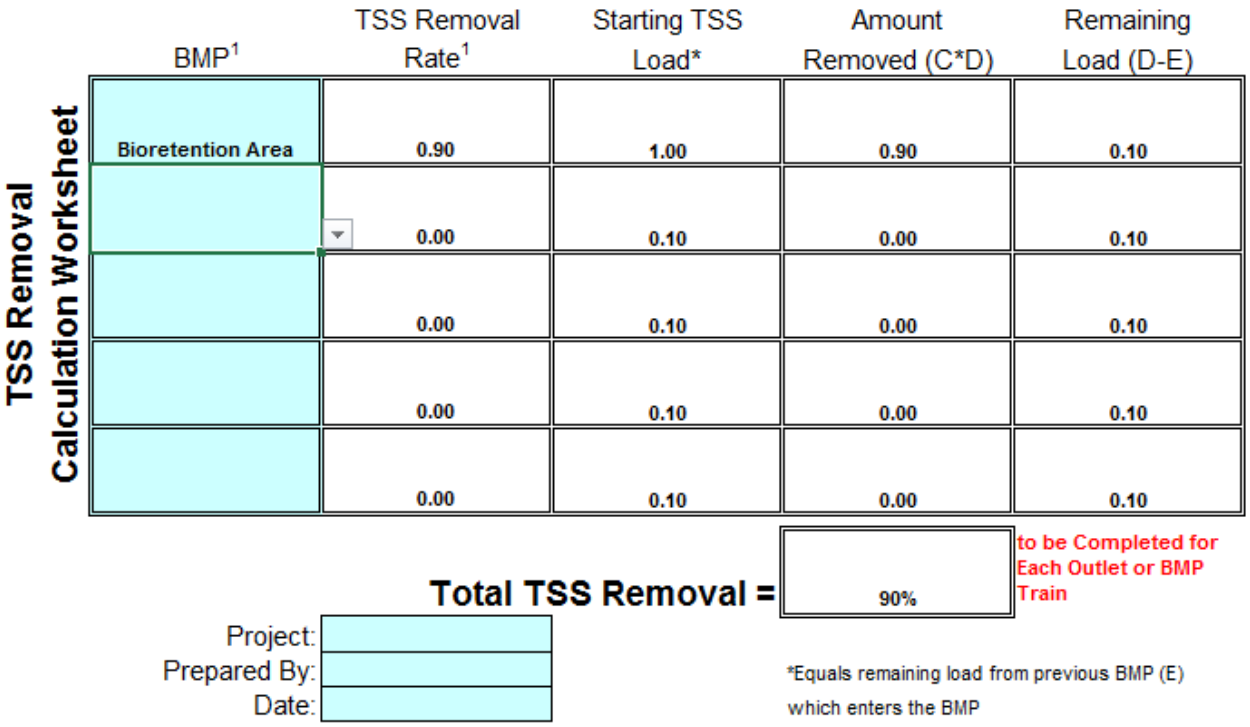
Stormwater Handbook states that to achieve the TSS removal rating of 80% for a bioretention area, a pretreatment option providing 44% TSS removal is needed.

Two designs, with their associated benefits and drawbacks, were considered for pretreatment:

- A grassed channel combined with a deep sump catch basin or
- A vegetated filter strip.

Within the first option, the grassed channel would guide the sheet flow of runoff from the road and convey it to the deep sump catch basin, which would then lead to the bioretention area. The catch basin has an estimated 25% TSS removal, while a grassed channel can remove 50% of TSS with proper pretreatment. However, in this instance there would be no pretreatment for the grassed channel, so its actual efficiency when used together with the deep sump catch basin needed to be calculated. To do so, an automated excel spreadsheet (Figure 7) provided by the MassDEP was used. BMPs are chosen from a dropdown menu in a cell on the left, and the percent removal is calculated automatically. Together, the grassed channel and the catch basin provide the required 44% removal efficiency.

The channel was sized based on the expected peak flow rate for a 10-year storm event, and the requirement that the hydraulic retention time is at least 9 minutes to capture sufficient amounts of solids.



TSS Removal Calculation Worksheet

BMP[1]	TSS Removal Rate[1]	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
Bioretention Area	0.90	1.00	0.90	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10

Total TSS Removal = 90%

to be Completed for Each Outlet or BMP Train

Project:
Prepared By:
Date:

*Equals remaining load from previous BMP (E) which enters the BMP

FIGURE 7: TSS REMOVAL EXCEL SHEET FROM MASSDEP

4.5 Design of Best Management Practices System

4.5.1 Vegetated Filter Strip Design

The Massachusetts Stormwater Handbook has fairly vague descriptions for the design of a vegetated filter strip. We believe this is because it assumes the reader has experience designing them or other similar BMPs and thus does not require as much detail. However, because this project was for learning purposes, we found another source with a more detailed description of the vegetated filter strip design process. The Georgia Stormwater Management Manual provides equations to estimate the necessary size of the filter strip. From these calculations, presented in Appendix D, both Area 1 and Area 2 require a minimum width of 5.5 feet and a length of around 94 feet.

4.5.2 Bioretention Design

- West of Sucker Brook

Area 1, the larger area to the west of Sucker Brook, had a drainage area of 46 acres, with 2.5 acres of impervious area. The results of the Rational Method gave a peak runoff rate for this area of 0.77 cubic feet per second for a 25-year storm and a runoff coefficient of 0.15. The calculations for this and all other calculations can be found in Appendix D.

Standard 3 of Volume 3, Chapter 1 of the Massachusetts Stormwater Handbook gave a required volume for the BMP in Area 1 of 1,153 cubic feet. Standard 4 of the Handbook gave a required BMP volume of 9,075 cubic feet. The volume from Standard 4 was used in sizing the bioretention area.

The depth of the bioretention area was chosen to be 4 ft, as is suggested in the Stormwater Handbook as the maximum depth for a bioretention area. The length and width requirements were adjusted based on the land area available directly to the west of Sucker Brook. The length of the bioretention area was designed to be 92 feet and the width, 25 feet.

- East of Sucker Brook

Area 2, east of Sucker Brook, had a drainage area of 15 acres, with 1.5 acres of impervious area. The Rational Method for Area 2 gave a peak runoff rate of 0.62 cubic feet per second for a 25-year storm and a runoff coefficient of 0.15. The higher runoff rate for the larger area makes sense because of the larger impervious area.

Standard 3 of Volume 3, Chapter 1 of the MA Stormwater Handbook gave a required volume for the BMP in Area 2 of 209 cubic feet. Standard 4 gave a required BMP volume of 5,445 cubic feet.

Again, the depth of the bioretention area design was 4 feet with a length of 92 feet. However, for this area, a width of 15 feet was decided upon. The two areas were designed with the same length to simplify design with the vegetated filter strips, as were discussed in the

previous section. The following section discusses the vegetation choices for the bioretention area. Figures 8 and 9 show sketches of the bioretention areas and the vegetated filter strips.

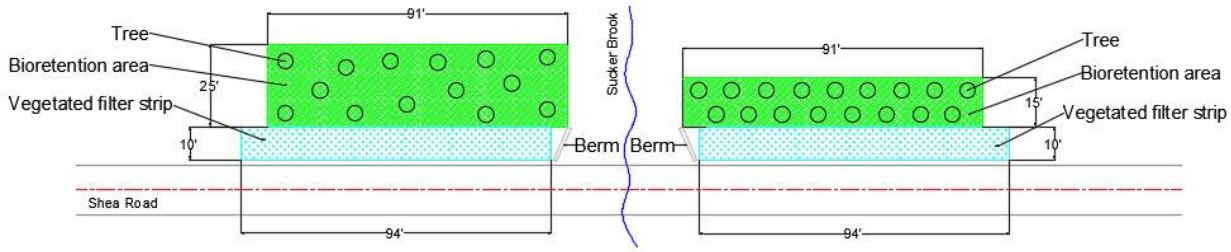


FIGURE 8: PLAN VIEW OF THE BMP DESIGN

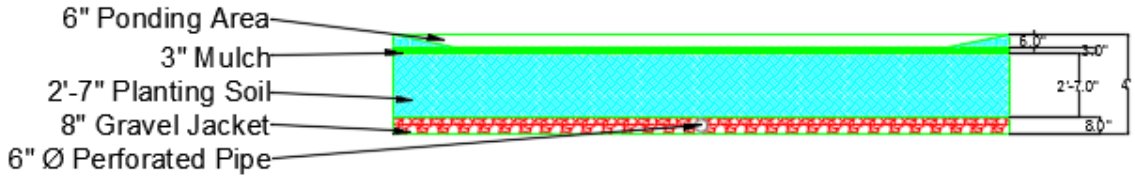


FIGURE 9: PROFILE VIEW OF THE BIORETENTION AREA

4.5.3 Vegetation Choices

The vegetation that was chosen to be utilized in the bioretention area was based off a table provided in the Massachusetts Stormwater Handbook, Volume 2 Chapter 2. This table classifies species of plants by the amount of moisture they prefer, tolerance to metals and other potential pollutants, the morphology of the plant and characteristics like whether it is native or not. Each of these categories have several subcategories that needed to be considered.

The first category, moisture preferences, has two subcategories that reflect their ability to thrive in wetlands and specific habitats where those plants may be found. The four types of wetland preference are: Facultative Upland (FACU), which include plants that are usually not found in wetlands; FAC, whose plants are equally likely to be found in wetlands or non-wetlands; FACW plants are more likely to be found in wetlands than not; and UBL plants that are almost always found in wetlands. For this project, preference was given to plants that were classified as FACW or UBL, although FAC plants were also included.

The next category outlines the ability of certain plants to tolerate pollutants and pests in the environment. The six tolerance subcategories found under this heading are: ponding, salt, oil/grease, metals, pests/disease and exposure. Ponding was not a priority in this analysis because the bioretention area was designed to facilitate the dispersion of water quickly. Salt tolerance was a high priority for this project because of the proximity of the bioretention area to the road. Oil and grease did not carry much weight in this analysis because the site is not near a parking lot and there is relatively low traffic on Shea Road. Metal tolerance was not a deciding factor because of the limited amount of data for this subcategory, as only a handful of suggested plants had an input for this subcategory. A high tolerance to pests and disease was viewed as beneficial for the health and perseverance of the plants. Finally, exposure was considered because there are many trees in the area immediately surrounding the bioretention area, meaning that plants that enjoy full sunlight may not thrive as much as those that prefer some shade.

The third category of the table discusses the morphology of the plants themselves. The subcategories for this classification include the form, height and root depth. The form of the plant was not as much of a priority as the height. For the height, shorter plants were given higher priority because they generally require less maintenance than larger plants. Additionally, they have shorter roots which was critical for this project because the design of the bioretention area is only four feet deep.

The general characteristics category of the table has subcategories that list whether the plant is native and its attractiveness to wildlife. While native plants were preferred, it was not the highest priority. Attractiveness to wildlife was given even less of a priority.

There were seven plant species that fell squarely within the criteria set for the specific location chosen. However, the MA Stormwater Handbook suggests that three species of grasses and shrubs are used with one tree every 50 square feet of bioretention area to prevent monoculture. Based on the information presented in Table 4, which was adapted from the Stormwater Handbook, the most fitting vegetation was selected. Tufted Hairgrass, Witch Hazel, Bayberry and Red Maple were the best fits for this situation.

TABLE 4: VEGETATION OPTIONS FOR THE VEGETATED FILTER STRIP

Plant	Moisture Preferences	Tolerance			Morphology			General Characteristics
	Wetlands	*Ponding (days)*	*Salt*	*Oil/Grease*	*Form*	*Height*	*Root Depth*	*Native*
Tufted Hairgrass	FACW	2 to 4	H	-	Grass	2-3'	Fibrous Shallow	Yes
Switchgrass	FAC to FACU	2 to 4	H	-	Grass	4-5'	Fibrous Shallow	Yes
WItch Hazel	FAC	2 to 4	M	M	Vase-like Compact Shrub	4-6'	Shallow	Yes
Common St. John's Wart	FAC	2 to 4	H	M	Ovoid Shrub	3-6'	Shallow	Yes
Bayberry	FAC	2 to 4	H	M	Rounded, Compact Shrub	6-8'	Shallow	Yes
Northern Wild Raisin	FACW	2 to 4	H	H	Rounded, Compact Shrub	6-8'	Shallow	Yes
Red Maple	FAC	4 to 6	H	H	Single to Multi-Stem Tree	50-70'	Shallow	Yes

4.6 Grant Writing Analysis

The 604(b) Water Quality Management Planning Grant awarded by the Massachusetts Department of Environmental Protection was chosen as the primary grant option for investigation due to the lack of understanding of the non-point source pollution sources within the watersheds north of Lake Wickaboag. Instead of pursuing the 319 implementation grant, which the Stormwater Authority has applied for and been awarded previously, the 604b was pursued in hopes of broadening the understanding of the watersheds north of Lake Wickaboag. The 319 implementation grant could be pursued again once the information is gathered from the watershed analysis funded by the 604b grant.

4.6.1 Writing a Competitive Proposal

A competitive grant proposal starts with the request for responses (RFR) issued by the funding organization. This request is the starting point for funding organizations to illustrate the specific requirements they are looking for in a proposal. The key components for an RFR outlined by the Massachusetts Department of Environmental Protection are as follows:

- Map the Project

The first step in mapping a project is drafting the problem statement. The problem statement must be direct and illustrate the key issues that the grant would address. Both Jane Peirce from MassDEP and Diana Payne from Connecticut Sea Grant emphasize that a proper problem statement is to the point and clearly stated. A proposal will suffer if the reviewer cannot identify what the major problem is that the proposal is supposed to be addressing.

- Identify Partners

The next step in writing a competitive proposal is to identify key partners that would want to help with the project. Partners provide alternative funding sources and individual resources that a single organization might not have access to on their own. Partners can be either non-profits or other municipalities who share similar interests in the outcome of the proposal. However, picking a poor partner could lead to a failure to finish the project. Ideally, the partner should have the same amount of investment in the project as the original organization.

- Sell Previous Success

To illustrate the capability to complete an intensive project, it is important to emphasize the previous successful projects completed by the organization. Specifically, completed grant projects help reassure funding organizations. Bill Hinkley of the Massachusetts Environmental Trust expressed at the Baystate Workshop that funding organizations want to continue to give money to organizations that have successfully completed grants. Therefore, it is important to illustrate to a reviewer or review board the previous successes that have been accomplished.

- Create a Cost Analysis

There are two types of cost analyses that can be completed for an RFR: simple and complex. The simple cost analysis roughly describes the amount of money certain big name items will cost, and gives a less precise value for how much money is being requested. The simple cost analysis should be used mostly for small requests similar to previous projects and are known to likely succeed. An example of a project that could use a simple cost analysis would be if West Brookfield implemented more StormTech chambers anywhere around Lake Wickaboag. Because the town has already successfully completed a project of this scope, the cost analysis does not need to be as detailed as a project with a larger scale.

Projects that require more accurate cost analyses would be projects like the 2011 dredging of the two adjacent ponds. Outlining the cost of ESS Group Inc., the price for volunteers, equipment costs, management costs, construction cost, etc. helps show the reviewer that the organization applying for the funding knows exactly how the award will be spent. Additionally, having a detailed breakdown of costs means that the requested amount can be more precise, therefore the funding organization can identify which other projects they can fund with the knowledge that they have given the exact amount necessary for the project.

- Triple Check the RFR

Finally, the most important component to a competitive grant is to review all aspects of the request for responses. A proposal can easily be disqualified by forgetting to check one box, or by neglecting to get an important signature. The RFR is there to illustrate what the funding organization wants, therefore the RFR should be reviewed extremely carefully to make sure all aspects are accounted for before submittal.

4.6.2 The Importance of Project Mapping

Carol Baldassari of the Program Evaluation and Research Group at Endicott College and Diana Payne of the Connecticut Sea Grant emphasize that the first step towards a completed request for responses is through the creation of a project map. The initial step of project

mapping is identifying a problem and conveying that problem into a clear and cohesive problem statement. For the Stormwater Authority, the problem they are addressing is sedimentation and algal blooms that negatively affect Lake Wickaboag. However, simply expressing this concern is not enough to qualify as a persuasive problem statement. Several aspects need to be expressed to fully round out an effective problem statement. Who specifically is the problem affecting? What are the economic effects? What is it that the Stormwater Authority wants to do to alleviate these issues? These are only a few examples of questions that a good problem statement should answer. An example problem statement for West Brookfield would be:

> "Algae blooms are disturbing natural habitats and disrupting recreational activities on Lake Wickaboag. Remediation of these disturbances can be economically expensive and environmentally destructive. Therefore, gathering information on the causes of algae blooms within the Lake Wickaboag watershed will provide alternatives to costly projects."

This problem statement expresses who is being affected, how it challenges the economy, and what is needed to help alleviate the issue. Furthermore, the problem statement expresses the first short-term outcome desired by the Stormwater Authority. A watershed analysis north of Lake Wickaboag would provide detailed information about the types and locations of pollutants entering the lake.

The 604b water quality management grant has no limit for what can be awarded to an individual project, but Gary Gonyea of the MassDEP expressed at the BayState workshop that funding smaller projects is better for the state and provides more opportunities to award funding. An appropriate amount for this analysis is around $60,000. This number is based off previous watershed analyses expressed in past 604b project summaries found on the Massachusetts government website. However, a more in-depth cost analysis would have to be compiled to accurately express where the costs would come from and whom the funds would be going to during the project.

The next step in project mapping is to outlining the rest of the short, medium, and long term goals. A logic model is a good way to visually represent the thought process behind a grant proposal. The logic model provides a graphical depiction for the logical relationships between; the resources an organization has, the investments the organization plans to make to solve the problem, the activities and actions the organization plans to carry out, and what the organization wants to achieve. The logic model shows the progression from the inputs through the outputs to finally reach the outcomes. However, when designing a logic model the input is not the starting point. The outcomes are what drive the project and therefore should be decided first.

