An Evaluation of Nonpoint Source Pollution Control Measure Tracking Systems for Long Island Sound

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New England Interstate Water Pollution Control Commission

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1.0 Introduction

An evaluation of nonpoint source (NPS) control measure tracking systems for Long Island Sound (LIS) was conducted to support the LIS TMDL implementation program. NPS control measures in this context refer to mitigation measures and management activities that result in control or reduction of pollutant loadings. Mitigation measures include a wide range of urban stormwater best management practices (BMPs) and agricultural BMPs. Management activities include programs such as municipal leaf collection programs and street sweeping practices. As a result, NPS control measures represent a wide range of activities and programs that result in control or reduction of pollutant loadings. The evaluation featured an assessment of LIS NPS control measure tracking system needs, a review of available tracking systems, and a screening process to match potentially suitable tracking systems with LIS needs.

1.1 Background

This evaluation project was conducted for the New England Interstate Water Pollution Control Commission (NEIWPCC) with funding provided by the Long Island Sound Study (LISS). NEIWPCC is a not-for-profit interstate organization serving and assisting its member states by providing coordination, research, public education, training, and leadership in the management and protection of water quality in the New England states and New York. NEIWPCC is working in cooperation with the LISS Nonpoint Source Pollution and Watersheds Workgroup and the LIS Total Maximum Daily Load (TMDL) Workgroup.

The LISS is a program dedicated to restoring and protecting LIS and has been at the forefront of estuarine management for over 25 years. The cooperating state and federal partners work to implement an approved Comprehensive Conservation and Management Plan (CCMP) to restore and protect the Sound. In 2000, Connecticut and New York completed a TMDL analysis for dissolved oxygen (DO) in Long Island Sound, referred to herein as the LIS TMDL. The TMDL identified specific reductions in point source and NPS nitrogen loadings to the Sound required to support removal of DO impairment (NYSDEC & CTDEP, 2000).

This evaluation project is an important component of the effort to track NPS control measures implemented in the watersheds draining to Long Island Sound. The NPS nitrogen tracking system is an important component of the Enhanced Implementation Plan initiated by the LIS TMDL Workgroup in 2012. It is anticipated that the tracking system will support quantitative TMDL planning and assessments relative to current and potential future reduction targets.

1.2 Objectives

The objective of the evaluation of NPS control measure tracking systems for Long Island Sound was to support stakeholder workgroups in selecting a quantitative tracking system that would support long-term evaluation of nitrogen reductions from NPS control measures throughout the watershed. Once selected, the tracking system would then be developed and applied to provide an ongoing quantitative evaluation of progress made toward the nitrogen-reduction allocations set forth in the LIS TMDL.

1.3 Approach

The evaluation project was conducted collaboratively with frequent interaction between NEIWPCC, stakeholder workgroups, and WaterVision staff. NEIWPCC guided and facilitated the project. The LISS NPS and Watersheds Workgroup and LIS TMDL Workgroup participated in a series of webinars, reviewed memos, and provided guidance throughout the project. WaterVision staff conducted research, reported back to stakeholders, listened to guidance, and continued to seek potentially suitable tracking systems.

The LIS tracking system evaluation project was conducted in a modular manner with a series of technical memoranda submitted for stakeholder review and comment, as follows:

1. LIS tracking system needs and specifications
2. Inventory of existing tracking systems and components
3. Initial tracking system screening process
4. Case studies of potentially suitable tracking systems
5. Final tracking tool screening process

The foundation of the approach was to identify LIS tracking system needs and then inventory and evaluate available systems. Next, a screening process was designed to take a closer look at potentially suitable tracking systems and attempt to match available tracking systems with LIS tracking system needs. This evaluation report describes each step of the tracking system evaluation process.

2.0 Overview of the Long Island Sound Dissolved Oxygen TMDL

The LIS TMDL specified the amount of nitrogen load reduction necessary to achieve dissolved oxygen standards in Long Island Sound. Recently, the Enhanced TMDL Implementation Plan provided the impetus for a tracking system for NPS nitrogen reductions in the LIS watershed. Thus, it is worthwhile to review and consider the key elements of the LIS TMDL as we begin evaluating tracking systems.

In 2000, a TMDL was developed for Long Island Sound to support achievement of dissolved oxygen standards and restore and maintain designated uses (NYSDEC & CTDEP, 2000). Monitoring and modeling confirmed that low DO impairment is primarily due to excess nitrogen entering the Sound. The resulting TMDL required nitrogen load reductions from a variety of point and nonpoint sources.

Through the load allocation process, a 10% reduction was assigned to NPS nitrogen from urban/suburban and agricultural land uses in the 2000 LIS TMDL. The 10% NPS nitrogen load reduction was applied to both “in basin”, meaning in Connecticut and portions of New York draining to LIS, and “out-of-basin”, meaning the portions of Massachusetts, New Hampshire, and Vermont draining to LIS.

The TMDL document included delineation of a set of sub-basins for the in-basin areas located within Connecticut and New York, as shown in Figure 2-1. Land use was represented in the LIS TMDL model in three categories; forested, urban/suburban, and agricultural. NPS nitrogen loading was estimated using export coefficients for nitrogen from each type of land use (Table 2-1).

For assessing NPS nitrogen, the LIS TMDL estimated nitrogen “generated”, meaning washing off of the land surface to the edge of a receiving stream, and “delivered” to Long Island Sound. To convert from generated to delivered nitrogen, attenuation factors were specified and applied based on the sub-basins shown in Figure 2-1.

The 10% NPS nitrogen reduction required by the TMDL was applied to the urban/suburban and agricultural land use areas only (not to the forest land). For the Connecticut and New York areas, specific sub-basin NPS nitrogen load reductions required by the TMDL were provided (in tons/year; Table 2-2). A general 10% NPS nitrogen reduction from baseline was specified for the watershed north of the Connecticut border (out-of-basin).