When determining outcomes, it is important to decide which outcomes should be done immediately, which outcomes need more information before accomplishing, and which outcomes are the ultimate goals. The outcomes that should be done immediately become the short-term outcomes identified in the logic model. These outcomes focus primarily on learning. Learning means that the outcomes should primarily focus on gaining awareness or information. Then, once that awareness or information is obtained, we can move closer to the medium-term outcomes. These outcomes focus on actions. The actions should primarily eliminate or address the awareness or information gained in the short term outcomes. If a short-term goal were to identify the locations of beaver dams along a stream, the medium-term outcome would possibly be the removal of the identified beaver dams. The long-term outcomes primarily focus on conditions. Whether these conditions are social, economic, civic, or environmental, the long-term outcomes should be the broadest and most impactful outcomes outlined in the logic model. See Figure 8.

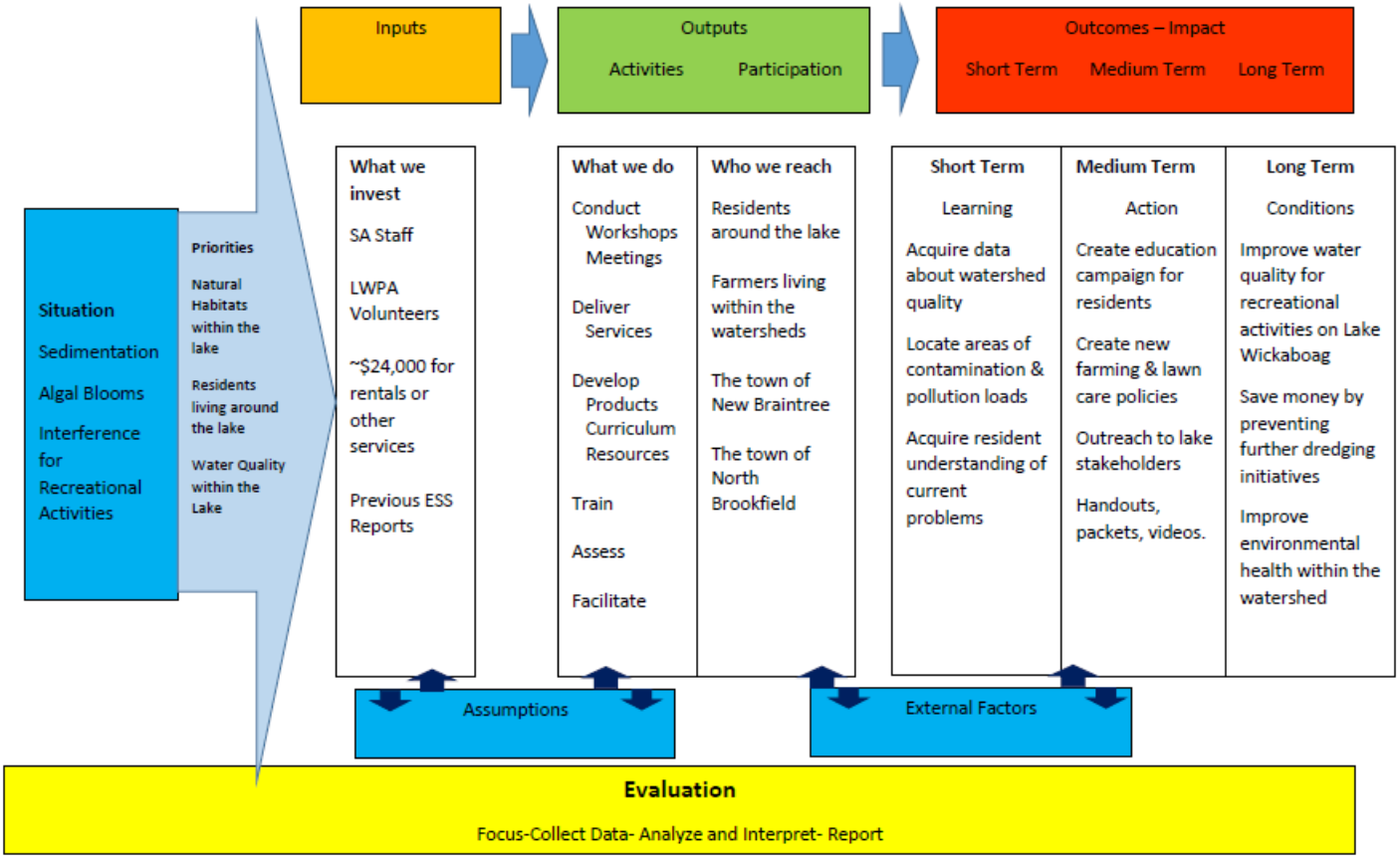


FIGURE 10: LOGIC MODEL CREATED FOR WEST BROOKFIELD

For West Brookfield, the ultimate long-term goals are to: improve the water quality for recreational activities on Lake Wickaboag, prevent further dredging initiatives, and improve the environmental health within the West Brookfield watersheds. To reach these long-term goals, various short-term outcomes have been outlined with the help of the Stormwater Authority. First, a watershed analysis of the watershed north of Lake Wickaboag must be completed to identify pollutants that are present. Once this analysis is completed the SA can begin to move towards achieving the medium-term outcomes. Members of the SA voiced opinions that gauging residential understanding of the issues affecting Lake Wickaboag would also be a good short-term outcome. To address the findings in the short-term outcomes, several medium term outcomes were established. An educational program was discussed briefly with the Stormwater Authority as an opportunity to increase awareness to residents while also addressing current

policies that are negatively affecting the lake. Additionally, handouts or packets were discusses as a possible way to supply residents with the tools needed to begin the process of changing behavior around Lake Wickaboag.

Following the expression of outcomes, the next step is the creation of activities and the identification of participation outputs needed to reach these outcomes. Activities such as public meetings to discuss policy changes for farmers or public presentations on how to wash your shoes before and after entering Lake Wickaboag to prevent the relocation of invasive species are just some examples of possible activities that the Stormwater Authority could use as outputs for the logic model. Within the outputs section, a key component of a competitive stormwater grant are the possible partners that could be helping with the project. For the Town of West Brookfield those partners are non-profits like the Lake Wickaboag Preservation Association or other municipalities like the bordering towns of New Braintree or North Brookfield. Working with partners provides opportunities to collaborate resources and acquire multiple sources of funding. More partners also means that there might be more items that can be input into the project that normally would need to be acquired separately.

Inputs refer to the equipment, volunteers, trained staff, technology, non-federal funding, and any other item the organization already has access to without the federal funding. This is the final step in project mapping because it illustrates to the reviewer what is not needed for the request. The inputs show that there is individual interest within the project by the organization applying for the funding. It also shows that the organization realizes its limitations and that the funding is a perfect source to bring people together to support a greater goal. If projects were completed based on the inputs first, the scale and scope of the projects would be based solely on how wealthy the organization is, therefore diminishing the types of projects done by organizations that have minimal finances. The state does not want to limit a project based on monetary value, which is why grants are given to organizations, so that the state can help anyone who has an idea that will better the Commonwealth of Massachusetts. A good project is not based on who submits the project, but on the core elements of the project.

Fortunately, the Town of West Brookfield has had some previous success with grant projects and has acquired strong inputs to help complete improvement projects. Both the Stormwater Authority and Lake Wickaboag Preservation Association have access to volunteers and staff that work diligently to procure forms in a timely manner and execute site visits to project sites. Additionally, based on previous 319 implementation grants, the Town of West Brookfield does well in acquiring non-federal match required in the 319 request for responses. Previous matches have ranged from $41,600 to $235,000. The 604b water quality management grant requires no match, yet Gary Gonyea and Jane Peirce of the MassDEP both suggest matching in some way to illustrate dedication to the project. The $24,000 in the logic model is a low range estimation of a match for the sought $60,000 from the 604b request for responses. Both of these values are subject to change based on changes in costs of equipment and services that the town may need to complete the watershed analysis.

4.6.3 The Reviewer's Perspective

Bill Hinkley of the Massachusetts Environment Trust expressed in his presentation the perspective of the grant reviewer. This section will summarize his points to provide an understanding of how a proposal is viewed.

Primarily, a grant is issued in order to advance the state's goal or policy. Currently, the Commonwealth of Massachusetts is trying to record the state of all major and minor surface waterbodies. The grant reviewers are tasked to take taxpayer funds and decide on projects that match the guidelines of the Code of Massachusetts Regulations. The proposal should act similar to a proposal brought forth by a contractor. It should be professional, concise, and easily understood. Images and graphs should be easily reproducible for the review committee and easily legible. Color is suggested for any and all maps. The review process uses a point based scoring system. The board discusses how scores were assigned and averaged between the board members. Finally, reviewers take notice on proposals that arrive earlier than the deadline. A proposal that arrives early shows that there is commitment to completing goals set

forth by the organization applying. A rushed proposal illustrates an organization that might rush the project.

Chapter 5: Conclusions and Recommendations

This section of the report contains the final recommendation for control of total suspended solids in Lake Wickaboag. In addition, it contains information and future recommendations for the Stormwater Authority to preserve the quality of the lake and the area surrounding Lake Wickaboag.

Stormwater samples were collected at five locations on Mill and Sucker Brook throughout October and November of 2015. The greatest levels of sediments were found to be at Sucker Brook on Shea Road. The annual loading estimated at this location was 14,543 lbs per year. To eliminate these sediments, treatment and infiltration BMPs became the primary BMP categories chosen for this design. From each category, three types of BMPs were considered: bioretention area, constructed wetland, wetbasin, infiltration trench, infiltration basin, and subsurface structure. A bioretention area was chosen as the primary design due to the use of native vegetation and 80% TSS removal rating with proper pretreatment. A vegetative filter strip was chosen as the pretreatment to convey and filter the primary runoff towards the bioretention area.

It is not recommended that the Stormwater Authority pursue the construction of this BMP design at this time. Rather, it is recommended that the Stormwater Authority pursue the 604(b) water quality management grant for the upcoming 2016-2017 request for responses in order to acquire a better understanding of the source of pollutants affecting Lake Wickaboag from the northern watershed. Additionally, it is recommended that the request for responses template, found in Appendix E, be reviewed and completed more thoroughly before submittal to the funding organization. Once the watershed analysis is complete, then the bioretention area can be considered as a possible BMP design for alleviating the influx of total suspended solids and total phosphorous to Lake Wickaboag.

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Appendices

Appendix A: Project Proposal

Lake Wickaboag Water Quality Management

A Major Qualifying Project Proposal
By
Miryam Becker
and
Kevin Gray

Date: October 2015

Table of Contents

1.0 Introduction

Lake Wickaboag is a crucial part of everyday life for the residents of the town of West Brookfield, Massachusetts. Recreational activities that take place on the lake include swimming, boating and fishing in the summer and ATVing, ice skating, hockey and ice fishing in the winter. However, in recent years there have been concerns about sediment accumulation and excess nutrients entering the relatively small, shallow lake and affecting water quality and the recreational activities practiced there. High levels of nutrients such as phosphorus lead to algae blooms that affect wildlife in the lake. The lake is considered one of the town's greatest assets and for that reason the water quality of the lake has become a prevalent issue.

The town of West Brookfield has completed several successful stormwater and drainage improvement projects around the lake over the past few years. While these projects have reduced the amount of pollutants in the water, West Brookfield hopes to further improve long-term water quality in the future. One such initiative is a hydraulic dredging project that will tackle sediment accumulation and increase the depth of the lake. The project is planned for the northern end of the lake where Mill Brook, the main tributary, enters Lake Wickaboag. Unfortunately, the project has run into numerous obstacles due to the cost and extent of the project. While this project will help in the short term, it does not ensure water quality and clarity in the future as more sediment continues to enter the water system. As such, taking steps to prevent sediment from ever entering the lake will reduce the need for another dredging project in the future.

The purpose of this MQP will be to assist the town in maintaining water quality for Lake Wickaboag in order to prevent future dredging projects. To do so, we plan to identify the sources of sediment and excess nutrients along Mill Brook, and prioritize those locations that have the largest effects. Once these locations have been identified, different strategies to address this pollution will be analyzed and chosen according to predetermined criteria. Such strategies include the design of structural stormwater best management practices to be implemented at one or more locations, a plan to educate landowners about reducing pollution loads, and the reduction of sand and salt utilized in road management.

To determine the best approach, we will research previous water quality studies completed on Lake Wickaboag as well as comparable situations experienced on similar bodies of water.

2.0 Lake Wickaboag Water Quality

Lake Wickaboag is a key component of the culture and quality of life that characterizes West Brookfield. For this reason, many studies and projects have been completed on and around the lake over the years as algae blooms and sedimentation have affected the health of the lake. The citizens of West Brookfield are active in preserving the health of the lake and have worked toward

2.1 Water Quality Issues of Lake Wickaboag

Lake Wickaboag covers an area of around 320 acres and is a relatively shallow lake, with an average depth of seven feet and a maximum depth of eleven feet. In certain places, such as

the northern cove, sediment accumulation has decreased the depth of the lake to as little as one foot. The shallowness of the lake means that flora and fauna can be largely affected by seemingly small changes in temperature and chemical composition of the lake. The temperature of the lake is dependent upon the ambient air temperature, while the chemical composition is affected by runoff from around the lake and the water that enters the lake from the main tributary, Mill Brook.

Mill Brook enters the lake at the northernmost point and is the reason that sediment accumulation is so pronounced in that region. The ESS Group, Inc., a civil engineering and consulting company hired by the town of West Brookfield, attributes an expected load of 5,200 kg of sediment per year into the lake through Mill Brook (ESS Group Inc, 2004). However, the sources of high levels of solids in Mill Brook have not been thoroughly investigated. Along Mill Brook, much of the land is wetlands, but the next most common land use is agricultural, particularly the raising of livestock (ArcGIS, 2015). Agricultural practices that require large amounts of fertilizer contribute excess nutrients to Mill Brook and, subsequently, to Lake Wickaboag. An excess of nutrients causes algae blooms that can kill off other wildlife in the lake. The health of the lake is important from economic and anthropocentric points of view, as well as biologic, since the lake is the heart of West Brookfield.

2.2 Stakeholders in a Healthy Lake System

As water quality issues have become more apparent, concerned citizens and the town itself have stepped up to tackle the issues of sedimentation and nutrient overload. Increased development around the lake creates more potentially polluted runoff that naturally flows downhill to the lake. A group of citizens formed an organization called the Lake Wickaboag Preservation Association to help vocalize the very important role the lake plays in the lives of all who live around the lake, in the town of West Brookfield, and in the surrounding areas. Their purpose is to help maintain the ecological health of the lake by supporting programs that work to improve water quality and watershed management (LWPA, 2016). While not in charge of completing projects, their presence and persistence motivates town officials to do as much as possible to improve the water quality of the lake.

Within the town government, a committee called the Stormwater Authority(SA) was formed to “protect the public health, safety, and welfare by establishing requirements and procedures to manage stormwater runoff and to prevent water pollution from new development and redevelopment” (Town of West Brookfield, 2006). As such, the SA ensures that development will not cause additional strain to the already-impacted lake system. The LWPA works with the Stormwater Authority to identify and promote stormwater improvement projects around the lake that reduce the amount of pollutants entering the water.

2.3 Past Water Quality Management Projects and Reports

The past 10 years has seen an increase in studies and reports about the health of the lake to understand and address the sources and impacts of sediments and excess nutrients.

A group of WPI students completed a study of Lake Wickaboag in 2011 to identify prominent sources of sediment and phosphorus to the lake. After analyzing water samples from various locations around the lake, they determined the Mill Brook area to be the most prevalent source. The team designed a stormwater BMP to be implemented at Shea Road to collect sediment and the phosphorus it carries, but the project was never constructed because it was sited to be on private land. At the time of the report, West Brookfield did not feel comfortable approaching the landowner about the project because they had not yet fully completed any stormwater management projects around the lake.

While the Stormwater Authority and the town of West Brookfield itself have been the main players in subsequent water quality management projects as far as design and applying for grants, the Lake Wickaboag Preservation Association has played a role in garnering support from the community and initiating the grant process. An example of a collaborative stormwater management project was a 2010 drainage improvement project undertaken on Wickaboag Valley Road to improve the existing stormwater runoff system. The engineering firm ESS Group, Inc was contracted to design and implement StormTech chambers at the site to prevent runoff from flowing directly into Lake Wickaboag. That project was estimated to reduce total phosphorus and total suspended solids concentrations in the runoff by eighty percent.

A second project to improve the water quality of Lake Wickaboag entailed dredging two adjacent ponds located southeast of the lake. These ponds act as catch basins for stormwater runoff that then flows into the lake. The top layer of sediment in the ponds had collected excess nutrients over time, and during storm events was contributing to phosphorus loading in the lake. The dredging project removed the top layer of nutrient-saturated sediment and implemented an outlet control mechanism to prevent the flushing of nutrient-rich sediment into the lake. This project was a successful collaboration between the LWPA, the Stormwater Authority, a landowner and the engineering firm ESS Group, Inc.

A project is underway to dredge the bay in the northern part of the lake where Mill Brook and Sucker Brook enter the lake to tackle sediment accumulation. That part of the lake has acquired so much sediment that certain areas are only one foot deep, affecting normal activities like boating. The dredging project will assist in reviving past uses of the lake there, but without further action to tackle the sources of sediment, another dredging project will be necessary in the future.

3.0 Relevant Water Quality Definitions

3.1 Nonpoint Source Pollution

Nonpoint source pollution encompasses all types of pollution that result from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification (US EPA, 2012). Nonpoint source is defined through the Clean Water Act section 502(14) as water that does not meet the definition of “point source” pollution. Section 502(14) of the Clean Water Act states:

> “The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete

fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture."