In summary, NPS nitrogen pollutant loadings were estimated for LIS TMDL baseline conditions using three types of land-use-based nitrogen export coefficients. NPS nitrogen loads were estimated in a set of Connecticut and New York sub-basins and attenuation of nitrogen from each of these sub-basins to LIS was estimated using attenuation factors. The LIS TMDL describes the process and provides specific quantitative estimates of NPS nitrogen loads and required load reductions to LIS relative to an established baseline condition.

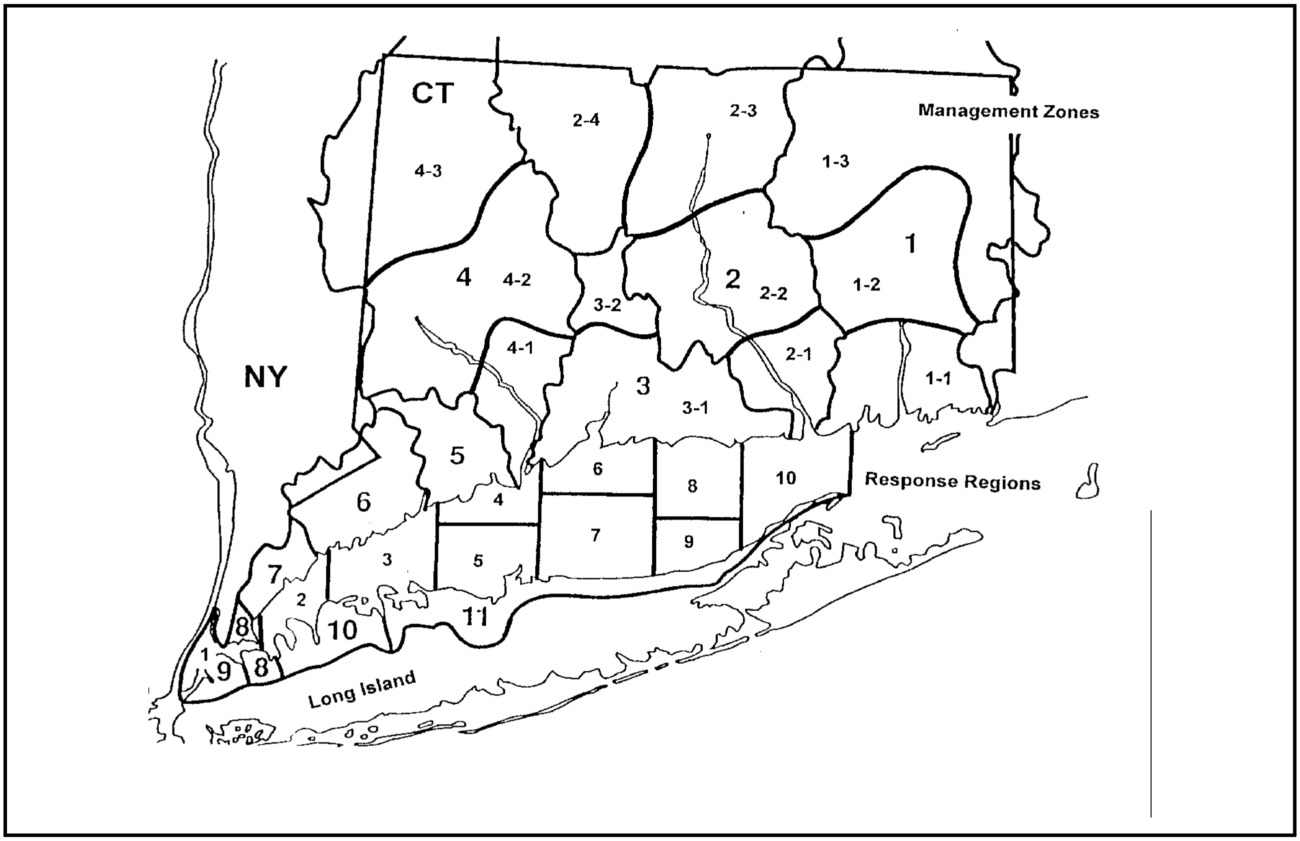


Figure 2-1. Map of In-basin Watersheds from the 2000 LIS TMDL (NYSDEC & CTDEP, 2000)

Table 2-1. NPS Nitrogen Export Coefficients from the 2000 LIS TMDL (NYSDEC & CTDEP, 2000)

Export coefficients (kg/ha/yr) used to derive pre-colonial, atmospheric, and terrestrial nonpoint estimates for three land cover types.				
Land Cover	Pre-Colonial	Terrestrial	Atmospheric	Total
Forest	2.9	0.0	1.4	4.3
Agriculture	2.9	3.3	1.4	7.6
Urban	2.9	5.0	5.5	13.4

Table 2-2. NPS Nitrogen Load Allocations and Required Reductions by Sub-basin from the 2000 LIS TMDL (NYSDEC & CTDEP, 2000)

Calculation of Load Allocation (tons/year)				
Management Zone	Nonpoint Total Load	Urban + Agriculture Load	10% of Urban + Agriculture Load	LA Target Load
1	1852	648	65	1787
2	2473	1231	123	2350
3	999	615	62	937
4	1652	772	77	1575
5	475	319	32	443
6	545	387	39	506
7	190	184	18	172
8	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A
10	275	226	23	252
11-west	393	356	36	357
11-east	34	31	3	31
Total	8888	4769	478	8410

3.0 Long Island Sound Tracking System Needs

Working collaboratively with stakeholders, we developed a conceptual design and specified a set of primary needs for a NPS nitrogen control measure tracking system for the LIS watershed. The proposed tracking system was referred to as a "system" because it would consist of a set of linked components or tools that will work together to track NPS nitrogen reductions.