The United States Environmental Protection Agency (EPA) reports that nonpoint source pollution is the primary cause of water quality problems. The EPA emphasizes the harmful effects nonpoint source pollution has on drinking water supplies, recreation, fisheries and wildlife (US EPA, 2012). The two major nonpoint source pollution types that affect Lake Wickaboag are total phosphorous (TP) and total suspended solids (TSS) (ESS Group Inc, 2004). The next sections explain the negative effects that TP and TSS have on lakes.

3.2 Phosphorous

Phosphorus plays an important role in water quality because it is a limiting factor to the growth of algae in aquatic systems. Phosphorus can enter an aquatic system through both point and nonpoint pollution. Phosphorus is a common element in fertilizers causing it to be a common contaminant transported in stormwater runoff. For Lake Wickaboag, the Massachusetts DEP specifies a Total Maximum Daily Load (TMDL) of 729 kg/yr of phosphorus (MA DEP, 2002). However, the actual amount of loading within Lake Wickaboag is 1983 kg/yr. Most of the phosphorus loading is due to stormwater runoff (ESS GRoup Inc, 2004). Additionally, due to the shallow nature of Lake Wickaboag, sediments play a large role in the distribution of phosphorus (Søndergaard, 2003). Understanding how phosphorus enters a body of water, either through external or internal loading, will allow our MQP team to make educated decisions about how to approach the problem in Lake Wickaboag.

3.3 Total Suspended Solids

The EPA clumps total suspended solids under the definition of Sediments and Embedded Sediments. The definition states:

"Suspended and bedded sediments (SABS) are defined by EPA as particulate organic and inorganic matter that suspend in or are carried by the water, and/or accumulate in a loose, unconsolidated form on the bottom of natural water bodies. This includes the frequently used terms of clean sediment, suspended sediment, total suspended solids, bedload, turbidity, or in common terms, dirt, soils or eroded materials (EPA, 2014)."

Loading imbalance is considered one of the greatest causes of impaired water quality (Berry, 2003). Additionally, sediments are the primary carrier of pollutants. These pollutants range from organic compounds, metals, ammonium ions, phosphates, and toxic organic compounds (EPA Office of Water, 2005). Damage due to sediment pollution in North America has an estimated annual cost of $16 billion (Osterkamp et al., 1998). The damages can be measured physically, chemically, and biologically. Harm to treatment facilities and interference in recreational usage fall under the physical harm category. The storage of nutrients, metals, and

pesticides within suspended sediment are all forms of chemical damage. Finally, biological damage equates to any harm or disruption to aquatic habitats (EPA Office of Water, 2005). The loading and movement of sediments within watersheds is a natural process. Therefore, it would be unrealistic to try to eliminate or control the sedimentation loads. However, the amount of sediments we add in excess to water bodies can and should be controlled to prevent negative effects to the quality of water.

3.4 Stormwater Best Management Practices

Best Management Practices (BMPs) refer to specific actions taken to achieve or aid in the achievement of a management measure (EPA Office of Water, 2005). The EPA breaks down BMPs into two basic categories: Nonstructural and Structural.

- Nonstructural BMPs can take the form of codes, ordinances, regulations, standards, or rules in order to reduce urban runoff issues. The goal of the nonstructural BMP is to reduce potential pollutants or manage runoff at the source. Furthermore, nonstructural BMPs can be broken down further into two more categories: Land Use Practices and Source Control Practices (EPA Office of Water, 2005).

  - Land use practices aim to reduce impacts on water from runoff of new developments by controlling or preventing land use in sensitive watershed areas. Additionally, they can minimize total land use during times of growth accommodation (EPA Office of Water, 2005).

  - Source control practices aim to prevent or reduce potential pollutants at the source before they encounter runoff or aquifers. Implemented before or after development, the practices attempt to modify human behavior through education (EPA Office of Water, 2005).

- Structural BMPs are engineered or designed to manage flow, velocity, duration, or other characteristics of runoff by physical means (USEPA, 1993). Therefor, one can control stormwater volume as well as peak discharge rates, hopefully improving water quality (EPA Office of Water, 2005).

Currently, the LWPA is spearheading a dredging project in the north end of the lake where Mill Brook enters Lake Wickaboag. The project will remove phosphorus-rich sediment, improving water quality and increasing the overall depth of that area of the lake. While this project is important for the health of the lake, in the long term dredging is not a sustainable solution. In order to prevent the need for dredging projects in Lake Wickaboag in the future, this MQP will tackle the sources of pollution by identifying them and then designing a BMP to be implemented.

3.5 Grant Funding

3.5.1 319 Grant

The 319 grant is the primary grant used for East Brookfield's project proposals. The 319 Grant comes from Section 319 of the federal Clean Water Act. The grant is giving to projects that "address the prevention, control, and abatement of nonpoint source (NPS) pollution" (MassGov, 2015). In order to achieve the previous requirement the project must adhere to the following measure: "implement measures that address the prevention, control, and abatement of NPS pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; contain an appropriate method for evaluating the project results; and must address activities that are identified in the Massachusetts NPS Management Plan" (MassGov, 2015). Additionally, the organization that is receiving the grant must acquire a 40% non-federal match. Due to the common use of the 319 grant, a different source of funding will be analyzed by the project team.

3.5.2 604(b) Grant

The 604(b) Water Quality Management Planning Grant comes from Section 604b of the Clean Water Act. The grant focuses on

> "watershed or subwatershed based nonpoint source assessment and planning projects leading to the: 1) determination of the nature, extent and causes of water quality problems; 2) assessment of impacts and determination of pollutant loads reductions necessary to meet water quality standards; 3) development of green infrastructure projects that manage wet weather to maintain or restore natural hydrology; 4) development of assessments, preliminary designs and implementation plans that will address water quality impairments in impaired watersheds, and 5) development of regional storm-water utilities in regulated and non-regulated communities" (MassGov, 2015).

4.0 Methods

The objective of this MQP is to identify the primary sources of sedimentation and phosphorous pollution along Mill Brook, the main tributary that flows into Lake Wickaboag. Specific tasks include:

- GIS analysis of the Mill Brook watershed to identify key aspects such as land uses, water flow (watershed subbasins), and existing infrastructure.
- Utilize the Simple Method for pollution analysis to make predictions about where pollution/sediments are entering Mill Brook, and compare them with predictions from the GIS analysis.
- Conduct field tests during both dry weather and storm events to calibrate predictions and narrow down problem areas. Water samples will be tested for total suspended solids, phosphorus, pH and any other vital components.

- Evaluate Best Management Practices, including both non-structural and structural applications, specific to the locations identified as sources of pollution/sediments while considering costs, efficiency, and operational strain.

4.1 GIS Analysis

The first step will be to complete an analysis of the Mill Brook watershed using the Geographic Information System, or GIS. Utilizing GIS will provide information about what the surrounding land is currently used for, what areas drain to Mill Brook and what infrastructure exists in the area. Understanding land uses in the area will allow the team to predict where the main sources of sediment and phosphorus are. To do so, the team will determine the extent of the Mill Brook watershed based on the lines determined by the engineering company that last did a water quality assessment of the area, ESS. Using the same area allows for a direct comparison between the two studies and conclusions to be drawn about the changes in water quality over time. Then, overlaying data layers from the MassGIS database will create an informative map of the drainage area. Useful data layers include: land use data, drainage subbasins, aerial images and soil types to help calculate runoff and potential pollutant loadings using the Simple Method. This data will be compiled, labeled and color-coded for optimal readability. Due to the possibility that GIS data is outdated, other approaches will be utilized to ensure accuracy of our assessment.

4.2 Predicting Pollution Inflow Using The Simple Method

The Simple Method is a technique used by civil and environmental engineers to determine the amount of pollutants that will be carried out of (and therefore into) certain areas during storm events. For this project, the Simple Method will be utilized to estimate the amount of pollutants, especially phosphorus, that enter Mill Brook. There are two drainage subbasins for Mill Brook, but a direct comparison may not be beneficial because the northern basin is about six times larger than the other. However, analyzing both subbasins will allow the team to estimate the total influx of pollutants to Mill Brook along its length.

There are five factors used to complete this calculation: the depth of rainfall in an average year, a correction factor to adjust for the rain that falls but does not become runoff, the total area of the site in acres, the runoff coefficient for the site, and the pollution concentration (Minnesota Pollution Control Agency, 2015). Although the Simple Method is not perfect, it gives a good generalization for what to expect.

4.3 Water Sample Gathering Methods

The required equipment needed for gathering samples are: plastic sample bottles (1L bottles for TSS analysis, 250mL bottles for phosphorus, ph, and other probe tests), a cooler, ice packs, labels, a marker and a water sample collecting device. Before going out into the field,

each 250 mL bottle will be washed with nitric acid to cancel out any contaminants, then rinsed three times with distilled water to remove effects of the acid when we collect the water. Once the equipment is gathered, team members will set up at the site designated to them. According to the MA DEP Standard Operating Procedure for Stormwater Gathering as of December 2005, the common minimum criteria for gathering stormwater are a 48-72 hour minimum dry period prior to the sampling as well as a 0.25 inch minimum total amount of rainfall per storm event or in 24 hours (MA DEP, 2008). The project team will designate a specific time to collect each sample in order to ensure more consistent results when analysing the data. Additionally, for each site, notes on the total rainfall, intensity, and duration will be recorded. During collection, the sample bottles will be held in the middle of the stream for best results. Once the bottle is full, it will be sealed and labeled with site number, time, and date it was collected and then placed within the cooler. The project team will repeat this process three times, once every 15 minutes. The samples will be delivered to the Environmental Engineering Laboratory at WPI to be stored within a refrigerator. The project team will complete TSS and phosphorus tests on these samples within an appropriate amount of time.

4.4 Testing for Total Phosphorus

To test for phosphorus a set of standards with known concentrations of phosphorus including and just beyond the range of expected results will be prepared before testing. The analysis of these standards will provide the calibration curve from which the unknown samples will be analyzed. Using a stock solution, standards will be prepared. All aqueous samples collected will be tested using a Dr/3000 Color Spectrophotometer. The spectrophotometer will allow us to compare our samples to the standards, illustrating the amount of phosphorus from the site locations. All glass materials will be washed thoroughly before and after use to prevent any contamination. The specific lab procedure can be found within the appendix.

4.5 Measuring Total Suspended Solids

Total suspended solids (TSS) will be determined by a gravimetric method approved by the EPA. A filter will be acquired with a specific micrometer retention that works for our project design. The filter will be placed onto a filtration apparatus. A vacuum pump will be used when rinsing the filter to make sure the filter is clean. The filter will be removed from the apparatus and placed into a oven safe dish with tweezers. Then the dish and filter will be oven baked at 103°-105° C for one hour.

After baking, the filter and dish will be placed into a desiccator for storage and cooled until ready for testing. Immediately before testing, the dish and filter will be weighed and recorded. The filter will then be removed from the dish and placed back into the filter apparatus. A sample volume will be chosen that leaves an appropriate amount of residue upon the filter. Our sample water will then be pulled through the filter, separating the solids onto the filter. The apparatus will be washed down with DI water to collect residual solids. The filter will then be placed onto the dish again and returned to the oven to be baked for one hour at 103°-

105° C. After baking, the sample will be relocated to the desiccator for cooling. Once cooled, the dish and filter will be weighed and recorded. We will use the following equation to calculate the total suspended solids:

$$\text{non-filterable residue (mg/L)} = (A-B)/C$$

Where:

A = weight of filter (or filter and crucible) + residue in mg
B = weight of filter (or filter and crucible) in mg
C = L of sample filtered

4.6 Selecting and Designing a Stormwater Best Management Practice

There is a plethora of types of structural BMPs that could be utilized, but no single BMP is equally effective for all project sites because different types of BMPs have different dimensions and levels of efficiency. The first criteria the team identified focuses on the compatibility of the BMP to the site location. Depending on which location the team selects, a BMP will have to be selected that is suitable for that site. The information gathered from the GIS, Simple Method, and water sample analyses will allow the team to make a decision about where a stormwater BMP would be most effective. The different types of BMPs will be considered and ranked based on their compatibility.

The second criteria focuses on the efficiency and efficacy of the system in regards to TSS and pollutant extraction. High efficiencies in both categories will rank better than BMPs with only high TSS or only high pollutant extraction. Additionally, the team's third criteria will focus on the implementation and operational costs for each BMP including the cost of materials, construction, and post construction, and yearly maintenance. Finally, the project team's fourth criteria focuses on the level of maintenance required to clean and maintain the BMP yearly.

Once all the designated criteria has been considered, a BMP will be chosen and the subsequent design will incorporate the dimensions, pollutant levels and topography for the specific site to ensure efficiency.

In addition to a structural BMP, the team will research the possibility of a non-structural BMP in the form of an educational campaign for landowners along Mill Brook. To analyze the feasibility of this approach, the team will reach out to landowners to gather information about land uses and what changes they would be willing to make. Additionally, the team will talk with the Lake Wickaboag Preservation Association and the Stormwater Authority to assess whether collaboration on this front is possible. To assess the procedure of creating an educational campaign, the project team will collect and evaluate previous examples of educational campaigns as a means of water quality protection.

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Appendix B: Summary of Site Visits

a. September 16, 2015

We arrived in West Brookfield at 4:00 pm on September 16th, 2015. The temperature that day was in the mid-sixties (WeatherSource, 2016) and sunny. Kevin, Miri and Professor LePage met Al Collings at the West Brookfield Town Hall, where we first discussed the role of the Lake Wickaboag Preservation Association and the specific projects that they have supported previously. We especially discussed the proposed dredging project in the northern basin and the plans for and hang-ups of that project. He described the two location options for dredged material disposal. Both locations had benefits and drawbacks.

The first location we visited was a landfill that has been closed to the public and no new garbage is allowed to be brought there. However, there is land available there that is unused. The concern with that location is that is is uphill from the lake and is near one of the tributaries, so pollutants could leak back into the lake. The pipe would also have to cut through various private plots of land, meaning that easements would need to be acquired.

The second location that we visited was just to the east of Mill Brook, near a privately-owned trailer park. It is separated from Mill Brook by a small hill. The location can be seen in Figure 11, looking from the road toward Mill Brook (located beyond the first line of trees).

FIGURE 11: POTENTIAL DREDGED MATERIAL DEPOSIT LOCATION. PHOTO CREDIT MIRYAM BECKER.

Seeing the possible discharge locations, we were better able to visualize and understand the potential implications of putting the dredged material there. This was important at the time because, while the goal of this project has always been to improve water quality, we considered several approaches. One possible approach was to assist in the planning of the dredging

project. We moved on from that idea because the Lake Wickaboag Preservation Association has been working on the logistics of the project and the main issue holding up the project are regulations, which can only be dealt with over a long period of time and does not quite satisfy the design requirements of the MQP project.

Following these site visits, Mr. Collings took us on a boat tour of the lake. He lives in a home located on the northwest shore of the lake. While on the boat, we talked about the history of the lake, the activities practiced there and what it means to live the "lake lifestyle". This conversation imparted the importance of the project by explaining the significance of the lake to the people who live there.

This visit with Mr. Collings was our first experience with the lake and helped us form our understanding of what the project required.

b) October 24th, 2015

On this day we traveled to Lake Wickaboag to collect the first set of water samples. The methods for this collection can be found in Section 3.1.1. We collected samples from four locations along Mill Brook: Wickaboag Valley Road, Shea Road, Tyler Road, and on the border of New Braintree. The location at New Braintree was sampled because we knew that it was likely that many of the excess nutrients entering the system were coming from farms upstream. This location was later disregarded because for the purposes of this project, we did not have any jurisdiction to design a BMP on the border.

c) November 9th, 2015

We went to West Brookfield to collect samples from the Sucker Brook locations: Shea Road and West Brookfield State Forest Road. These locations were identified as relevant from information from the 2004 ESS report on the watershed, which determined that high concentrations of sediment were entering from that area. Originally, Sucker Brook was not included in our sampling locations because of its relatively low flow, but as we later saw, in storm events it can convey a significant amount of runoff into Lake Wickaboag.

d) November 12th, 2015

This third day of sampling was to collect additional samples from all five of our selected locations to ensure that we had consistent data that could reasonably be compared. Rainfall for the storm event on this day was recorded as being 0.09 inches, according to the rain meter set up by Professor LePage. The temperature that day was reportedly 48 ºF. This storm event was not very representative of the storm events we were trying to address because it is unlikely that a significant amount of runoff was produced. Two sets of samples were collected for each location, to try to see how the levels of pollution may have changed as the storm progressed. The lack of runoff made this exercise somewhat futile in the long run, but due to a lack of runoff-producing storm events we had to at least try.

e) February 25th, 2016

After deciding on the location of the BMP and beginning the design portion of the project, we needed to acquire additional information on the site we selected. We traveled to the site to take

pictures from and of various points around the site so we could better design the specifics. There was a storm event on February 24th, and the evidence of that was clear. Layers of sediment, as think as four inches, lined the northern edge of Shea Road until it ran into Sucker Brook. The bottom right corner of Figure 12 shows the sediment. It spans a width of about 2 feet onto the road.

FIGURE 12: SEDIMENT ACCUMULATION ALONG SHEA ROAD AT SUCKER BROOK.

Mill Brook flooded in this storm event and covered parts of Shea Road. This flooding highlights the need for other stormwater management projects in the area. These improvements are beyond the scope of this project, but can and should be considered in future watershed analyses, such as that through the 604b grant.