3.1 Conceptual Design

The conceptual design of the tracking system is illustrated in Figure 3-1. The system would have an interactive user interface, a modular set of accounting tools, and a database capable of providing output in a variety of formats. The interactive user interface would guide the user through a series of questions designed to specify the NPS control measure and then direct the user to provide the specific information needed. Specific information required from the user would depend upon the type of control measure being entered. For example, if the user specified "Control Measure Type 2", then the interface would provide the user with a set of customized information that was required to support calculation of nutrient reductions for that type of control measure.

The tracking system would be modular, as shown in Figure 3-1, in that it would have different components (i.e., tools) for accounting for nitrogen reductions from each of many types of control measures. The system would quantify nitrogen reductions from various types of mitigation measures and management measures. The system would also account for qualitative activities, such as municipal ordinances and public outreach, through a separate, dual process by providing links to quantitative nitrogen reductions that occurred as a result of or in coordination with those activities. The tracking system would be housed in a database with links to enable queries and multiple forms of output. Spatial data could also be included in the tracking system to enable mapping of control measure locations and other geospatial outputs.

3.2 Tracking System Requirements

The core needs of the tracking system include the following:

<u>1. Ability to bring diverse control measures information into a common framework</u>. Control measures information would come in from the States, municipalities, and other sources in different forms and formats and would need to be normalized for use in the tracking system. A protocol would need to be established for converting some information, such as different land use partitioning schemes, into the common framework. A protocol would also need to be developed to use default data to fill data gaps.

We would also need to identify a set of control measure-specific parameters that would be applied to calculate nitrogen load reductions for each type of control measure. These parameters might include, for example, type of control measure, area treated, land use, and soil type. Additional data needs for each control measure may include geographic location, date of installation, maintenance program, source of funding, and cost. To get the information into a common framework, we would need to set up an easy-to-use online form for entering data. The online form would need to be flexible to allow users to add detailed site-specific information (when available) or simply select default information to fill data gaps. Careful specification of the information needed by the Tracking System is critically important for guiding users in entering information into a common framework.

2. Ability to track a wide variety of types of control measures. There are many types of activities that can result in reduction (or change) in nitrogen loadings in watersheds. These control measure activities may be categorized in several different ways including as:

- Quantitative vs. qualitative;
- Parcel-site specific vs. larger spatial scale;
- Structural vs. non-structural; and
- Regulatory vs. non-regulatory.

The tracking system needs to be capable of precisely identifying and accounting for each type of control measure. Each type of quantitative and qualitative control measure would have a modular calculation tool, as shown in Figure 3-1. For quantitative control measures, the tool would calculate nitrogen reduction using a set of input parameter values and sum direct nitrogen reductions. For qualitative control measures, the tool would provide a set of links to quantitative control measures that occurred as a result of or in coordination with those activities. The tracking system would then sum indirect nitrogen reductions associated with the qualitative control measure in a separate, parallel accounting process. This parallel qualitative tracking system would enable credit to be assigned for the critically important role of "set-up" tasks, such as public outreach and municipal ordinance revisions, in the watershed pollution reduction process.

Control measures also vary by structure and scale and these variations need to be captured by the tracking system. For example, site-specific measures, such as structural urban stormwater BMPs, are situated at one location and reduce nitrogen loadings from one site or parcel. Larger-scale non-structural measures, such as lawn fertilizer regulations or street sweeping programs, result in reductions in nitrogen loadings over larger areas. The tracking system needs to contain a protocol for identifying, categorizing, and quantifying nitrogen reductions associated with each type of program.

3. Ability to categorize and rank control measures by geographic location. Control measures implemented along the coast and along major rivers draining to Long Island Sound will reduce nitrogen loading to the Sound more directly than control measures implemented in remote locations. Delineating the LIS watershed into priority zones, based on proximity to the Sound and adjacent surface waters is needed to support assessment of overall nitrogen load reduction. The tracking system may need to have a protocol for ranking control measures based on geographic location.

4. Ability to apply scientifically-defensible methods for assigning nitrogen reduction credits to each type of control measure. There are numerous types of NPS control measures that have been and will be implemented in the LIS watershed. A core task of the tracking system would be to accurately and efficiently take the type of control measure and the other information obtained as part of item 1 above and to assign an annual nitrogen reduction credit. The tracking system needs to contain a set of straightforward, scientifically-defensible nitrogen accounting tools, many of which could potentially be borrowed or adapted from other programs.