Appendix C: Color Spectrophotometer Methodology

Worcester Polytechnic Institute
Department of Civil & Environmental Engineering

Determining Total Phosphorus using Sulfuric Acid-Nitric Acid Digestion and a Hach DR/3000 Color Spectrophotometer

adapted from Wen, Huajing, "Analytical Procedures for Nutrients in Water," WPI (2005)
with input from Don Pellegrino, WPI CEE Lab Manager

Preparations

1. Turn the color spectrophotometer on. It will need approximately 2 hours for the lamp to warm sufficiently to prevent drifting of absorbance readings.
2. Prepare a set of standards with known concentrations of phosphorus including and just beyond the range of expected results. The analysis of these standards will provide the calibration curve from which the unknown samples will be analyzed.
   - Using a stock solution, standards can be prepared as follows:

$$x\ ml = \frac{C\ mg}{L} \times \frac{ml}{0.1\ mg} \times 100\ ml \times \frac{1\ L}{1000\ ml}$$

where x = volume (ml) of stock solution needed
C mg/L represents the desired standard concentration
0.1 mg/ml is the concentration of the stock solution
100 ml represents the volume of standard that will be prepared
1 L/1000 ml is used to convert ml to L

   - For example, if a 0.5 mg/L (PPM) standard solution is desired, the above equation determines that 0.5 ml (or 500 □l) of 0.1 mg/ml stock solution would be needed

$$x\ ml = \frac{0.5\ mg}{L} \times \frac{ml}{0.1\ mg} \times 100\ ml \times \frac{1\ L}{1000\ ml} = 0.5\ ml$$

Digestion of Aqueous Samples

All aqueous samples, standards, and blanks should be digested using the same procedure, as follows:

1. Pour 25 ml of sample or standard (or e-pure water for blank) into a clean beaker
2. Add 5 ml conc. HNO_3 and 1 ml conc. H_2SO_4. Add the nitric acid first.
3. Cover the beaker with a watch cover – making sure there is a small gap between the cover and the top of the beaker to allow room for release of evaporated gases. Heat gently on a preheated hot plate under hood. The sample should simmer, but not boil. Heat until the sample is "down to fumes," which means that there will be visible white fumes in the beaker, and the sample will have been reduced down to a volume of about 1 ml.
4. Remove watch covers, remove beakers from hot plate, and allow to cool.

Digestion of Soil, Sediment, and/or Plant Material

Solid samples, such as sediment or plant material should be digested using the following procedure:

1. Place a known mass of sample into a clean beaker
2. Add ~40 ml of e-pure water to the sample in the beaker
3. Add 10 ml conc. HNO_3
4. Cover the beaker with a watch cover – making sure there is a small gap between the cover and the top of the beaker to allow room for release of evaporated gases. Heat gently on a preheated hot plate under hood. The sample should simmer, but not boil. Heat for a few hours and then leave overnight, stirring occasionally as needed.
5. Next day, warm slightly and filter through #4 filter paper, rinsing all solid material very well with e-pure water. Add enough e-pure to bring the filtrate up to a known volume. The preferred volume is 25 ml, but dilution to higher volumes may be necessary if phosphorus levels are anticipated to be high. For example, for soil in the range of 500-800 mg Tot-P/kg, diluting the filtrate up to 500 ml produced results within the standard calibration curve for the spectrophotometer (0.2-10 PPM).
6. Pour 25 ml of filtrate into a clean beaker.
7. Add 1 ml conc. H_2SO_4.
8. Cover the beaker with a watch cover – making sure there is a small gap between the cover and the top of the beaker to allow room for release of evaporated gases. Heat gently on a preheated hot plate under hood. The sample should simmer, but not boil. Heat until the sample has been reduced to about 10 ml. Carefully add a few drops of hydrogen peroxide to the beaker and observe. Vigorous bubbling indicates consumption of organic matter. Continue to carefully add hydrogen peroxide dropwise until sample remains a clear color or until bubbling has ceased.
9. Continue to heat sample until "down to fumes," which means that there will be visible white fumes in the beaker, and the sample will have been reduced down to a volume of about 1 ml.
10. Remove watch covers, remove beakers from hot plate, and allow to cool.

Analysis with DR/3000 Color Spectrophotometer

Zero instrument with a blank.

1. Transfer digested blank from beaker into a clean sample cell.
2. Add 1 drop of phenolphthalein indicator solution, and as much 5N NaOH solution as required to produce a faint pink tinge.
3. Once the pink tinge has appeared, add E-pure water to the 25-ml mark.
4. Add 1 ml Molybdovanadate to the sample cell. (Note: a small amount of yellow tinge might be present in the blank because of the reagent. Darker tinges will develop in samples with higher concentrations of phosphorus.)
5. Press: **3 Timer** (a 3-minute reaction period will begin. The display will indicate 3 minutes and then decrease in increments of tenths until 0 is reached.)
6. Press: **Manual Program**, then rotate the wavelength selector dial to a setting of 400 nm. (This will likely already be set appropriately)

7. After the timer beeps, place the sample cell into the cell holder. The 25-ml mark on the cell should face the front of the instrument for proper orientation. Close the compartment door.
8. Zero the instrument by pressing **Zero Abs**. The display should then read 0.000 Abs. If not, press the **ZERO** key again.
9. Empty and rinse the sample cell. Use the same cell for each successive standard and unknown sample.

Note: When there is no sample cell in the compartment, the absorbance may range between -0.075 and -0.081 or so. If this reading does not stay stable between sample analyses, the lamp may not have warmed up sufficiently. Delay further testing until the absorbance readings remain stable.

Analyze standards and samples

1. Transfer digested standard or sample from beaker into the same sample cell used to analyze the blank and zero the instrument. Filter if necessary to remove particulate material or turbidity. Use up 5 ml E-pure water to rinse the beaker (and filter).
2. Repeat steps 2-7 above.
3. Pres **Abs.** and read the absorbance or %T from the display.
4. Empty and rinse the sample cell. Use the same cell for each successive standard and unknown sample.

Appendix D: Excel Calculations

Filter Strip Calculations

	Water Quality Volume	Maximum Discharge loading per foot filter strip	Minimum Width	Depth of flow	Velocity of runoff	Length of strip
	WQ = (1.2)(Rv)(A)/12	q=(0.0237/n)*(s^.5)	W=Qwq /q	0.11	2.03	94.1
	620	0.22	1.67			
	0.095	0.15	0.37			

Rational Method Calculations: Area 1

Storm Events (years)	Peak Discharge	Rainfall Intensity	Runoff Coefficient
100	0.975	2.6	0.15
50	0.975	2.6	
25	0.76875	2.05	
10	0.65625	1.75	
5	0.65625	1.75	
2	0.46875	1.25	
Storm Events (years)	Peak Discharge	Rainfall Intensity	0.2
100	1.3	2.6	
50	1.215	2.43	
25	1.025	2.05	
10	0.875	1.75	
5	0.76	1.52	
2	0.625	1.25	
Storm Events (years)	Peak Discharge	Rainfall Intensity	0.25
100	1.625	2.6	
50	1.51875	2.43	
25	1.28125	2.05	
10	1.09375	1.75	
5	0.95	1.52	
2	0.78125	1.25	
Rational Method			
Q=Peak Discharge (cfs)	0.04875		
C = runoff coeff	0.15		
I = rainfall intensity (inch/hr)	0.13		
A = drainage area (acres)	2.5	62.0967	
	46.313604		

Rational Method Calculations: Area 2

Storm Events (years)	Peak Discharge	Rainfall Intensity	Runoff Coefficient
100	0.585	2.6	0.15
50	0.54675	2.43	
25	0.46125	2.05	
10	0.39375	1.75	
5	0.342	1.52	
2	0.28125	1.25	
Storm Events (years)	Peak Discharge	Rainfall Intensity	0.2
100	0.78	2.6	
50	0.729	2.43	
25	0.615	2.05	
10	0.525	1.75	
5	0.456	1.52	
2	0.375	1.25	
Storm Events (years)	Peak Discharge	Rainfall Intensity	0.25
100	0.975	2.6	
50	0.91125	2.43	
25	0.76875	2.05	
10	0.65625	1.75	
5	0.57	1.52	
2	0.46875	1.25	
Rational Method			
Q=Peak Discharge (cfs)	0.02925		
C = runoff coeff	0.15		
I = rainfall intensity (inch/hr)	0.13		
A = drainage area (acres)	1.5	62.0967	
	15.459961		

Standard 3 Calculations

Simple Dynamic method	**Area 1**		**Area 2**		Required recharge volume Rv (ft^3)
Constants	**Variables**	Soil depth (ft)	**Variables**	Soil depth (ft)	Rv = F x Aimp
Rawls Rate = 1.02	**A soil**	0.05	**A soil**	0.05	F = Target Depth
Sat Hydrolic Cond (2.0-6.0 in/hr)	**B soil**	0.03	**B soil**	0.03	Aimp = impervious area
T assumed 2 hours	**C soil**	0.02	1=(/12)*(E4*43560)	0.97	
D = depth of infiltration	**A Aimp**	0.69	**B Aimp**	0.16	Minimum Required Surface Area SA(ft^2)
K = Ksat = Rawls Rate	**B Aimp**	0.37			A = Rv / (D+KT)
	C Aimp	1.27	**Rv**	209	
			SA	34	
	Rv	1152			
	SA	190			

Standard 4 Calculations

Water Quality Standard 4		**Area 1**	**Area2**
Vwq = Dwq* Aimp (Ft^3)			
Vwq = Required H2O quality volume			
Dwq = Water quality Depth = 1inch	Imp Area (acres)	2.5	1.5
Aimp = Impervious area	Vwq (ft^3)	9075	5445
Design Sizing	Length (ft)	90.75	90.75
Volume/(Depth*Width)	Width (ft)	25	15
	Depth (ft)	4	4

Appendix E: The Initial Liaison Interview

Principle Elements

1. Conduct background research.
2. Prepare an interview plan.
3. Schedule and conduct the interview.
4. Write up an interview summary.
5. Send thank you note to interviewee and a copy of the interview summary to confirm accuracy.

Elements Described

If your liaison does not respond to you in 1 week, follow-up your email with a phone call. Be polite, reiterate the contents of your letter (in summarized form, don't read the letter) and explain that this interview is crucial to keeping your project on schedule. Schedule an interview while on the phone, if possible. When an interview time is set up, confirm the time with a follow-up email. Let me know if you have difficulty getting a response from your liaison.

Conduct Background Research

Review all sources of material you have on your sponsor and the project (e.g., sponsor's web site, previous IQPs, sources from preliminary conceptualization, etc.). You should know as much as you can about your project *before* your interview.

Prepare a semi-structured interview plan

Submit the plan to instructor for feedback and approval **before** conducting the interview!

Based upon our class discussions, readings, and other sources of guidance, prepare a semi-structured interview plan. Your primary objective is to **gather information from your liaison** – you should express your ideas only as absolutely needed to elicit relevant information from them. A semi-structured plan allows you the opportunity to do this and the flexibility to follow threads of information that emerge as a result of your interview. The interview should be comfortable and conversational. This is another reason to do a thorough job of background research, you'll be more comfortable because you'll be confident.

Include in your interview plan:

- Where, when, and with whom the interview will be conducted.
- Which team members will be responsible for various tasks: note-taking, introducing the team, writing the summary, reviewing the summary for factual and grammatical errors, etc.
- The specific kinds of information you will need to collect (question form often works well).
- As a team decide on an interview schedule, which is a general order of questions (i.e., write your questions down in "ideal" order, or organize them thematically with numbers beside indicating question order). Be flexible, though. If the interview flows into questions that are further down on your schedule, do not hesitate to jump around as necessary. It is also good to ask a couple of easy questions up front, just to put you and the respondent at ease.

Interview

Be professional in your dress and manner. Listen carefully. Ask appropriate follow-up questions. Stay on point. Be enthusiastic, but let people finish. End on a positive note.

If your project liaison identifies other people you need to speak to, prepare and conduct the interview ASAP. Preparation for this interview will take less time. Simply modify your general interview schedule to the context of the new contact. Write up a summary of this interview, too. But only flesh out those elements that add to initial liaison interview.

Interview Summary

Immediately following the interview at least 2 team members should write up a summary of the interview. All major points should be summarized. Summaries should be prepared **independently,** then compared and any discrepancies resolved. If any questions remain about the information, note it, and have a team member contact the respondent to clarify his or her position.

Once you agree on an "official" version, you must verify it with the respondent. Prepare an email cover letter to include with the summary. The cover letter should include:

- reconfirmation of your interest in the project;
- a "thank you" for the interview;
- request to review the enclosed summary;
- ask them to clarify any misunderstandings when they speak with you next.

Possible Interview Topics

Here is a **partial** list of topics that in some way you will likely want to discuss. Carefully think about and discuss your questions as a team, and put your interview plan into your own words.

Respondent background

- Role in organization?
- How long in job?
- Other jobs within the organization?

Organization background:

- Mission?
- Methods?
- Funding?
- Resources?
- Organizational structure: chart?
- Key external interest groups?

Project goals and objectives

- What are the short term/long term goals of project for agency? For society?
- How else are you attacking this problem?

Specific outputs of the project

- What tangible outcomes of the project do you envision (reports? New networks? Recommendations? Etc.)

Methodological ideas

- How do you see us accomplishing the project?
- Etc.

Potential problems

- What problems do you envision that we should plan for?
- Are there any project “opponents”?

Who else in the organization should you talk to?

Most practical ways to communicate: phone, email, etc;

Indicate your general schedule, and schedule for interview follow-up.

Appendix F: West Brookfield's Request for Responses

The Commonwealth of Massachusetts

Stormwater Authority

Town of West Brookfield

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2 East Main Street, West Brookfield, MA 01585

Request for Response (RFR)

Document Title: 604(b) Water Quality Management Planning Grant

COMMBUYS Bid#:

March 6, 2015

Please Note: This is a single document associated with a complete Bid (also referred to as Solicitation) that can be found on COMMBUYS (www.COMMBUYS.com). All Bidders are responsible for reviewing and adhering to all information, forms and requirements for the entire Bid, which are all incorporated into the Bid. Bidders may also contact the COMMBUYS Helpdesk at COMMBUYS@state.ma.us or the COMMBUYS Helpline at 1-888-MA-STATE. The Helpline is staffed from 8:00 AM to 5:00 PM Monday through Friday Eastern Standard or Daylight time, as applicable, except on federal, state and Suffolk county holidays.

RFR Introduction and General Description

Procurement Scope and Description

The Commonwealth of Massachusetts Stormwater Authority of West Brookfield is soliciting Bidders for the acquisition of services from ESS Group Inc.

Applicable Procurement Law

This Bid is issued under the following law(s):

MGL c. 7A, § 7; St. 1986 c. 206, § 17; 815 CMR 2.00 (Grants)

Number of awards

The target maximum number of Contractors is One. This is a target number; the SST may award more or fewer, Contracts if it is in the best interests of the Commonwealth to do so.

Adding Contractors after initial Contract award

If, over the life of the Contract, the Strategic Sourcing Team (SST) determines that additional Contractors should be added, these may first be drawn from qualified companies which responded to this Bid but were not awarded contracts. If necessary to meet the requirements of the Commonwealth, the Bid may be reopened to obtain additional Quotes.

Eligible Entities

Any contract resulting from this Bid will be open for use by the Issuing Entity as well as the following other entities:

Ess Group Inc.

Lake Wickaboag Preservation Committee.

The Issuing Entity reserves the right to add or remove additional eligible entities during the contract term. Each eligible entity is responsible for executing its own purchase orders and paying its own invoices for goods and/or services acquired from this Contract. Contractors will be responsible for marketing their goods and/or services to Commonwealth Agencies and other eligible entities.

Acquisition Method(s)

The acquisition method(s) to acquire goods and/or services from this Bid are Outright Purchase, Tax Exempt Lease Purchase (TELP), Term Lease, Fee for Service, and License.

Performance and Payment Time Frames Which Continue Beyond Duration of the Contract.

All term leases, rentals, maintenance or other agreements for services entered into during the duration of this contract and whose performance and payment time frames extend beyond the duration of this contract shall remain in effect for performance and payment purposes (limited to the time frame and services established per each written agreement). No new leases, rentals, maintenance or other agreements for services may be executed after the contract has expired. Any contract termination or suspension pursuant to this section shall not automatically terminate any leases, rentals, maintenance or other agreements for services already in place unless the department also terminates said leases, rentals, maintenance or other agreements for service, which were executed pursuant to the main contract.

Contract Duration

The expected duration of this contract is as follows:

Contract Duration	Number of Options	Number of Years/Months
Initial Duration		**From the execution date through 02/01/2018**
Renewal Options	**One**	**One year**
Total Maximum Contract Duration		**Three years**

No goods may be ordered and no new leases, rentals, maintenance or other agreements for services may be executed after the Contract has expired.

Estimated Value of the Contract

The estimated value of purchase(s) resulting from this Bid is $60,000. The Commonwealth makes no guarantee that any commodities or services will be purchased from any Contract resulting from this Bid. Any estimates or past procurement volumes referenced in this Bid are included only for the convenience of Bidders, and are not to be relied upon as any indication of future purchase levels.

Estimated Procurement Calendar

Procurement Activity	Date
Bid Release Date	March 6, 2015
Physical Bidder's Conference	January 27, 2015
Deadline for Submission of Questions through COMMBUYS "Bid Q&A"	February 27, 2015
Deadline for Quotes/Bid Responses ("Bid Opening Date/Time" in COMMBUYS)	March 27, 2015
Notification of Apparent Successful Bidder(s) (Estimated)	June 2015
Estimated Contract Start Date	Fall 2015

Times are Eastern Standard/Daylight Savings (US), as displayed on the COMMBUYS system clock displayed to Bidders after logging in. If there is a conflict between the dates in this Procurement Calendar and dates in the Bid's Header, the dates in the Bid's Header on COMMBUYS shall prevail. Bidders are responsible for checking the Bid record, including Bid Q&A, on COMMBUYS for Procurement Calendar updates.

Written questions via the Bid Q&A on COMMBUYS

The "Bid Q&A" provides the opportunity for Bidders to ask written questions and receive written answers from the SST regarding this Bid. All Bidders' questions must be submitted through the Bid Q&A found on COMMBUYS (see below for instructions). Questions may be asked only prior to the Deadline for Submission of Questions stated in the Estimated Procurement Calendar. The issuing department reserves the right not to respond to questions submitted after this date. It is the Bidder's responsibility to verify receipt of questions.