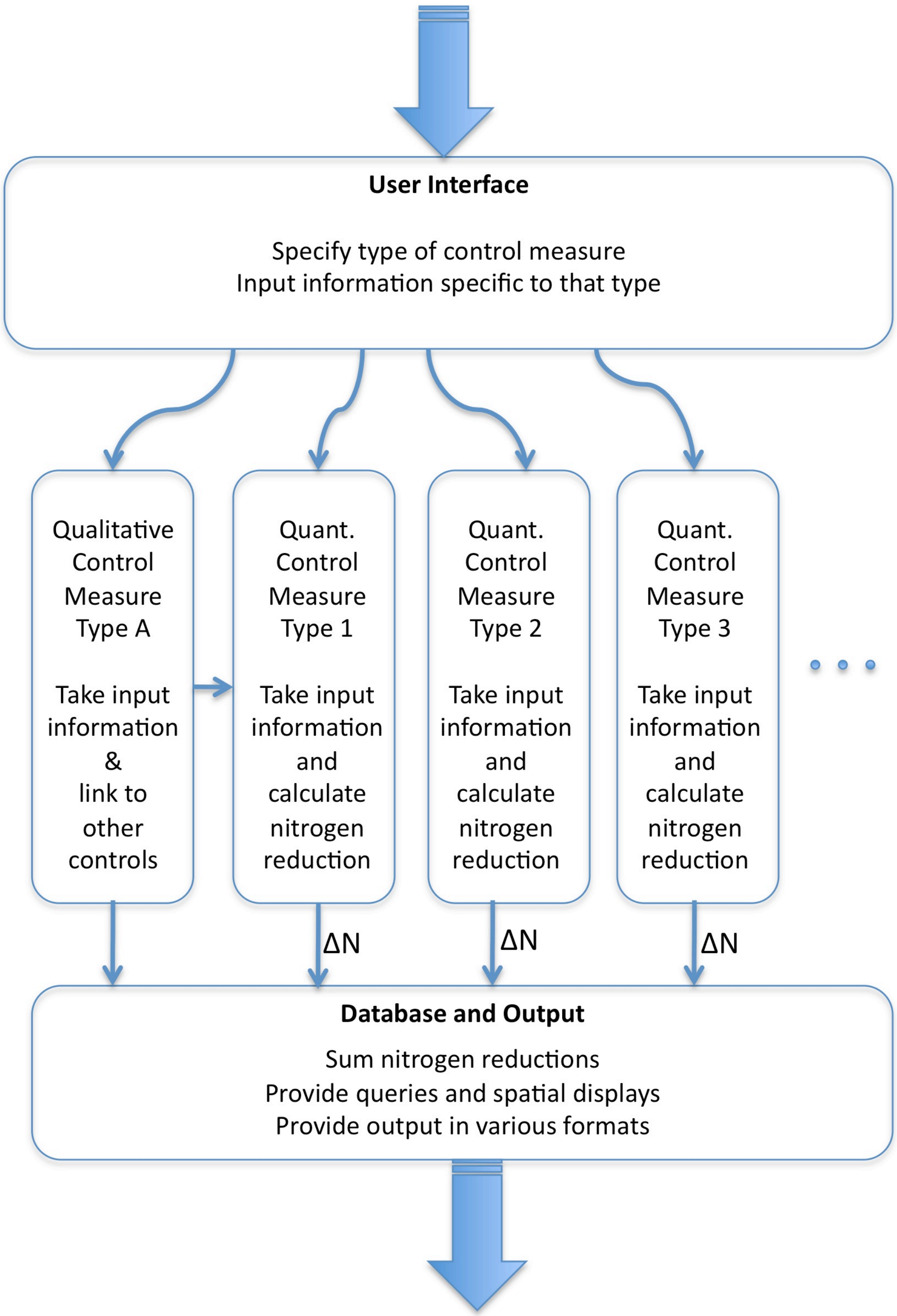
5. Additional needs

Numerous additional tracking system needs and issues may need to be resolved including:

- Operational feasibility considerations. Issues such as what organization would be responsible for housing and maintaining the tracking system needs to be resolved. Also, protocols for conducting QA/QC and for adding new NPS control measures information and updating the system need to be developed.
- Accessibility of the tracking system database and nitrogen credit information. Access to the tracking system could range from agency-only to publically-available. There may be the need for regulators or a workgroup to be able to easily change BMP performance credit information and baseline nitrogen loading information applied to the tracking system. Public access online could potentially be beneficial to support outreach and education objectives, but also poses challenges.
- Field verification. NPS control measures do not always perform as well as expected and degrade over time. A field verification program would improve accuracy by inspecting NPS control measures and adjusting expected nitrogen load reductions accordingly.
- Cost considerations. It would be beneficial to include information on the cost of individual NPS control measures and/or programs (e.g., installation and maintenance costs) in the tracking system. This information would facilitate cost-benefit analyses of NPS control measures. Conversely, cost information may be difficult and time-consuming to obtain, and would need to be updated regularly.
- Baseline date. A baseline date (i.e., time zero) is needed for the tracking system. The baseline date would provide the basis of comparison required to support calculation of the watershed-wide NPS nitrogen load reduction over time.

Each of these issues and needs is important and will need to be addressed by the selected tracking system.

Figure 3-1. Schematic Diagram of Tracking System Conceptual Framework



4.0 Inventory of Available NPS Control Measure Tracking Systems

An inventory of existing tracking systems and system components (i.e., tools) was compiled and is described below. The inventory provided a basis for beginning a matchmaking process by comparing tracking system needs (Section 3) with existing tracking systems and tools. This inventory was not intended to be exhaustive or complete. Rather, it was a targeted compilation of tracking systems and tools that could potentially meet LIS tracking system needs.

4.1 Overview

Existing tracking systems and tools were compiled in Table 4-1 and organized as:

- New England and New York systems and tools
- New England land use-based resources
- Chesapeake Bay-related systems and tools
- BMP performance databases
- Selected State and other major nitrogen impairment TMDL program tools

Table 4-1 provides a matrix with each tracking system and tool listed as a row and key characteristics provided in columns. Three categories were assigned for the type of tracking tool (columns 2-4 on left); integrated tracking systems, pollutant load accounting and tracking tools, and individual load calculators. An integrated tracking system is defined as a tool that is able to calculate individual site pollutant load reductions, sum them together (as the accounting and tracking tool does), and integrate them together to estimate total load reductions for entire watersheds. In columns 5 and 6, the table indicates whether the tools specifically consider nitrogen pollution and are available electronically. Available electronically means that the tool appears to be complete and readily available for download online or via email. Column 7 provides an estimate of the number of specific types of control measures accounted for in each tool. Next, the table indicates the general types of control measures evaluated, categorized as urban stormwater, land use, agricultural, and atmospheric deposition. The last two columns provide an indication of the level of complexity of the tool and additional comments.

4.2 Tracking Systems and Tools

Tracking tools were organized into five categories, compiled in Table 4-1, and described below.

New England/New York Programs – The majority of tracking tools in this category were developed for programs located in areas adjacent to the LIS watershed and therefore have geographic relevance for this project. These tools include those developed for the Charles River watershed, Lake Champlain watershed, and the Massachusetts portion of the LIS watershed. Also included are two BMP performance tools developed by USEPA Region 1, tools under development by the UNH Stormwater Center, the PRedICT estimation tool applied within the LIS watershed, and a NPS control measures tool developed by the Maine DEP.