Please note that any questions submitted to the SST using any other medium (including those that are sent by mail, fax, email or voicemail, etc.) will not be answered. To reduce the number of redundant or duplicate questions, Bidders are asked to review all questions previously submitted to determine whether the Bidder's question has already been posted.

Bidders are responsible for entering content suitable for public viewing, since all of the questions are accessible to the public. Bidders must not include any information that could be considered personal, security sensitive, inflammatory, incorrect, collusory, or otherwise objectionable, including information about the Bidder's company or other companies. The SST reserves the right to edit or delete any submitted questions that raise any of these issues or that are not in the best interest of the Commonwealth or this Bid.

All answers are final when posted. Any subsequent revisions to previously provided answers will be dated.

It is the responsibility of the prospective Bidder and awarded Contractor to maintain an active registration in COMMBUYS and to keep current the email address of the Bidder's contact person and prospective contract manager, if awarded a contract, and to monitor that email inbox for communications from the Purchasing

Department, including requests for clarification. The Purchasing Department and the Commonwealth assume no responsibility if a prospective Bidder's/awarded Contractor's designated email address is not current, or if technical problems, including those with the prospective Bidder's/awarded Contractor's computer, network or internet service provider (ISP) cause email communications sent to/from the prospective Bidder/Awarded contractor and the Purchasing Department to be lost or rejected by any means including email or spam filtering.

Locating Bid Q&A

Log into COMMBUYS, locate the Bid, acknowledge receipt of the Bid, and scroll down to the bottom of the Bid Header page. The "Bid Q&A" button allows Bidders access to the Bid Q&A page.

Amendment Deadline

The SST reserves the right to make amendments to the Bid after initial publication. It is each Bidder's responsibility to check COMMBUYS for any amendments, addenda or modifications to this Bid, and any Bid Q&A records related to this Bid. The SST and the Commonwealth accepts no responsibility and will provide no accommodation to Bidders who submit a Quote based on an out-of-date Bid or on information received from a source other than COMMBUYS.

Physical Bidders' Conference (in person)

The Bidders' Conference is the physical conference conducted by the SST for the purpose of informing prospective Bidders about general Bid information and answering questions from prospective Bidders. Attendance is optional. Please refer to the COMMBUYS website for any updated information, including the location, time and date of the Bidders' Conference.

Providing Draft Catalog Information / Punchout (G2B) Catalog Enablement

The Contractor will be required to work with the SSSL and COMMBUYS staff to develop the data and/or capabilities for Eligible Entities to place orders from the Contractor through COMMBUYS. <SSSTs are advised to provide ample time for the creation of such catalogs. Use ONE of the four options below based on the catalog type to be used for the Master Blanket Purchase Order resulting from this Bid>

<For catalogs created directly from awarded Quotes> Additional information on this requirement is located in RFR Section <update section number if needed> 3.7 COMMBUYS Catalog Enablement and Updates.

<For catalogs created by the SSSL>Additional information on this requirement is located in RFR Section <update section number if needed> 3.7 COMMBUYS Catalog Enablement and Updates.

Specifications

Additional required terms appear in the Appendices to this RFR.

Bidder Qualifications

Company certifications and affiliations

Authorization letters from Manufacturers or Dealers

Company affiliations

Statutory, certification and license requirements

Company experience

Business background

Years in business

Years in the industry of the Bid

Organizational chart

Financial stability including bankruptcy, litigation and contract defaults

Most current audited annual financial statements

Gross annual revenue for most recently completed fiscal year

Last bankruptcy and current/pending litigation

Defaults on contracts

Current days to pay <supplier invoices>

Date of last order

References and reference information and/or requirements

Largest customers in MA if applicable

Largest state government customers if applicable

Employee requirements

Employee technical/business experience, certifications, licenses

Resumes

Background/CORI check requirements

Commodity Specifications

Functional description

Eligible commodities

Eligible brands and models

Brand name or equal

Unless otherwise specified in this Bid, any reference to a particular trademark, trade name, patent, design, type, specification, producer or supplier is not intended to restrict this Bid to any manufacturer or proprietor or to constitute an endorsement of any commodity or service, and the department may consider clearly identified offers of substantially equivalent commodities and services submitted in response to such reference.

Quantity, size, shape, color, material

Operational, electrical, environmental and other requirements

Performance specifications, durability, disclosures and recalls

Approvals and standards (UL, CE, FCC, FDA, ASTM, IEEE)

Warranties and guarantees

Availability guarantees of service, service parts, accessories and supplies

Upgrades & upgradeability

Operating manuals

Product evaluations and samples

New in the box, most current version and not discontinued by the manufacturer

Open box, remanufactured and refurbished equipment & supplies provisions

Remanufactured or Reconditioned is defined as products or equipment partially or fully manufactured from existing product materials where such materials are cleaned and repaired to the extent possible and reused in the new product or equipment in accordance with the original manufacturer's specifications. All unusable parts are to be removed and replaced with new or remanufactured parts, which meet OEM standards and any governing standards/regulations.

Sample products for evaluation

Service Specifications <select only those items that apply from below>

Rental <include pickup, return & responsibilities>

Lease <include pickup, return & responsibilities>

Tax Exempt Lease Purchase (TELP) <Please note that the Executive Office for Administration and Finance Capital Group must be contacted before a department conducts a solicitation for a TELP>

Loaner Equipment

If the time for warranty or service repairs will exceed the specified time, the Contractor shall provide equivalent loaner equipment upon request by the customer. Loaner equipment shall be provided at no cost, including shipment to the customer's location and return of loaner equipment to the Contractor.

Technical Support

<Describe contact, staffing, times available (e.g. 9AM – 5PM EST), response time (e.g. within x hours), and escalation procedures.>

Capacity plan, resources and infrastructure for this Contract

Capacity plan for meeting the contractual requirements for delivery

Local warehouse, stocking levels and order lead times

Infrastructure including facilities, trucks, equipment and offices

Customer forecasting (Vendor Managed Inventory or VMI)

<describe a process or service for forecasting Commonwealth Agency needs to maintain minimum inventory levels, e.g. Fuel oil keep fill programs, auto replenishment programs>

Emergency response plans/preparedness

In a declared state of emergency where the safety and well-being of Commonwealth citizens are at risk, contractors may be asked to supply the Commonwealth with the commodities and/or services under the Contract on a priority basis. The Bidder's Quote should include the following:

Indicate whether there is a written Continuity of Operations Plan (COOP) that describes how the company will continue to do business in case of an emergency.

A list of emergency contact information including name, position/title, phone, email and cell phone.

A list of the Bidder's building location (s) that would be available to serve the Commonwealth during an emergency.

A description of the areas of Massachusetts that the Bidder could supply in the event of an emergency (e.g., Entire State, Specific City or Region).

This information will not be considered in the evaluation of the Quote.

Design requirements

Pre-installation

Site inspection requirements

Implementation requirements <Contractor and end user>

Installation

Requirements <Contractor and end user>

As built documentation or manuals

Normal work days, holidays and hours

Anticipated service disruption

Post-installation

Clean up

Recycling of packaging

Removal/recycling/disposal/destruction of old equipment and data

Training & training materials

Use of Contractor training facilities

Use of eligible entity facilities

Content, media, delivery and time frames

Ownership and copyright provisions of training materials designed under this Contract

Ownership and rights of copyrighted training materials

Environmental issues to be included in general product/service training (e.g. Energy Star, climate change considerations, recycling of old product, etc.)

Maintenance agreements and eligibility requirements

Time & Material service and repairs

Service Level Agreements (SLAs)

Response time guarantee

Up time guarantee

Maintenance

Quality

SLA Penalties

Geographic service and delivery areas

Disposal services, data erasure, ability to be recycled and end of life requirements

Requirements for consultant <or any other> services

Service parts & service parts warranties

Statement of Work (SOW) requirements

Responsibilities of the user

Responsibilities of the Contractor

Work schedules and performance dates

Scheduled payments

Change management procedures

**Ownership of intellectual property developed under the Contract **

Requirements at Contract or engagement termination

<An agency needs to consider when writing a Bid what if any problems are likely to arise when a Contract or engagement ends. If a future problem is perceived then transition language addressing it should be

incorporated into the Bid. Some items to consider would be requiring cooperation to assure smooth transition, transfer of data to new Contractor, buyout of materials or equipment in place by new Contractor, no restrictions on new Contractor hiring old Contractor's employees, overlapping of Contract time frames, knowledge transfer, allowing for a rolling transfer approach.>

Environmental Specifications

<Minimum environmental specifications are available for dozens of product and service categories. Such specifications may address product / service performance, end-of-life management, disposal/reuse/recycling and other factors. The SST must consult with EPP Program staff to draft the recommended EPP language and ensure that current specifications are included.>

Executive Order 515, Establishing an Environmental Purchasing Policy

Products and services purchased by state agencies must be in compliance with Executive Order 515, issued October 27, 2009. Under this Executive Order, Executive Departments are required to reduce their impact on the environment and enhance public health by procuring environmentally preferable products and services (EPPs) whenever such products and services perform to satisfactory standards and represent best value, consistent with 801 CMR 21.00. In line with this directive, all contracts, whether departmental or statewide, must comply with the specifications and guidelines established by OSD and the EPP Program. EPPs are considered to be products and services that help to conserve natural resources, reduce waste, protect public health and the environment, and promote the use of clean technologies, recycled materials, and less toxic products. Questions concerning the EO or the appropriate specifications may be directed to OSD's EPP Procurement Program, www.mass.gov/epp. The Order can be seen at http://www.mass.gov/Agov3/docs/Executive%20Orders/executive_order_515.pdf.

Environmental plan

Beginning the first year of the Contract and throughout the life of the Contract, awarded Bidders must agree to work with the SST to examine the feasibility of implementing an environmental plan. The objective of this requirement is to actively encourage suppliers to incorporate sustainable practices throughout their business operations and further market such practices to Contract users. Such a plan may include, but not be limited to, the following:

Implementing energy efficiency initiatives at the corporate level in line with Executive Order 484, such as lighting retrofits, purchase of energy from renewable sources, use of bio-heat fuel, and other energy reduction technologies.

Encouraging environmental initiatives at a corporate and/or manufacturing level for the purpose of reducing the impact of manufacturing on the environment; such as clearly identifying recycled content of packaging on the packaging, providing product life cycle assessments, working toward the elimination of ozone depleting chemical usage in the manufacturing or refining process (where applicable), and conducting internal environmental auditing related to pollution control.

Adopting standards and/or obtain certifications, where applicable, for product development and manufacturing processes such as but not limited to LEED, ISO 14001, Cradle to Cradle (C2C) Protocol, Green Seal, Environmental Choice and others.

Using alternative fuel vehicles for delivery or transportation purposes and/or vehicles equipped with diesel emission control devices and operating such vehicles with guidance on anti-idling initiatives.

Working with the SST to develop and distribute information and/or materials to Commonwealth customers on the Awarded Bidder's environmental practices and initiatives throughout the term of the Contract.

Developing a plan to implement the recycling of materials used or produced in normal business operations.

The SST may award points to Bidders who provide evidence that measures and initiatives such as these are already in place within their operations, and/or for written proposals submitted with their Quote detailing a commitment to action contingent upon receipt of a Contract award. (See the Additional Environmentally Preferable Products / Practices form on COMMBUYS).

License Agreements and Service Agreements

<Must be negotiated by SST in advance of use. Such agreements must not conflict with Commonwealth's T & Cs. In general, see OSD and CTR Policy Guidance, "State Finance Law and General Requirements," concerning execution of vendor contracts.>

Compensation Structure/Pricing

Cost tables

Cost will be based solely on the cost tables or catalogs supplied by the Bidder and accepted by the SSST and incorporated into a catalog on COMMBUYS <OR> MSRP (Manufacturer's Suggested Retail Price). Cost tables must contain all goods and services to be provided on this Statewide Contract. Compensation will be based on these cost tables, which will form the basis for the Contractor's catalog in COMMBUYS.

Commodities

ServicesVolume purchase discounts (VPD)

Tiered discounts

Dock Delivery Discounts (DDD)

Cost Plus

Definition of cost <describe how it is measured and whether a percentage or amount is to be added to the cost as a mark-up. Is it supplier's LIFO (Last In, First Out) inventory cost only or is overhead, delivery and burden included in the cost? Bidder to provide a cost breakdown for all deliverables. (See Environmental Section for Life Cycle Cost considerations to include where possible)>

<Bidder to describe and list suppliers, quote process and cost management methods>

<Bidder to describe Bidder's cost basis, such as supplier's discount to Bidder based on annual volumes or one time purchases or "National Corporate Prices" from the suppliers/manufacturers>

<Bidder to describe basis for complete life cycle costs>

Unscheduled updates to commodities/services/pricing process and approvals

Scheduled or automatic price adjustments

Price adjustments based on PPI (Producer Price Index) or CPI (Consumer Price Index)

Fuel surcharge provisions

Shipping FOB Destination

<Freight prepaid or freight allowed or prepay freight & add or freight collect>

Labor rates or project based compensation

<Describe how the Contractor will be compensated for labor>

Unit Rate Compensation and labor categories.

Project Based compensation

Standard labor rates

Prevailing wage

<For services that require the payment of prevailing wages, the Agency must request a prevailing wage schedule for the applicable service(s) from the Department of Labor Standards (DLS).>

<All or part of the service(s) available under this RFR and resulting contract may require the payment of prevailing wages pursuant to G.L. c. 149, Sections 26 through 27D (construction); Section 27F (trucks, vehicles and other equipment performing public works functions (non-construction); Section 27G (moving office furniture) and 27H (state cleaning contracts). The awarding authority has a legal obligation to request a prevailing wage schedule from the Department of Labor Standards (DLS) at www.mass.gov/dols and to ensure that annual updates are requested pursuant to G.L. c. 149 s. 27. In addition, bidders and proposers must agree to comply with the Prevailing Wage Law, as administered by the DLS. Questions regarding the Prevailing Wage Law may be answered by accessing the DLS website at www.mass.gov/dols or by calling the DLS Prevailing Wage Program at (617) 626-6953.>

Union wages

Travel expenses and all other expenses

Commuting expenses

Commuting expenses will not be reimbursed.

Standard Business Expenses

Standard Business Expenses may be allowed with prior authorization from a Commonwealth Agency but in no case will the amount be more than that allowed for Commonwealth of Massachusetts employees. (Search the Human Resources Division (HRD) website at www.mass.gov/hrd for the term "Red Book.")

Reimbursable Expenses

All or some of the expenses below may be allowed with prior authorization from the Commonwealth Agency, but in no case will the amount be more than that allowed for Commonwealth of Massachusetts employees. (Search the Human Resources Division (HRD) website at www.mass.gov/hrd for the term "Red Book.")

Travel

Meals

Lodging

Incidental

Other expenses

Sample Configurations/Scenarios for evaluation

<Describe how to respond and the requirements, for example sample configurations requested for pricing purposes.>

COMMBUYS Catalog Enablement and Updates

<This section addresses additional issues related to catalogs continued from Section 2.6, Providing Draft Catalog Information / Punchout (G2B) Catalog Enablement.>

COMMBUYS enables Eligible Entities to place orders using online catalogs. Contractors will be required to participate in the creation and maintenance of such catalogs as described below. Throughout the life of the contract, the SSST reserves the right to revise COMMBUYS catalog structure and type in order to optimize ordering by Eligible Entities.

<For catalogs created directly from awarded Quotes>

The set of Items published as part of the Bid with pricing provided by the Bidder(s) and accepted by the SSST will become basis for the contract catalog. In order to enable more effective ordering of items covered by the contract, throughout the life of the contract, the Contractor may be required to revise, or assist the SSSL in revising, the item descriptions or other information associated with the Items included in this Bid.

<For catalogs created by the SSSL>

Online catalogs for this contract will be set up by the SSSL based on <edit as appropriate> contract categories, product/service groups submitted by Bidders. In order to enable more effective ordering of items covered by the contract, throughout the life of the contract, the Contractor may be required to assist the SSSL in creating or revising item descriptions or other information associated with the products and/or services included in this Bid.

<For punchout / vendor-created system-hosted catalogs. In addition to the language provided below, this section for punchout catalogs may contain item naming conventions, unit of measure requirements, a link / reference to instructions on the completion of the catalog template in Excel, etc. The development of punchout catalogs must be performed in consultation with the Operational Services Division.>

Contractors wishing to offer Eligible Entities ordering through punchout catalogs hosted on their company websites must meet the following technical requirements:

Have an eCommerce site or commit to complete its development within 30 days after contract award.

The eCommerce site must allow CXML integration and support XML punchout purchase orders.

The eCommerce site must display custom pricing and content for users of this contract.

The eCommerce site must display only products and/or services available on this contract and not display items excluded or not awarded on this contract.

The eCommerce site must allow for contract prices to remain constant even if pricing for the same items changes elsewhere on the site.

The eCommerce site must accept orders with multiple ship-to addresses.

Accept bill-to and ship-to addresses from the order.

Assign a UNSPSC code to each order.

<Additional language for punchout catalogs. One or more of the provisions below may be a requirement for some types of products> It is highly desirable that the punchout catalog provide Eligible Entities the capability to perform the following actions on items prior to including them into the punchout purchase order:

Customize items within the catalog (e.g. changing color, size, custom fabrication, etc.).

Request a quote or special pricing for special order or bulk order items.

Other Terms

Continued qualification based on performance

Reporting.

Contractors are responsible for compliance with all other contract reporting requirements including, but not limited to, Supplier Diversity Program (SDP) and other contract reports, as required by this contract.

Restrictions on Contract use <describe or list excluded commodities and services inside or outside the scope of the Bid, if needed>

Security and confidentiality

The Contractor shall comply fully with all security procedures of the Commonwealth and Commonwealth Agencies in performance of the Contract. The Contractor shall not divulge to third parties any confidential information obtained by the Contractor or its agents, distributors, resellers, subcontractors, officers or employees in the course of performing Contract work, including, but not limited to, security procedures, business operations information, personally identifiable information, or commercial proprietary information in the possession of the Commonwealth Agency.

Orders

<Effective July 1, 2014, all orders will be required to be placed through COMMBUYS.>

Online/web capability

Prior to the Contract Start Date, the Contractor will establish and enable a COMMBUYS-compatible online catalog, which may be hosted in COMMBUYS or by the Contractor. The catalog must utilize the Commonwealth commodity codes based on the United Nations Uniform Product and Service Code (UNSPSC) and must provide Eligible Entities with the capability to order only those products and/or services authorized by the vendor's contract with the Commonwealth from the Contractor using COMMBUYS. The Contractor is required to maintain the catalog for the duration of the contract and must receive prior approval from the SSL before posting any updates or changes to the catalog, which must be consistent with the terms of the contract.

Order procedures

Purchase order form for commodities and/or services

Order cancellations

Shipping, Delivery and Acceptance

Partial Shipments

Shipping methods

Delivery time frames and prior approvals

Acceptance, acceptance testing and inspection

Invoice and payment specifications <include funding restrictions>

Payments <including timeframe, e.g., monthly, weekly, per order>

Incorrect invoice

Payment address

Product returns

Time constraints

Amount of credit including shipping

Payment by credit or check

Return shipping costs or pickup by Contractor

On-site requirements

Security requirements

Use of Contractor owned materials during performance

Entity owned materials during performance

Risk of loss - insurance and performance or surety bonds

Proof of Worker's Compensation and unemployment insurance

Alternatives

Contractors may propose alternatives for equivalent, better or more cost effective performance than specified under the Contractor's original Quote at any time during the life of the Contract.

Failure to perform contractual obligations

Termination

Suspension

Adding additional contractors

Cover/Replacement Costs

Liquidated Damages

Audit

During the term of this Agreement and for a period of six years thereafter, the Town of West Brookfield, its auditors, the Operational Services Division, the Office of the Inspector General or other authorized representatives shall be afforded access at reasonable times to Contractor's accounting records, including sales information on any system, reports or files, in order to audit all records relating to goods sold or services performed pursuant to this Agreement. If such an audit indicates that Contractor has materially overcharged the Town of West Brookfield, then the Contractor shall remit the overcharged amount and be responsible for payment of any costs associated with the audit.

Evaluation criteria

Bidder scores will be used to rank Bidders and will determine which Bidders will proceed to subsequent stages of the evaluation and/or enter into negotiations with the Commonwealth to receive a Contract award.

Mandatory requirements

Mandatory Specifications must be met in order for a Bid to be evaluated and may be used to disqualify Bidders. In addition, certain mandatory specifications have desirable components to them that may be evaluated by the SST. The SST reserves the right, in its discretion, to determine if non-compliance with a Mandatory Specification is insignificant or can be easily corrected.

Bid sections that include terms such as: "must", "shall", "will" and "required" are "mandatory." Failure to meet the requirements of a mandatory specification without providing an alternate that is acceptable to the evaluators may result in the disqualification of a Bidder's proposal.

Desirable specifications

Desirable specifications will be scored according to the Evaluation Criteria.

RFR specifications prefaced with language such as: "desirable", "could," "can," "should," "preferably," "prefers," "suggested," and "requested" identify a desirable or discretionary item or factor that is considered by the Purchaser to be "desirable." The Purchaser has listed all desirable specifications which will receive points in the evaluation criteria.

Alternatives

A Quote which fails to meet any material term or condition of the Bid, including the submission of required attachments, may lose points or be deemed unresponsive and disqualified. Unless otherwise specified, Bidders may submit Quotes proposing alternatives which provide equivalent, better or more cost effective performance than achievable under the stated Bid specifications. These alternatives may include related commodities or services that may be available to enhance performance during the period of the Contract. The Quote should describe how any alternative achieves substantially equivalent or better performance to that of the Bid specifications.

The SST will determine if a proposed alternative method of performance achieves substantially equivalent or better performance. The goal of this Bid is to provide the best value of commodities and/or services to achieve the goals of the procurement.

Evaluation Components

The following components will be some of the criteria considered by the SST when evaluating each Quote:

Price

Please note that price will carry a significant weight in the evaluation process.

The following price components will be evaluated:

Volume purchase discounts

Tiered discounts

Cost plus mark-up percentage

Cost plus mark-up amount

Dock Delivery Discounts

Prompt Pay Discounts (PPD)

Time limited specials

Supplier Diversity Plan (formerly Affirmative Market Plan) (minimum of 10% weight)

Bidders responding to this RFR are required to submit a Supplier Diversity Plan. Requirements for the Supplier Diversity Plan are included in Section 9.

Company certifications and affiliations

Company experience

Financial stability including DUNS Reports, bankruptcy, litigation and contract defaults

References and reference information and/or requirements

Employee requirements

Capacity plan, resources and infrastructure for this Contract

Customer forecasting

Environmental specifications

Online/web capability

Samples for evaluation

Other desirable or optional specifications

HOW TO SUBMIT A quote

All Bidders may begin creating and compiling Quote materials as soon as the Bid with all attachments is in the Sent document status. Bidders are instructed not to submit Quotes before the Bid Amendment Deadline has been reached (see Estimated Procurement Calendar).

Quote Submission Method

Online Quote Submission via COMMBUYS is required.

All Bidders must submit Quotes online using tools available only to Sellers registered in COMMBUYS. COMMBUYS provides Seller registration functionality at no charge. To register, go to www.COMMBUYS.com and click on the "Register" link on the front page. All Bidders who are awarded a contract resulting from this Bid, if any, will be required to maintain an active account during the duration of the Contract, by reviewing their registration information regularly and maintaining its accuracy.

COMMBUYS Quote Submission Training and Instructions

The following resources are provided to assist Bidders in submitting Quotes:

Appendix 5 Instructions for Vendors Responding to Bids Electronically through COMMBUYS, which is part of this document;

Training sessions focused on online Quote submission, if offered, are noted in the Estimated Procurement Calendar;

An online job aid on How to Create a Quote;

Webcast video on How to Find Bids (Solicitations) and Submit Quotes (Responses) through COMMBUYS.

COMMBUYS Support

Technical assistance is available during the procurement process. Every effort is made to respond to inquiries within one business day.

Website: Go to www.mass.gov/osd/commbuys and select the COMMBUYS Resource Center link offered under Key Resources.

Email: Send inquiries to the COMMBUYS Helpdesk at COMMBUYS@state.ma.us

Telephone: Call the COMMBUYS Help Desk at 1-888-MA-STATE (1-888-627-8283). The Help Desk is staffed from 8:00 AM to 5:00 PM Monday through Friday Eastern Standard or Daylight time, as applicable, except on federal and state holidays.

Bidders are advised that COMMBUYS will be unavailable during regularly scheduled maintenance hours of which all users will be notified.

Bid Opening Date/Time

All Bids must be received by the Operational Services Division before the specified date, month, year and time displayed as the Bid Opening Date/Time in the Header Information section of the Bid in COMMBUYS. Times are Eastern Standard/Daylight Savings (US), as applicable. All Bidders are advised to allow adequate time for

submission by considering potential online submission impediments like Internet traffic, Internet connection speed, file size, and file volume. OSD is not responsible for delays encountered by Bidders or their agents, or for a Bidder's local hardware failures, such as computers or related networks, associated with bid compilation or submission. Bids submitted via COMMBUYS are time stamped by the COMMBUYS system clock which is considered the official time of record.

Quote Contents

Bidders must comply with the requirements below.

RFR Submission Checklist

Strategic Sourcing Services Teams seek to reduce the number of Bidder disqualifications based on incomplete submissions. Therefore, Bidders must complete and submit the RFR Submission Checklist and all documents referenced in the Checklist.

Electronic Signatures

Quotes submitted via COMMBUYS must be signed electronically by the Bidder or the Bidder's Agent by accepting the terms and conditions of the bid on the "Terms & Conditions" tab of the Bid in COMMBUYS. By selecting "Save & Continue" on the "Terms and Conditions" tab after accepting the terms and conditions of the bid, the submitter attests that s/he is an agent of the Bidder with authority to sign on the Bidder's behalf, and that s/he has read and assented to each document's terms.

Ink Signatures

Original ink signatures are required only after contracts have been awarded. The Commonwealth of Massachusetts requires Contractors to submit original ink-signature versions of the following forms:

Standard Contract Form

Commonwealth Terms and Conditions

Contractor Authorized Signatory Listing

Request for Taxpayer Identification and Verification (Mass. Substitute W9 Form)

Electronic Funds Transfer Sign Up Form

Successful Bidders who agreed to the terms and conditions of these forms electronically via COMMBUYS online Quote submission tool must still submit the above forms with ink signatures within seven (7) calendar days of award notification or their contract may not be executed by the Commonwealth. Bidders who have previous contract(s) with the Commonwealth and have up-to-date, ink-signature versions of the Commonwealth Terms and Conditions and Request for Taxpayer Identification and Verification (Mass. Substitute W9 Form) on file with the Office of the State Comptroller may submit copies of the signed forms. However, a new Standard Contract Form and Contractor Authorized Signatory Listing with original ink signatures must be submitted for each new contract with the Commonwealth.

Limits and Restrictions

Document Pages

<SSST should decide whether to set page limits and, if so, include language, such as: Bidders should submit no more than _____ double-sided pages (excluding the required forms and attachments) of narrative in response to

the questions asked and information requested. If Bidders exceed the page limits, the SSST may make provisions to penalize the Bidder in the Evaluation Criteria, read and evaluate only those pages up to the page limit referenced above or take other steps as determined by the SSST.>

File Naming Conventions

Files submitted via COMMBUYS must follow the file naming convention specified below. The Description entered during the file upload process ensures each file is readily identified by Company Name and content. The File Name assigned by the Bidder as stored on their computer or network must be structured such that each file can be processed by the upload tool. The upload tool will reject any file name that includes spaces or symbols, like the brackets [ ] some systems apply when files are downloaded from the Internet.

RFR Section or Quote Component	Description Enter in COMMBUYS during upload	File Name Assign when creating files
Section 1 Organizational Chart	Company Name Org Chart	CompanyName_Org.doc
Section 2 Marketing Materials	Company Name Marketing Brochure Company Name Marketing Print Ad Company Name Marketing Postcard	CompanyName_MktBroch.doc CompanyName_MktPrint.doc CompanyName_MktPost.doc
Section 3 Pricing	Company Name Pricing	CompanyName_Price.xls
Section 3.8 SDP Plan	Company Name SDP Form 1	CompanyName_SDPform1.doc
Section 4 Implementation Plan	Company Name Implementation Plan	CompanyName_Imp.doc
Section 5 Product Catalogs	Company Name Footwear Catalog Company Name Clothing Catalog Part 1 Company Name Clothing Catalog Part 2	CompanyName_FootCat.pdf CompanyName_ClothCat1.pdf CompanyName_ClothCat2.pdf

File Size Limits

The system will not accept files that approach or exceed 10 MB. If a large file fails to upload, the Bidder must save the contents as multiple files. Note the naming convention used above which illustrates distinguishing multi-part files through use of Part 1, Part 2, etc. If a large file fails to upload, bidders must break up the file and append _Part1, _Part2 to the end of the Description and File Name.

File Format Restrictions

All scanned documents must be in .pdf or .gif format, and must be scanned in such a way that they can be read on a computer monitor and printed on 81/2" x 11" paper, unless otherwise specified. Forms provided for the Bidder to complete, with the exception of the forms requiring ink signatures, must be completed and submitted in their original formats, NOT scanned and submitted as PDF or other file types.

Documents and items that cannot be submitted electronically

Documents and items that cannot be submitted electronically, like confidential business references submitted by the reference, or requests for material samples, respectively, must be submitted to the following address in accordance with all of the Quote submission requirements including Bid Opening Date/Time, Bid Package and Environmental Response Submission Compliance provisions.

Withdrawing a Quote

Prior to Bid Opening Date/Time

Quotes may be withdrawn using the "Withdraw Quote" button offered under the Summary tab of a submitted Quote.

After Bid Opening Date/Time

No Quote can be withdrawn after the Bid Opening Date/Time. If the Bidder wants to remove a Quote from consideration, contact the Strategic Sourcing Services Lead for guidance.

Additional Quote Terms

Prohibition regarding contract terms

Bidders must not, as part of their Quote, propose additional contractual terms, or supplemental or clarifying language pertaining to contractual terms, even if the proposed additions/clarifications are not in conflict with the Commonwealth Terms and Conditions, the Standard Contract Form, or other documents comprising this RFR. It is essential for Contracting Departments that all contractors' Statewide Contracts can be depended upon to incorporate the same terms and only those terms. Contractors who wish to propose additional non-conflicting contractual terms, or supplemental or clarifying language, may do so ONLY on a case-by-case basis, negotiated for each specific engagement and memorialized in the Project Statement of Work.

Bidder Response Form

All specifications of this RFR that are not mandatory such as those specifically identified as "optional," "desirable" or in other terms indicating that the specification is not mandatory must have a response within the Bidder Response Form (or equivalent) provided on COMMBUYS for this Bid in order to be evaluated. Most items within the Bidder Response Form will be scored to determine the apparent successful bidders. The SSST does not want and will not read, consider or evaluate a line by line response to this RFR.

Appendix 1 – Required Terms for all RFRs

General Procurement Information

Alterations

Bidders may not alter (manually or electronically) the Bid language or any Bid component files, except as directed in the RFR. Modifications to the body of the Bid, specifications, terms and conditions, or which change the intent of this Bid are prohibited and may disqualify a Quote.

Ownership of Submitted Quotes

The SST shall be under no obligation to return any Quotes or materials submitted by a Bidder in response to this Bid. All materials submitted by Bidders become the property of the Commonwealth of Massachusetts and will not be returned to the Bidder. The Commonwealth reserves the right to use any ideas, concepts, or configurations that are presented in a Bidder's Quote, whether or not the Quote is selected for Contract award.

Quotes stored on COMMBUYS in the encrypted lock-box are the file of record. Bidders retain access to a read-only copy of this submission via COMMBUYS, as long as their account is active. Bidders may also retain a traditional paper copy or electronic copy on a separate computer or network drive or separate media, such as CD or DVD, as a backup.

Prohibitions

Bidders are prohibited from communicating directly with any employee of the procuring Department or any member of the SST regarding this RFR except as specified in this RFR, and no other individual Commonwealth employee or representative is authorized to provide any information or respond to any question or inquiry concerning this RFR. Bidders may contact the contact person using the contact information provided in the Header Information this Bid in the event that this RFR is incomplete or information is missing. Bidders experiencing technical problems accessing information or attachments stored on COMMBUYS should contact the COMMBUYS Helpdesk (see the document cover page for contact information).

In addition to the certifications found in the Commonwealth's Standard Contract Form, by submitting a Quote, the Bidder certifies that the Quote has been arrived at independently and has been submitted without any communication, collaboration, or without any agreement, understanding or planned common course or action with, any other Bidder of the commodities and/or services described in the RFR.

Terms and Requirements Pertaining to Awarded Contracts

Commonwealth Tax Exemption

Invoices or invoices submitted to Massachusetts government entities must not include sales tax.

Contractor's Contact Information

It is the Contractor's responsibility to keep the Contractor's Contract Manager information current. If this information changes, the Contractor must notify the Contract Manager by email immediately, using the address located in the Header Information of the Purchase Order or Master Blanket Purchase Order on COMMBUYS.

The Commonwealth assumes no responsibility if a Contractor's designated email address is not current, or if technical problems, including those with the Contractor's computer, network or internet service provider (ISP), cause e-mail communications between the Bidder and the SST to be lost or rejected by any means including email or spam filtering.

Contractual Status of Orders and Service Contracts

Orders or service contracts placed under the Contract established as a result of this Bid by Eligible Entities shall be considered separate Contracts between the Eligible Entity and the Contractor, and shall be deemed to incorporate all of the terms and conditions of the Contract. Nothing contained in any order or service contract shall amend or vary the terms of the Contract. Additional terms which do not conflict with the Commonwealth's Terms and Conditions, the Massachusetts Standard Contract Form, this Bid and any amendments, or the Bidder's Quote, may be included in an order or service contract if mutually agreed upon by the Contractor and eligible entity.

Publicity

Any Contractor awarded a contract under this Bid is prohibited from selling or distributing any information collected or derived from the Contract, including lists of participating Eligible Entities, Commonwealth employee names, telephone numbers or addresses, or any other information except as specifically authorized by the SST.

Appendix 2 - RFR - Required Specifications

In general, most of the required contractual stipulations are referenced in the Standard Contract Form and Instructions and the Commonwealth Terms and Conditions (either version). However, the following RFR provisions must appear in all Commonwealth competitive procurements conducted under 801 CMR 21.00:

The terms of 801 CMR 21.00: Procurement of Commodities and Services (and 808 CMR 1.00: Compliance, Reporting and Auditing for Human and Social Services, if applicable) are incorporated by reference into this RFR. Words used in this RFR shall have the meanings defined in 801 CMR 21.00 (and 808 CMR 1.00, if applicable). Additional definitions may also be identified in this RFR. Other terms not defined elsewhere in this document may be defined in OSD's Glossary of Terms. Unless otherwise specified in this RFR, all communications, responses, and documentation must be in English, all measurements must be provided in feet, inches, and pounds and all cost proposals or figures in U.S. currency. All responses must be submitted in accordance with the specific terms of this RFR.

Items with the text, "☞ Required for POS Only" specify a requirement for Purchase of Service (POS) human and social services procured under 801 CMR 21.00, Procurement of Commodities or Services, Including Human and Social Services and 808 CMR 1.00, Compliance, Reporting and Auditing for Human and Social Service.

COMMBUYS Market Center. COMMBUYS is the official source of information for this Bid and is publicly accessible at no charge at www.commbuys.com. Information contained in this document and in COMMBUYS, including file attachments, and information contained in the related Bid Questions and Answers (Q&A), are all components of the Bid, as referenced in COMMBUYS, and are incorporated into the Bid and any resulting contract.