Land Use-Based Resources – While not stand-alone tracking tools, land use-based resources are important because they would be needed to support estimation of changes in nitrogen over large areas within the LIS watershed. The USGS SPARROW model developed for New England, New England

and New York state GIS databases and, in particular, the CLEAR "Long Island Sound Watershed Changing Landscape" program are worthy of further evaluation.

Chesapeake Bay TMDL Program – The most advanced nitrogen reduction tracking and accounting systems in the United States have been developed in the Chesapeake Bay region. There are several major programs established and others under development to support quantification of nitrogen reduction associated with a wide range of control measures through the Chesapeake Bay Program (CBP). These programs include the Chesapeake Bay Watershed Model, the Nutrient and Sediment Scenario Builder, the TMDL Tracking and Accounting System (BayTAS), and the Chesapeake Assessment and Scenario Tool (CAST). In addition, the CBP has and continues to convene expert panels to develop recommended load reductions associated with specific types of control measures (e.g., urban stormwater retrofits and street sweeping programs). Several states have also established tracking tools to support TMDL implementation in the Chesapeake Bay region.

BMP Performance Databases – The U.S. EPA, the American Society of Civil Engineers (ASCE), Water Environment Research Foundation (WERF), and other sponsors have developed large databases of the effectiveness of hundreds of stormwater BMPs. These BMP performance databases are available to support BMP reduction calculations within the tracking system.

Selected State and Other TMDL Programs –Other TMDLs for large watersheds impaired by nutrient pollution nationwide were also reviewed in an attempt to identify potentially useful NPS control measure tracking systems. One program included in the review was the Tar-Pamlico basin in North Carolina which has had a basin-wide water quality management plan in place since 1994 and under this plan has implemented a pioneering nutrient trading program. Also considered was the Gulf of Mexico (GOM) TMDL program to deal with the dead zone/hypoxia impairment in the GOM which is primarily caused by nutrient pollution from the Mississippi River watershed. Several state TMDL programs were reviewed to determine if any have developed tools that might be applicable for this project. Unfortunately, the tracking systems associated with these programs appear to be currently under development and not yet ready for use.

4.3 Summary

Twenty-eight potentially useful tracking systems and tools were identified and compiled in the tracking tool inventory. A wide range of tools was identified from simple spreadsheet tools to complex integrated systems. The most relevant tools identified were developed for the New England/New York and the Chesapeake Bay regions. Several NE/NY tools and Chesapeake Bay tools appear to be capable of estimating pollutant load reductions within a tracking systems framework. Numerous tools are set up to calculate load reductions associated with individual sites, but are not capable of integrating multiple load reductions within a tracking system framework. All of the Chesapeake Bay-related tools and some of the New England/New York tools specifically include nitrogen load reduction as an output. Existing NPS control measure tracking systems and system components were further evaluated for potential use in the LIS tracking system application as part of the screening process described below.

Table 4-1 (1 of 3). Inventory of Tracking Tools

Tracking Tool	Integrated Tracking System Full-sets of control measures for entire watersheds	Pollutant Load Accounting and Tracking Tool (Sums Sites)	Pollutant Load and Reduction Calculation for individual Sites	Nitrogen Specifically Included	Available Electronically	# of Control Measures	Urban Stormwater	Land Use	Agricultural - Livestock & Crops	Atmospheric Deposition	Level of Tool Complexity	Additional Comments
<u>**New England/New York Programs**</u>												
Charles River Watershed Association Accounting and Tracking Tools	✔	✔	✔		✔	>10	✔	✔			Comprehensive calculation of pollutant loads and reductions	Load calculations from USEPA Region 1 spreadsheet tool
USEPA Region 1 Spreadsheet Tool			✔	✔	✔	>10	✔	✔			Comprehensive calculation of pollutant loads and reductions	Used to estimate N reductions for BMPs in Draft NH Small MS4 Permit
USEPA Region 1 Performance Extrapolation Tool			✔	✔		>10	✔	✔			Comprehensive calculation of pollutant loads and reductions	Will contain user-friendly interface; under development
UNH Stormwater Center BMP Decision Support System			✔	✔		TBD	✔				Calculation of N removal from SW treatment systems	Under development
MassDEP LIS Tracking System - TMDL Implementation Plan	✔	✔	✔	✔	✔	>10	✔	✔	✔		Relatively simple, spreadsheet-based tool	Includes compilation of 100s of BMPs
Lake Champlain, VT Watershed Nutrient Scenario Builder and Tracking Tool		✔	✔			TBD	✔	✔	✔		Primarily for P control	Under development; not currently available
UCONN/URI/EPA N-Sink Nitrogen Removal Tool		✔	✔			TBD	✔	✔			Designed to estimate N removal at specified points in watershed	Under develop.; decision support tool to ID N sources and sinks
Maine DEP NPS Site Tracker					✔	NA		✔			Simple, qualitative assessment of BMP performance	
LIS PRedICT Tool	✔	✔	✔		✔	>10	✔	✔	✔		Relatively simple calculation of N load reduction & cost est.	Pollution Reduction Impact Comparison Tool (with AVGWLF)

Table 4-1 (2 of 3). Inventory of Tracking Tools

Tracking Tool	Integrated Tracking System Full-sets of control measures for entire watersheds	Pollutant Load Accounting and Tracking Tool (Sums Sites)	Pollutant Load and Reduction Calculation for individual Sites	Nitrogen Specifically Included	Available Electronically	# of Control Measures	Urban Stormwater	Land Use	Agricultural - Livestock & Crops	Atmospheric Deposition	Level of Tool Complexity	Additional Comments
Land Use-based Resources												
USGS SPARROW				✔	✔	NA		✔			Statistically-based model of N loading based on land use	Calibrated for New England watersheds; No control measures
New York and New England State Land Use Databases					✔	NA		✔			Land-use characterization	Each state has land use data that varies on level of detail to support characterization
CLEAR Changing Landscape					✔	NA		✔			Land-use characterization	Detailed land use coverages for each of 6 yrs spanning 1985-2010
Chesapeake Bay-Related Programs												
USEPA CB Nutrient and Sediment Scenario Builder and Watershed Model	✔	✔	✔	✔	✔	>100	✔	✔	✔		Comprehensive calculation of pollutant loads and reductions	Provides load and load reduction input to BayTAS
USEPA Chesapeake Bay TMDL Tracking and Accounting System (BayTAS)	✔	✔		✔	✔	NA	✔	✔	✔	✔	Comprehensive compilation of pollutant loads and reductions	Integrates input from Scenario Builder, model, and state programs
Maryland Assessment and Scenario Tool (MAST)		✔	✔	✔	✔	>100	✔	✔	✔		Less complex calculation of pollutant loads and reductions	Designed to integrate with USEPA Scenario Builder
Virginia Site Planning & Compliance Spreadsheet		✔	✔	✔	✔	>10	✔	✔			Calculation of pollutant loads and reductions	Designed to integrate with USEPA Scenario Builder
Chesapeake Stormwater Network - BMP Effectiveness Tools			✔	✔	✔	>20	✔	✔			Detailed calculation of pollutant loads and reductions	Provides technical support to Chesapeake Bay Program

Table 4-1 (3 of 3). Inventory of Tracking Tool

Tracking Tool	Integrated Tracking System Full-sets of control measures for entire watersheds	Pollutant Load Accounting and Tracking Tool (Sums Sites)	Pollutant Load and Reduction Calculation for individual Sites	Nitrogen Specifically Included	Available Electronically	# of Control Measures	Urban Stormwater	Land Use	Agricultural - Livestock & Crops	Atmospheric Deposition	Level of Tool Complexity	Additional Comments
BMP Performance Databases												
USEPA Urban BMP Performance Tool			✔	✔	✔	>100	✔	✔			Detailed calculation of pollutant loads and reductions	National web-based too compiling BMP effectiveness calculations
International Stormwater BMP Database (U.S. EPA/ASCE/WERF)			✔	✔	✔	>500	✔	✔			Detailed calculation of pollutant loads and reductions	Compilation of BMP effectiveness studies
Selected State and Other TMDL Programs												
NC Tar-Pamlico Basin Program												Tracking programs in development, expected in 2014
Gulf of Mexico/Mississippi River Nutrient TMDL												State and federal programs at various levels of development
Illinois, Iowa TMDL Programs			✔	✔		~10			✔		Relatively simple analytical tool	Tracking loading reductions for agriculture conservation practices
Michigan TMDL Program			✔			~10			✔		Relatively simple analytical tool	Tracking estimated load reductions from grant-funded NPS projects
Minnesota TMDL Program			✔	✔		<10			✔		Relatively simple analytical tool	Load reduction estimates entered into USEPA's GRTS database
Texas TMDL Program			✔			<10					Relatively simple analytical tool	BMP effectiveness data collection
Washington State EAP Study Tracker			✔	✔		<10					Relatively simple analytical tool	Database for BMP effectiveness monitoring tracking studies
Indiana TMDL Program												Developing Sharepoint system for estimating pollutant loads
Mississippi TMDL Program												Developing tools for evaluating BMP nutrient load reductions

5.0 Initial Screening of Potentially Suitable Tracking Systems

The objective of the initial screening process was to remove unsuitable systems from further consideration and move toward focusing on the few most promising systems. The rationale applied in the screening process and the results are provided below.

5.1 Screening Process

The inventory of available tracking systems and tools was organized into the following five categories:

- New England and New York systems and tools
- New England land use-based resources
- Chesapeake Bay-related systems and tools
- BMP performance databases
- Selected State and other major nitrogen impairment TMDL program tools

Three of the five categories, land-use based resources, BMP performance databases, and state and other TMDL programs, were identified as system tools (or components) through the screening process. These three categories of system tools would be used to support whatever tracking system is selected. As a result, these three categories were removed from consideration as potential tracking systems and were set aside for future use within the selected tracking system, as outlined below.

New England land use-based resources are useful for establishing spatial characteristics related to nutrient loading. Land use resources are an essential component of large-scale nutrient load estimation processes and would be applied to establish baseline nitrogen loading conditions. These resources are not tracking systems and were set aside for potential future use within the selected tracking system. Similarly, BMP performance databases can be invaluable in supporting specification of appropriate nutrient load reductions associated with control measures and for other BMP specification purposes. BMP performance databases are also not tracking systems and were also set aside for future use. The review of state and other regional TMDL programs' tracking systems and components found relatively little that was potentially applicable to the LIS tracking system. State and other regional TMDL program tools tended to be relatively simple and incomplete (e.g., currently under development). As a result, the state and other regional TMDL program category was removed during the screening process.

Several strong candidate tracking systems and components were identified in the New England/New York and Chesapeake Bay-related categories. Table 5-1 provides a matrix of the results of the initial screening of available tracking systems and tools from New England/New York region and from the Chesapeake Bay region. Each row represents a tracking system or tool. The second column provides the screening process outcome and the third column provides a summary of the rationale for the screening decision outcome. Some of the tracking system components are interconnected and were evaluated further in combination. There were four possible screening process outcomes, as follows:

- *Accepted* – indicates that the tracking system or component has been accepted as potentially applicable for LIS and was evaluated further;

- *Combined* – indicates that the tracking system or system component was similar to or works in combination with other tracking systems and was evaluated further in combination with other potentially applicable tracking systems and tools;
- *Partial* – indicates that there was a subset of the tracking system that may be useful and could potentially be evaluated further, but the overall system is not appropriate for use for LIS; and
- *Removed* – indicates that the tracking system was found to be not applicable to the LIS application and was removed from further consideration.

A brief discussion of each tracking system reviewed and screened is provided below along with links to additional information.