Bidders are solely responsible for obtaining all information distributed for this Bid via COMMBUYS. Bid Q&A supports Bidder submission of written questions associated with a Bid and publication of official answers.

It is each Bidder's responsibility to check COMMBUYS for:

Any amendments, addenda or modifications to this Bid, and

Any Bid Q&A records related to this Bid.

The Commonwealth accepts no responsibility and will provide no accommodation to Bidders who submit a Quote based on an out-of-date Bid or on information received from a source other than COMMBUYS.

COMMBUYS Registration. Bidders may elect to obtain a free COMMBUYS Seller registration which provides value-added features, including automated email notification associated with postings and modifications to COMMBUYS records. However, in order to respond to a Bid, Bidders must register and maintain an active COMMBUYS Seller account.

All Bidders submitting a Quote (previously referred to as Response) in response to this Bid (previously referred to as Solicitation) agree that, if awarded a contract: (1) they will maintain an active seller account in COMMBUYS; (2) they will, when directed to do so by the procuring entity, activate and maintain a COMMBUYS-enabled catalog using Commonwealth Commodity Codes; (3) they will comply with all requests by the procuring entity to utilize COMMBUYS for the purposes of conducting all aspects of purchasing and invoicing with the Commonwealth, as added functionality for the COMMBUYS system is activated; (4) Bidder understands and acknowledges that all references to the Comm-PASS website or related requirements throughout this RFR, shall be superseded by comparable requirements pertaining to the COMMBUYS website; and (6) in the event the Commonwealth adopts an alternate market center system, successful Bidders will be required to utilize such system, as directed by the procuring entity. Commonwealth Commodity Codes are based on the United Nations Standard Products and Services Code (UNSPSC).

The COMMBUYS system introduces new terminology, which bidders must be familiar with in order to conduct business with the Commonwealth. To view this terminology and to learn more about the COMMBUYS system, please visit the COMMBUYS Resource Center.

Multiple Quotes. Bidders may not submit Multiple Quotes in response to a Bid unless the RFR authorizes them to do so. If a Bidder submits multiple quotes in response to an RFR that does not authorize multiple responses, only the latest dated quote submitted prior to the bid opening date will be evaluated.

Quote Content. Bid specifications for delivery, shipping, billing and payment will prevail over any proposed Bidder terms entered as part of the Quote, unless otherwise specified in the Bid.

Supplier Diversity Program (SDP). Massachusetts Executive Order 524 established a policy to promote the award of state contracts in a manner that develops and strengthens Minority and Women Business Enterprises (M/WBEs) that resulted in the Supplier Diversity Program in Public Contracting. M/WBEs are strongly encouraged to submit responses to this RFR, either as prime vendors, joint venture partners or other type of business partnerships. Similarly, Executive Order 546 established the Service-Disabled Veteran-Owned Business Enterprise (SDVOBE) Program to encourage the participation of businesses owned and controlled by service-disabled veterans in all areas of state procurement and contracting, thereby including them in the SDP. All bidders must follow the requirements set forth in the SDP section of the RFR, which will detail the specific requirements relating to the prime vendor's inclusion of M/WBEs and/or SDVOBEs. Bidders are required to develop creative initiatives to help foster new business relationships with M/WBEs and/or SDVOBEs within the primary industries affected by this RFR. In order to satisfy the compliance of this section and encourage bidder's participation of SDP objectives, the Supplier Diversity Program (SDP) Plan for large procurements greater than $150,000 will be evaluated at 10% or more of the total evaluation. Once an SDP commitment, expressed as a percentage of contract revenues, is approved, the agency will then monitor the contractor's performance, and use actual expenditures with SDO certified M/WBE contractors and the Center for Veterans Enterprise certified SDVOBEs to fulfill their own SDP expenditure benchmarks. M/WBE and SDVOBE participation must be incorporated into and monitored for all types of procurements regardless of size; however, submission of an SDP Plan is mandated only for large procurements over $150,000.

Unless otherwise specified in the RFR, the following SDP forms are required to be submitted by the deadlines noted below in order to meet the mandatory participation requirements of the SDP:

SDP Plan Form #/Name	Submitted By	When Submitted
SDP Plan Form #1 – SDP Plan Commitment	All Bidders	With Bid Response
SDP Plan Form #2 – Declaration of SDP Partners	Newly Awarded Contractors	Within 30 days of contract execution
SDP Plan Form #3 – SDP Spending Report	Contractors	Within 45 days of the end of each quarter

Supplier Diversity Program (SDP) Resources:

Resources available to assist Prime Bidders in finding potential Minority Business Enterprises (MBE) and Women Business Enterprises (WBE) partners can be found at: www.mass.gov/sdp

Resources available to assist Prime Bidders in finding potential Service-Disabled Veteran-Owned Business Enterprise (SDVOBE) partners can be found on the Operational Services Division's SDO webpage at: www.mass.gov/sdo

The Operational Services Division's Supplier Diversity Program offers training on the SDP Plan requirements. The dates of upcoming trainings can be found at: http://www.mass.gov/anf/budget-taxes-and-procurement/procurement-info-and-res/osd-events-and-training/osd-training-and-outreach.html In addition, the SDP Webinar can be located on the SDP website at www.mass.gov/SDP.

Supplier Diversity Program Subcontracting Policies. In addition to the Subcontracting Policies (See Subcontracting Policies section below and see Section 9, Subcontracting By Contractor, in the Commonwealth Terms and Conditions) that apply to all subcontracted services, agencies may define specific required deliverables for a contractor's SDP Plan, including, but not limited to, documentation necessary to verify subcontractor commitments and expenditures with Minority- or Women-Owned Business Enterprises (M/WBEs) and Service-Disabled Veteran-Owned Business Enterprises (SDVOBE) for the purpose of monitoring and enforcing commitments made in a contractor's Supplier Diversity Program (SDP) Plan.

Agricultural Products Preference (only applicable if this is a procurement for Agricultural Products) - Chapter 123 of the Acts of 2006 directs the State Purchasing Agent to grant a preference to products of agriculture grown or produced using locally grown products. Such locally grown or produced products shall be purchased unless the price of the goods exceeds the price of products of agriculture from outside the Commonwealth by more than 10%. For purposes of this preference, products of agriculture are defined to include any agricultural, aquacultural, floricultural or horticultural commodities, the growing and harvesting of forest products, the raising of livestock, including horses, raising of domesticated animals, bees, fur-bearing animals and any forestry or lumbering operations.

Best Value Selection and Negotiation. The Strategic Sourcing Team or SST (formerly referred to as Procurement Management Team or PMT) may select the response(s) which demonstrates the best value overall, including proposed alternatives that will achieve the procurement goals of the department. The SST and a selected bidder, or a contractor, may negotiate a change in any element of contract performance or cost identified in the original RFR or the selected bidder's or contractor's response which results in lower costs or a more cost effective or better value than was presented in the selected bidder's or contractor's original response.

Bidder Communication. Bidders are prohibited from communicating directly with any employee of the procuring department or any member of the SST regarding this RFR except as specified in this RFR, and no other individual Commonwealth employee or representative is authorized to provide any information or respond to any question or inquiry concerning this RFR. Bidders may contact the contact person for this RFR in the event this RFR is incomplete or the bidder is having trouble obtaining any required attachments electronically through COMMBUYS.

Contract Expansion. If additional funds become available during the contract duration period, the department reserves the right to increase the maximum obligation to some or all contracts executed as a result of this RFR or to execute contracts with contractors not funded in the initial selection process, subject to available funding, satisfactory contract performance and service or commodity need.

Costs. Costs which are not specifically identified in the bidder's response, and accepted by a department as part of a contract, will not be compensated under any contract awarded pursuant to this RFR. The Commonwealth will not be responsible for any costs or expenses incurred by bidders responding to this RFR.

Debriefing. ☞ Required for POS Only. This is an optional specification for non-POS RFRs. Non-successful bidders may request a debriefing from the department that issued the RFR. Department debriefing procedures may be found in the RFR. Non-successful POS bidders aggrieved by the decision of a department must participate in a debriefing as a prerequisite to an administrative appeal.

Debriefing/Appeals: Administrative Appeals to Departments. ☞ Required for POS Only. Not applicable to non-POS bidders. Non-successful bidders who participate in the debriefing process and remain aggrieved with the decision of the department may appeal that decision to the department head. Department appeal procedures may be found in the RFR.

Debriefing/Appeals: Administrative Appeals to OSD. ☞ Required for POS Only. Not applicable to non-POS bidders. Non-successful bidders who participate in the department appeal process and remain aggrieved by the selection decision of the department may appeal the department decision to the Operational Services Division. The basis for an appeal to OSD is limited to the following grounds:

The competitive procurement conducted by the department failed to comply with applicable regulations and guidelines. These would be limited to the requirements of 801 CMR 21.00 or any successor regulations, the policies in the OSD Procurement Information Center, subsequent policies and procedures issued by OSD and the specifications of the RFR; or

There was a fundamental unfairness in the procurement process. The allegation of unfairness or bias is one that is easier to allege than prove, consequently, the burden of proof rests with the bidder to provide sufficient and specific evidence in support of its claim. OSD will presume that departments conducted a fair procurement absent documentation to the contrary.

Requests for an appeal must be sent to the attention of the Operational Services Division, Legal, Policy and Compliance Office, Room 1017, One Ashburton Place, Boston, MA 02108 and be received within fourteen (14) calendar days of the postmark of the notice of the department head's decision on appeal. Appeal requests must specify in sufficient detail the basis for the appeal. Sufficient detail requires a description of the published policy or procedure which was applied and forms the basis for the appeal and presentation of all information that

supports the claim under paragraphs 1 or 2 above. OSD reserves the right to reject appeal requests based on grounds other than those stated above or those submitted without sufficient detail on the basis for the appeal.

The decision of the Operational Services Division shall be rendered, in writing, setting forth the grounds for the decision within sixty (60) calendar days of receipt of the appeal request. Pending appeals to the Operational Services Division shall not prohibit the department from proceeding with executing contracts.

Electronic Communication/Update of Bidder's/Contractor's Contact Information. It is the responsibility of the prospective bidder and awarded contractor to keep current on COMMBUYS the email address of the bidder's contact person and prospective contract manager, if awarded a contract, and to monitor that email inbox for communications from the SST, including requests for clarification. The SST and the Commonwealth assume no responsibility if a prospective bidder's/awarded contractor's designated email address is not current, or if technical problems, including those with the prospective bidder's/awarded contractor's computer, network or internet service provider (ISP) cause email communications sent to/from the prospective bidder/awarded contractor and the SST to be lost or rejected by any means including email or spam filtering.

Electronic Funds Transfer (EFT). All bidders responding to this RFR must agree to participate in the Commonwealth Electronic Funds Transfer (EFT) program for receiving payments, unless the bidder can provide compelling proof that it would be unduly burdensome. EFT is a benefit to both contractors and the Commonwealth because it ensures fast, safe and reliable payment directly to contractors and saves both parties the cost of processing checks. Contractors are able to track and verify payments made electronically through the Comptroller's Vendor Web system. A link to the EFT application can be found on the OSD Forms page (www.mass.gov/osd). Additional information about EFT is available on the VendorWeb site (www.mass.gov/osc). Click on MASSfinance.

Successful bidders, upon notification of contract award, will be required to enroll in EFT as a contract requirement by completing and submitting the Authorization for Electronic Funds Payment Form to this department for review, approval and forwarding to the Office of the Comptroller. If the bidder is already enrolled in the program, it may so indicate in its response. Because the Authorization for Electronic Funds Payment Form contains banking information, this form, and all information contained on this form, shall not be considered a public record and shall not be subject to public disclosure through a public records request.

The requirement to use EFT may be waived by the SST on a case-by-case basis if participation in the program would be unduly burdensome on the bidder. If a bidder is claiming that this requirement is a hardship or unduly burdensome, the specific reason must be documented in its response. The SST will consider such requests on a case-by-case basis and communicate the findings with the bidder.

Environmental Response Submission Compliance. In the event that paper submissions are required and in an effort to promote greater use of recycled and environmentally preferable products and minimize waste, all required paper responses that are submitted should comply with the following guidelines:

All copies should be printed double sided.

All submittals and copies should be printed on recycled paper with a minimum post-consumer content of 30% or on tree-free paper (i.e. paper made from raw materials other than trees, such as kenaf). To document the use of such paper, a photocopy of the ream cover/wrapper should be included with the response.

Unless absolutely necessary, all responses and copies should minimize or eliminate use of non-recyclable or non re-usable materials such as plastic report covers, plastic dividers, vinyl sleeves and GBC binding. Three ringed binders, glued materials, paper clips and staples are acceptable.

Bidders should submit materials in a format which allows for easy removal and recycling of paper materials.

Bidders are encouraged to use other products which contain recycled content in their response documents. Such products may include, but are not limited to, folders, binders, paper clips, diskettes, envelopes, boxes, etc. Where appropriate, bidders should note which products in their responses are made with recycled materials.

Unnecessary samples, attachments or documents not specifically asked for should not be submitted.

Executive Order 509, Establishing Nutrition Standards for Food Purchased and Served by State Agencies. Food purchased and served by state agencies must be in compliance with Executive Order 509, issued in January 2009. Under this Executive Order, all contracts resulting from procurements posted after July 1, 2009 that involve the purchase and provision of food must comply with nutrition guidelines established by the Department of Public Health (DPH). The nutrition guidelines are available at the Department's website: Executive Order # 509 Guidance.

Filing Requirements. ☞ Required for POS Only. Not applicable to non-POS bidders. Successful bidders must have filed their Uniform Financial Statements and Independent Auditor's Report (UFR), as required for current contractors, with the Operational Services Division via the Internet using the UFR eFiling application for the most recently completed fiscal year before a contract can be executed and services may begin. Other contractor qualification/risk management reporting requirements and non-filing consequences promulgated by secretariats or departments pursuant to 808 CMR 1.04(3) may also apply. In the event immediate services are required by a department, a contract may be executed and services may begin with the approval of OSD and the appropriate secretariat. However, unless authorized by OSD and the appropriate secretariat, the contractor will not be paid for any such services rendered until the UFR has been filed.

HIPAA: Business Associate Contractual Obligations. Bidders are notified that any department meeting the definition of a Covered Entity under the Health Insurance Portability and Accountability Act of 1996 (HIPAA) will include in the RFR and resulting contract sufficient language establishing the successful bidder's contractual obligations, if any, that the department will require in order for the department to comply with HIPAA and the privacy and security regulations promulgated thereunder (45 CFR Parts 160, 162, and 164) (the Privacy and

Security Rules). For example, if the department determines that the successful bidder is a business associate performing functions or activities involving protected health information, as such terms are used in the Privacy and Security Rules, then the department will include in the RFR and resulting contract a sufficient description of business associate's contractual obligations regarding the privacy and security of the protected health information, as listed in 45 CFR 164.314 and 164.504 (e), including, but not limited to, the bidder's obligation to: implement administrative, physical, and technical safeguards that reasonably and appropriately protect the confidentiality, integrity, and availability of the protected health information (in whatever form it is maintained or used, including verbal communications); provide individuals access to their records; and strictly limit use and disclosure of the protected health information for only those purposes approved by the department. Further, the department reserves the right to add any requirement during the course of the contract that it determines it must include in the contract in order for the department to comply with the Privacy and Security Rules. Please see other sections of the RFR for any further HIPAA details, if applicable.

Minimum Quote (Bid Response) Duration. Bidders Quotes made in response to this Bid must remain in effect for at least 90 days from the date of quote submission.

Prompt Payment Discounts (PPD). All bidders responding to this procurement must agree to offer discounts through participation in the Commonwealth Prompt Payment Discount (PPD) initiative for receiving early and/or on-time payments, unless the bidder can provide compelling proof that it would be unduly burdensome. PPD benefits both contractors and the Commonwealth. Contractors benefit by increased, usable cash flow as a result of fast and efficient payments for commodities or services rendered. Participation in the Electronic Funds Transfer initiative further maximizes the benefits with payments directed to designated accounts, thus eliminating the impact of check clearance policies and traditional mail lead time or delays. The Commonwealth benefits because contractors reduce the cost of products and services through the applied discount. Payments that are processed electronically can be tracked and verified through the Comptroller's Vendor Web system. The PPD form can be found as an attachment for this Bid on COMMBUYS.

Bidders must submit agreeable terms for Prompt Payment Discount using the PPD form within their proposal, unless otherwise specified by the SST. The SST will review, negotiate or reject the offering as deemed in the best interest of the Commonwealth.

The requirement to use PPD offerings may be waived by the SST on a case-by-case basis if participation in the program would be unduly burdensome on the bidder. If a bidder is claiming that this requirement is a hardship or unduly burdensome, the specific reason must be documented in or attached to the PPD form.

Provider Data Management. ☞ Required for POS Only. Not applicable to non-POS bidders. The Executive Office of Health and Human Services (EOHHS) has established a Provider Data Management (PDM) business service that is integrated into the Virtual Gateway. PDM is accessible by providers with current POS contracts. Departments may require that bidders with current POS contracts submit certain RFR-required documents through PDM. These documents have been specified in the RFR. When submitting documents via PDM, bidders

are required to print and sign a PDM Documentation Summary. PDM users should verify that all information is accurate and current in PDM. Bidders are required to include the signed PDM Documentation Summary in their RFR response.

Public Records. All responses and information submitted in response to this RFR are subject to the Massachusetts Public Records Law, M.G.L., c. 66, s. 10, and to c. 4, s. 7, ss. 26. Any statements in submitted responses that are inconsistent with these statutes shall be disregarded.

Reasonable Accommodation. Bidders with disabilities or hardships that seek reasonable accommodation, which may include the receipt of RFR information in an alternative format, must communicate such requests in writing to the contact person. Requests for accommodation will be addressed on a case by case basis. A bidder requesting accommodation must submit a written statement which describes the bidder's disability and the requested accommodation to the contact person for the RFR. The SST reserves the right to reject unreasonable requests.