5.2 Screening Process Results for New England and New York Systems and Tools

BMP Performance Extrapolation Tool (PET) for New England provides efficient calculation of BMP stormwater treatment performance by site, BMP-type, and pollutant of concern. The BMP-PET provides an interface with the results of BMP performance modeling conducted by Tetra Tech, Inc for EPA Region 1. Through BMP performance modeling, regional BMP performance curves were developed to support estimation of percent pollutant reduction vs. runoff depth treated for each type of BMP. The regional BMP performance curves are used within the BMP-PET tool.

In BMP-PET, the user specifies the source area type (e.g., commercial, industrial, residential), BMP type (including several types of infiltration and non-infiltration BMPs), BMP size, pollutant(s) or concern, and several site-specific parameters. Based on the input data provided, BMP-PET calculates the pollutant load removal efficiency. An initial version of this tool appears to be available and a more advanced version is currently under development. Notably, total nitrogen is not currently available, but will reportedly be part of the advanced version.

BMP-PET is recommended for use by a variety of groups including:

- *MS4 communities* to track changes in pollutant removal associated with reduction of impervious cover and other BMP implementation;
- *Watershed stakeholders* to estimate BMP pollutant removals within the watershed based management plans framework; and
- *State and local regulators* to determine if BMPs will be adequate to protect lakes and streams from excessive stormwater discharges.

BMP-PET was accepted for further evaluation.

Online at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/BMPPETInstructions.pdf

U.S. EPA Region 1 Great Bay Nitrogen MS4 Permit tool for estimating nitrogen and phosphorus load reductions resulting from BMP installation. This tool was applied to estimate annual phosphorus and nitrogen load reductions for various structural control measures as part of New Hampshire's 2013 MS4 general permit (U.S. EPA, 2013). This approach uses a spreadsheet tool, accepts site-specific data, and applies established BMP performance curves to estimate pollutant load reductions. This tool appeared to have similar characteristics as the BMP-PET and was evaluated further in combination with BMP-PET.

Online at: *http://www.epa.gov/region1//npdes/stormwater/nh/2013/Appendix-H-Small-MS4-NH.pdf*

A **UNH Stormwater Center nitrogen removal investigation** is currently being conducted to investigate stormwater BMP nitrogen removal in the field over a 2-year period. The UNH investigation will support EPA Region 1's regional stormwater BMP model by improving nitrogen reduction estimates from BMPs. This project in its early stages and should be evaluated further as information becomes available.

Online at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/BMPNitrogenRemoval.pdf

The **Charles River Watershed Association's (CWRA) tracking and accounting system** is called the Blue Cities® Exchange. This system is proprietary to CWRA and is described as a simple, interactive web-based BMP design program. The Blue Cities® Exchange reportedly uses BMP calculation methods similar to those of EPA Region 1 and seeks to provide an easy-to-use framework for stakeholders to estimate pollutant reductions, costs, and other factors associated with BMPs. A primary goal of the Exchange is to support establishment of a market for stormwater trading. Since the CWRA tool uses similar methods as the EPA Region 1 tool and is proprietary, it was removed from further evaluation.

Online at: http://www.crwa.org/bcexchange.html

MassDEP LIS TMDL NPS and Stormwater BMP Analysis was developed for the Massachusetts portion of the LIS watershed as part of the LIS TMDL Enhanced Implementation Plan (MassDEP, 2013). MassDEP compiled over 300 urban/suburban BMPs and over 500 agricultural BMPs from over 100 municipalities within the LIS watershed. BMP data was compiled in Excel spreadsheets and methods for estimating nitrogen load reduction for each type of BMP were selected and applied. The MassDEP tool demonstrates an approach for gathering the required BMP data for large areas within the LIS watershed and adapting nitrogen reduction methods from other sources. The MassDEP tool should be evaluated further and methods for compiling BMP-related data and calculating control measure pollutant load reductions should be adapted, as appropriate.

Lake Champlain Watershed Nutrient Tracking Tools are currently under development. Tetra Tech, Inc. has conducted a watershed nutrient modeling project using the SWAT model and is reportedly near the beginning of a project to develop a nutrient tracking tool for the Lake Champlain watershed. Separately, the NRCS and the Vermont Department of Agriculture are reportedly working on a project to bring available agricultural control measure data for Vermont into a common database. The NRCS project would include implementation of an agricultural tracking tool to estimate nutrient removal efficiency. We learned through further discussions with U.S. EPA and Vermont Department of Environmental Conservation staff that the Lake Champlain tracking systems were in the early phases of development and were not available. As a result, Lake Champlain-related tracking systems were removed from the candidate list, but should be evaluated further as information becomes available.

Other New England/New York Tools

The UCONN & URI N-Sink nitrogen removal tool is currently under development and appears to be primarily a tool for estimating nutrient load reductions. N-sink should be evaluated further as information becomes available. The PRedICT model is a tool for calculating nitrogen reductions associated with specific types of control measures. Specific calculation modules within PRedICT may be applicable and could be further evaluated. The Maine DEP Site Tracker is a spreadsheet-based inventory of NPS Sites with BMPs, but does not estimate pollutant removal. Since Maine DEP's Site Tracker does not provide assessment of nutrient load reductions, it was removed from further consideration.

5.3 Screening Process Results for Chesapeake Bay Region Systems and Tools

The Chesapeake Bay region leads the nation in developing nutrient reduction tracking systems and has several potentially applicable tools available. The Chesapeake Bay Program (CBP) has established a set of tools that are designed to work together as a TMDL tracking and assessment system.

Scenario Builder provides input on land uses, nonpoint sources, BMPs, and other control measures to the CBP Watershed Model. The Watershed Model is a complex HSPF (Hydrological Simulation Program–Fortran)-based model that predicts watershed pollutant loads and load reductions from NPS control measures. CAST is a user-friendly tool for control measure tracking. Chesapeake Stat and BayTAS (through Chesapeake Stat) provide graphic presentation of the Watershed Model results. Each component of the CBP tracking system is briefly summarized below.