Restriction on the Use of the Commonwealth Seal. Bidders and contractors are not allowed to display the Commonwealth of Massachusetts Seal in their bid package or subsequent marketing materials if they are awarded a contract because use of the coat of arms and the Great Seal of the Commonwealth for advertising or commercial purposes is prohibited by law.

Subcontracting Policies. Prior approval of the department is required for any subcontracted service of the contract. Contractors are responsible for the satisfactory performance and adequate oversight of its subcontractors. Human and social service subcontractors are also required to meet the same state and federal financial and program reporting requirements and are held to the same reimbursable cost standards as contractors.

Workplace Violence and Prevention and Crisis Response Plan. ☞ Required for POS Only. Not applicable to non-POS bidders. 101 CMR 19.00, Workplace Violence and Prevention and Crisis Response Plan, governs the procedures and criteria for workplace violence prevention and response plans for programs that provide direct services to clients that are operated, licensed, certified or funded by a department, commission, office, board, division, institution or other entity within the Executive Office of Health and Human Services under M.G.L. c. 6A § 16. Any direct service program that contracts with the Executive Office of Health and Human Services (EOHHS) or the constituent agencies of EOHHS must comply with 101 CMR 19.00, including having a plan that meets the criteria set forth in 101 CMR 19.04, which is updated annually, available electronically and provided to any human service worker upon request. The regulations and response plan guidelines are available at the following web site: www.mass.gov/hhs/HSW-safety-regs

Appendix 3 - Other Specifications

The following RFR provisions appear in this section at the department's discretion. If a specification is selected by the department, it is required of the bidder.

Emergency Standby Commodities and/or Services. Due to a declaration of a state of emergency where the safety and well-being of Commonwealth citizens are at risk, the Commonwealth of Massachusetts may request specific commodities and/or services from its contractors. Contractors may be called upon to supply and/or deliver to the Commonwealth on a priority basis such commodities and/or services currently under contract.

Such accommodations may be requested from a contractor during an actual emergency. To accommodate such requests, contractors may be requested and must make every effort to service these requests from regular sources of supply at the rates set forth in any standard contract resulting from this RFR.

Estimated Provisions. The Commonwealth makes no guarantee that any commodities or services will be purchased from any contract resulting from this RFR. Any estimates or past procurement volumes referenced in this RFR are included only for the convenience of bidders, and are not to be relied upon as any indication of future purchase levels.

Reverse Auction Participation and Payment. In addition to negotiations and Best and Final Offers (BAFOs) that may be conducted with bidders pursuant to 801 CMR 21.00, the PMT will be conducting a Reverse Auction subsequent to the submission of proposals. After the conclusion of the reverse auction and the determination of the winning bidder(s), the winning bidder(s) will be responsible for paying the cost for this reverse auction, not to exceed $3,000 per event, directly to the Commonwealth's reverse auction contractor. That payment must be made within 30 days of the end of the auction event or of the contract award date, whichever is later. In the case of multiple winners, the department will determine how payments will be made in a fair and equitable manner. In addition, the PMT reserves the right to employ the use of reverse auctions at any time during the contract term under the same payment terms as referenced above in this section.

APPENDIX 4- Instructions for Execution and Submission of Commonwealth Standard Forms

The purpose of this appendix is to provide guidance to Bidders on the Commonwealth Standard forms to be submitted (in addition to the other forms and documents required) and how they must be executed and submitted. Please note that these instructions are meant to supplement the Instructions found on each of these forms. It is advisable to print this document first so that it may be referenced when filling out these forms.

Some of the forms listed below can be electronically signed by the Bidder, see Electronic Signatures. However, online Bidders must, if notified of Contract award, submit the following four (4) forms on paper with original ink signatures unless otherwise specified below, within the timeframe referenced in the RFR section entitled Ink

Signatures: the Commonwealth Standard Contract Form, the Commonwealth Terms and Conditions, the Request for Taxpayer Identification Number and Certification (Mass. Substitute W9 Form) and the Contractor Authorized Signatory Listing.

Commonwealth Standard Contract Form

Sign electronically as described above; if notified of Contract award, complete as directed below and submit on paper with original ink signature and date.

By executing this document or signing it electronically, the Bidder certifies, under the pains and penalties of perjury, that it has submitted a Response to this RFR that is the Bidder's Offer as evidenced by the execution of its authorized signatory, and that the Bidder's Response may be subject to negotiation by the SST. Also, the terms of the RFR, the Bidder's Response and any negotiated terms shall be deemed accepted by the Operational Services Division and included as part of the Contract upon execution of this document by the State Purchasing Agent or his designee.

If the Bidder does not have a Vendor Code beginning with "VC," or does not know what their Vendor Code is, the Bidder should leave the Vendor Code field blank. The Bidder should NOT enter a Vendor Code assigned prior to May 2004, as new Vendor Codes have been assigned to all companies since that time.

Signature and date MUST be handwritten in ink, and the signature must be that of one of the people authorized to execute contracts on behalf of the Contractor on the Contractor Authorized Signatory Listing (See below).

Commonwealth Terms and Conditions

Sign electronically as described above; if notified of Contract award, complete as directed below and submit on paper with original ink signature and date, or submit a copy of a previously executed, up-to-date copy of the form as directed below.

If the Bidder has already executed and filed the Commonwealth Terms and Conditions form pursuant to another RFR or Contract, a copy of this form may be included in place of an original. If the Bidder's name, address or Tax ID Number have changed since the Commonwealth Terms and Conditions form was executed, a new Commonwealth Terms and Conditions form is required. The Commonwealth Terms and Conditions are hereby incorporated into any Contract executed pursuant to this RFR.

This form must be unconditionally signed by one of the authorized signatories (see Contractor Authorized Signatory Listing, below), and submitted without alteration. If the provisions in this document are not accepted in their entirety without modification, the entire Proposal offered in response to this Solicitation may be deemed non-responsive.

The company's correct legal name and legal address must appear on this form, and must be identical to the legal name and legal address on the Request for Taxpayer Identification and Certification Number (Mass. Substitute W9 Form).

Request for Taxpayer Identification Number and Certification (Mass. Substitute W9 Form)

Sign electronically as described above; if notified of Contract award, complete as directed below and submit on paper with original ink signature and date, or submit a copy of a previously executed, up-to-date copy of the form as directed below.

If a Bidder has already submitted a Request for Taxpayer Identification and Certification Number (Mass. Substitute W9 Form) and has received a valid Massachusetts Vendor Code, an original W-9 form is not required.

A copy of the form as filed may be included in place of an original. If the Bidder's name, address or Tax ID Number have changed since the Mass. Substitute W9 Form was executed, a new Mass. Substitute W9 Form is required. The information on this form will be used to record the Bidder's legal address and where payments under a State Contract will be sent. The company's correct legal name and legal address must appear on this form, and must be identical to the legal name and legal address on the Commonwealth Terms and Conditions. Please do not use the U.S Treasury's version of the W9 Form.

Contractor Authorized Signatory Listing

Sign electronically as described above; if notified of Contract award, complete as directed below and submit on paper with original ink signature and date.

In the table entitled "Authorized Signatory Name" and "Title," type the names and titles of those individuals authorized to execute contracts and other legally binding documents on behalf of the Bidder. Bidders are advised to keep this list as small as possible, as Contractors will be required to notify the Procurement Manager of any changes. If the person signing in the signature block on the bottom of the first page of this form will also serve as an "Authorized Signatory," that person's name must be included in the typed table.

With regard to the next paragraph, which begins "I certify that I am the President, Chief Executive Officer, Chief Fiscal Officer, Corporate Clerk or Legal Counsel for the Contractor…," if your organization does not have these titles, cross them out and handwrite the appropriate title above the paragraph.

The signature and date should be handwritten in ink. Title, telephone, fax and eMail should be typed or handwritten legibly.

The second page of the form (entitled "Proof of Authentication of Signature") states that the page is optional. However, the "optional" aspect of the form is that Commonwealth Departments are not required to use it. In the case of Statewide Contracts, this page is REQUIRED, not optional. The person signing this page must be the same person signing the Standard Contract Form, the Commonwealth Terms and Conditions, and the RFR Checklist.

Please note that in two places where the form says "in the presence of a notary," this should be interpreted to mean "in the presence of a notary or corporate clerk/secretary." Either a notary or corporate clerk/secretary can authenticate the form; only one is required.

Organizations whose corporate clerks/secretaries authenticate this form are not required to obtain a Corporate Seal to complete this document.

Additional Environmentally Preferable Products / Practices

In line with the Commonwealth's efforts to promote products and practices which reduce our impact on the environment and human health, Bidders are encouraged to provide information regarding their environmentally preferable/sustainable business practices as they relate to this Contract wherever possible. Bidders must complete this form and submit it with their RFR Response.

Prompt Payment Discount Form

Download this form and complete as directed below; include with online submission. Ink signature is not required.

Pursuant to the Prompt Payment Discount terms set forth in the RFR Required Specifications for Contracts and on the Prompt Payment Discount Form itself, all Bidders must execute this form. After entering the "Bidder Name" and "Date of Offer for Prompt/Early Payment Discount", the Bidder must identify the prompt payment discount(s) terms by indicating the "Percentage Discount off of the Proposed Pricing" and the "Turn-around-time for Payments." In the event of a hardship that prevents the Bidder from offering a prompt payment discount, the Bidder must document this fact and provide supporting information. If awarded a contract, the final negotiated prompt payment discounts should be reflected on the Commonwealth Standard Contract Form.

Business Reference Form

Download this form and complete as directed below; include with online submission. Ink signature is not required.

Bidders must provide all requested information on this form for three (3) references. In completing this form, note that the "Bidder" is the name of the company submitting a Quote in response to this RFR and the "RFR Name/Title" and the "Agency Document Number" can be found on the cover of the RFR document and in the Short Description field in the Header Information of the Bid record in COMMBUYS. Also, please note that: "Reference Name" is the name of the organization (if not applicable, then name of the individual) that is providing the reference; "Contact" is the name of the individual inside the organization that will provide the reference; and the "Address," "Phone #" and "Fax/Internet Address" are those of the "Contact" so that the SST may be able to reach them.

appendix 5 – Instructions for Vendors Responding to Bids Electronically through COMMBUYS

Introduction

COMMBUYS refers to all solicitations, including but not limited to Requests for Proposals (RFP), Invitations for Bid (IFB), Requests for Response (RFR), Requests for Quote (RFQ), as "Bids." All responses to Bids are referred to as "Quotes."

Steps for Bidders to Submit a Quote

Launch the COMMBUYS website by entering the URL (www.COMMBUYS.com) into the browser.

Enter Bidder login credentials and click the Login button on the COMMBUYS homepage. Bidders must be registered in COMMBUYS in order to submit a Quote. Each Vendor has a COMMBUYs Seller Administrator, who is responsible for maintaining authorized user access to COMMBUYS.

Upon successful login, the Vendor home page displays with the Navigation and Header Bar as well as the Control Center. The Control Center is where documents assigned to your role are easily accessed and viewed.

Click on the Bids tab

Clicking on the Bid tab opens four sections:

Request for Revision

Bids/Bid Amendments

Open Bids

Closed Bids

Click on the blue Open Bid hyperlinks to open and review an open bid

A new page opens with a message requesting you acknowledge receipt of the bid. Click Yes to acknowledge receipt of the bid. Bidders should acknowledge receipt to receive any amendments/updates concerning this bid.

After acknowledgement, the bid will open.

The top left half of the page contains the following information:

Purchaser

Department

Contact for this bid

Type of purchase

Open Market

Blanket

Pre-Bid Conference details (if applicable)

Ship-to and Bill-to addresses

Any attachments to the bid, which may include essential bid terms, response forms, etc.

The top right half of the bid includes the following information:

Bid Date

Required Date

Bid Opening Date – date the bid closes and no further quotes will be accepted

Informal Bid Flag

Date goods/services are required

The lower half of the page provides information about the specific goods/services the bid is requesting.

Click Create Quote to begin.

The General tab for a new quote opens. This page is populated with some information from the bid. Fields available to update include:

Delivery days

Shipping terms

Ship via terms

Is "no" bid – select if you will not be submitting a quote for this bid

Promised Date

Info Contact

Comments

Discount Percent

Freight Terms

Payment Terms

It is important to note that the bid documents (RFR and attachments) may specify some or all of these terms and may prohibit you from altering these terms in your response. Read the bid documents carefully and fill in only those items that are applicable to the bid to which you are responding.

Update these fields as applicable to the bid and click Save & Continue to save any changes and create a Quote Number.

The page refreshes and messages display. Any message in Red is an error and must be resolved before the quote can be submitted. Any message in Yellow is only a warning and will allow processing to continue.

Click the Items tab. The Items tab displays information about the items requested in the bid. To view additional details about an item, click the item number (blue hyperlink) to open.

The item opens. Input all of your quote information and click Save & Exit.

Click on the Attachments Tab. Follow the prompts to upload and name all required attachments and forms and bid response documents in accordance with the instructions contained in the solicitation or bid documents. After uploading each individual file or form, click Save & Continue. After you have uploaded all required documents click Save & Exit. Be sure to review your attachments to make sure each required document has been submitted.

Click on the Terms & Conditions Tab. This tab refers to the terms and conditions that apply to this bid. The terms and conditions must be accepted before your quote can be submitted. If your acceptance is subject to any exceptions, those exceptions must be identified here. Exceptions cannot contradict the requirements of the RFR, or required Commonwealth standard forms and attachments for the bid. For instance, an RFR may specify that exceptions may or will result in disqualification of your bid.

Click the Summary tab. Review the information and update/correct, as needed. If the information is correct, click the Submit Quote button at the bottom of the page.

A popup window displays asking for verification that you wish to submit your quote. Click OK to submit the quote.

The Summary tab redisplays with an updated Status for the quote of Submitted.

Your quote submission is confirmed only when you receive a confirmation email from COMMBUYS. If you have submitted a quote and have not received an email confirmation, please contact the COMMBUYS Help Desk at COMMBUYS@state.ma.us.

If you wish to revise or delete a quote after submission, you may do so in COMMBUYS: (1) for a formal bid, prior to the bid opening date, or (2) for an informal bid (which may be viewed upon receipt), prior to the opening of your quote by the issuing entity or the bid opening date, whichever is earlier.

Bidders may not submit Multiple Quotes in response to a Bid unless the Bid authorizes Multiple Quote submissions. If you submit multiple quotes in response to a bid that does not allow multiple quotes, only the latest submission prior to the bid opening date will be evaluated.

appendix 6 - glossary

In addition to the definitions found in 801 CMR 21.00, which apply to all procurements for goods and services, the definitions found below apply to this Solicitation. Those definitions below designated with an asterisk ("*") are quoted directly from 801 CMR 21.00 and are included below for quick reference purposes.

Agency – See Department

Bid – While a bid may generally refer to an offer or response submitted in response to a Solicitation or Request for Response (RFR), in COMMBUYS, a "bid" refers to the solicitation, RFR or procurement.

Bidder * - An individual or organization proposing to enter into a Contract to provide a Commodity or Service, or both, to or for a Department or the State.

Commonwealth Contract Manager – See Strategic Sourcing Services Lead

Contract * - A legally enforceable agreement between a Contractor and a Department. ANF, OSD and CTR shall jointly issue Commonwealth Terms and Conditions, a Standard Contract Form and other forms or documentation that Departments shall use to document the Procurement of Commodities or Services, or both. COMMBUYS refers to Contract records as "Purchase Orders" or "Blanket Purchase Orders."

Contractor * - An individual or organization which enters into a Contract with a Department or the State to provide Commodities or Services, or both.

Contractor Contract Manager – The individual designated by the Contractor to interface with the Commonwealth.

Department - For the purposes of this Solicitation, the terms "Department," "Eligible Entity," "Agency," "Commonwealth Agency," and "Contracting Department" include all entities listed in the Eligible Entities section of this RFR. COMMBUYS refers to such entities as "Organizations."

Eligible Entity – See Department

Environmentally Preferable Product (EPP) - A product or service that has a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. Such products or services may include, but are not limited to, those which contain recycled content, minimize waste, conserve energy or water, and reduce the amount of toxic materials either disposed of or consumed.

Evaluation – The process, conducted by the Strategic Sourcing Team, of reviewing, scoring and ranking the submitted Quotes related to this Bid.

FY – See Fiscal Year

Fiscal Year - The year beginning with July first and ending with the following June thirtieth as defined in M.G.L. Chapter 4, Section 7. This may also be referred to as the "State Fiscal Year."

Organization – See Department

Procurement Team Leader (PTL) – See Strategic Sourcing Services Lead

PTL – See Procurement Team Leader

Purchasing Entity – Same as "Eligible Entity."

Quote or Response - generally refers to the offer submitted in response to a Bid or Request for Response (RFR).

Request for Response (RFR) * – The mechanism used to communicate Procurement specifications and to request Quotes from potential Bidders. An RFR may also be referred to as a "Bid" or "Solicitation."

Response – The Bidder's complete submission (or "Quote" as referenced in COMMBUYS) in response to a Solicitation, in other words, a "Bid" or "Proposal."

Solicitation – See Request for Response (RFR)

SST – See Strategic Sourcing Team

SSSL – See Strategic Sourcing Services Lead

Strategic Sourcing Team (SST) – Representatives from various eligible entities and interested stakeholders that design procurements, develop specifications, conduct Solicitations, evaluate responses to Bids and award Statewide or Department Contracts. The SST also monitors Contractor performance through performance measures and the level of customer satisfaction throughout the life of the Contract. In some agencies, SSTs are referred to as "Procurement Management Teams (PMT)."

Strategic Sourcing Services Lead (SSSL) – Individual designated by the procuring Department to lead the Strategic Sourcing Team and the solicitation and resulting contract. In some agencies SSSLs are referred to as "Procurement Team Leads (PTL)." COMMBUYS Refers to the SSSL in the Header Information section of a Bid as the "Purchaser."