Online at:

http://www.chesapeakebay.net/about/programs/watershed_implementation_plan_tools/

http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/AppendixBIndexofDocuments_final.pdf

Scenario Builder generates information that is used with other watershed characteristic data to simulate nutrient and sediment loads related to animal production areas, application of manures and fertilizers to cropland and turf grass, septic inputs, plant growth/uptake, BMP implementation, atmospheric deposition of nutrients, and discharges from wastewater treatment facilities. As such, Scenario Builder is a decision support tool that facilitates the creation of input decks for the Chesapeake Bay Program HSPF-based Watershed Model management scenarios.

U.S. EPA and the CBP staff input data to Scenario Builder using an internal web-based interface. Control measures that may be input include urban growth reduction, impervious urban surface reduction, stormwater bioretention, permeable pavement, street sweeping, forest conservation/buffers, stream restoration/buffers, wetland restoration, forest buffers, alternative crops, conservation tillage, cover crops, animal waste management, and septic system management. Scenario Builder considers a comprehensive set of scenarios including 25 land use categories, over 100 crop types, and over 40

BMP categories. Scenario Builder provides the input data required to enable the Watershed Model to estimate nutrient load reductions associated with implementation of control measures throughout the watershed. Scenario Builder was accepted for further evaluation.

Online at:

http://www.chesapeakebay.net/publications/title/documentation_for_scenario_builder

http://archive.chesapeakebay.net/pubs/SB_V22_Final_12_31_2010.pdf

Chesapeake Assessment and Scenario Tool (CAST) is a user-friendly tool that provides a quick method for assessing the NPS loads and load reductions from BMPs. CAST provides a simplified version of some of the CBP Watershed Model and Scenario Builder functions described above. CAST scenarios use the same land uses, BMPs, and BMP effectiveness values to closely replicate the results of the CBP Watershed Model. Maryland and Virginia have customized versions of CAST, called MAST and VAST.

CAST provides a web-based user interface for data input. State and local agencies and the public can provide input data and can use CAST (unlike Scenario Builder that is only accessible by EPA and CBP staff). CAST output includes estimates of load reductions for point and nonpoint sources including agriculture, urban, wastewater, forest, and septic loading. CAST file formats are compatible with Scenario Builder and were developed to complement the other Chesapeake Bay modeling tools. CAST was selected for further evaluation.

Online at:

http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/CASTFactSheet.pdf

http://www.casttool.org/About.aspx

Chesapeake Stat is an interactive public website that provides summary information about Bay Program partner restoration activities, funding, and progress toward goals. Chesapeake Stat receives input from results of CBP Water Quality Model and Watershed Model simulations, environmental samples, and tracking data on restoration activities gathered by CBP partners. Chesapeake Stat provides analysis and visually compelling presentations of data using a publically available web-based user interface. Output includes GIS-based maps with graphical summaries of numerous results including nitrogen loading from agriculture, nitrogen loading from urban areas, nitrogen removal effectiveness, and percent impervious cover. Chesapeake Stat was selected for further evaluation in combination of other CBP tools.

Online at:

http://stat.chesapeakebay.net/

http://archive.chesapeakebay.net/pubs/calendar/45645_03-23-10_Presentation_4_10619.pdf

BayTAS is a tracking and accounting system that stores TMDL allocations and tracks implementation progress. It is integrated with the CBP Watershed Model and Chesapeake Stat. Input data to BayTAS is obtained from the Watershed Model output and Watershed Implementation Plans. Output is provided through integration with Chesapeake Stat. As with Chesapeake Stat, a web-based user interface is used for viewing output. BayTAS output includes total nitrogen loading compared to the TMDL goal on a bar chart for the entire watershed, each state, and each basin. BayTAS was selected for further evaluation in combination of other CBP tools.

Online at:

http://stat.chesapeakebay.net/?q=node/130&quicktabs_10=2

http://stat.chesapeakebay.net/sites/all/cstat/tmdl/BayTAS_factsheet.pdf

5.4 Summary and Discussion

The tracking system screening process reduced the twenty-eight inventoried tracking systems and components to the following three combined tracking systems for further evaluation:

1. EPA Region 1 tracking systems including BMP-PET, the Great Bay MS4 BMP tool, and the MassDEP LIS tracking system. Some of these tools have been developed while others are currently under development.
2. Chesapeake Bay Program Watershed Model, Scenario Builder, and associated tools represent the most comprehensive nutrient accounting and tracking system available. This system is fully functional and available for review. We talked with several key staff that work with the CBP tools and continued to evaluate the system for applicability to LIS needs.
3. Chesapeake Assessment and Scenario Tool and associated tools represent a simplified version of the CBP watershed model and scenario builder. We talked with key staff who work with this tool and continued to evaluate CAST separately to determine whether it had a sufficient level of complexity to meets the LIS application's needs.

Three of the above tracking systems were reviewed and evaluated further in the final screening process described below.

Table 5-1. Tracking Systems and Initial Screening Results

Tracking Tool	Outcome	Rationale
New England/New York Programs		
USEPA Region 1 Performance Extrapolation Tool PET)	Accepted	Used by EPA Region 1 to estimate control measure performance based on BMP performance modeling
USEPA Region 1 Spreadsheet Tool	Combined	Applied in the NH 2013 MS4 General Permit and believed to be similar to the BMP-PET
UNH Stormwater Center Nitrogen BMP Investigation	Combined	Under development via EPA Region 1 contract and designed to support EPA Region 1 tools
MassDEP LIS Tracking System - TMDL Implementation Plan	Combined	Spreadsheed system that includes a variety of NPS control measures and sums nitrogen load reductions by sub-basin
CWRA Tracking and Accounting Tool	Removed	Proprietary tool for calculating nutrient reductions associated with control measures using methods similar to EPA Region 1 methods
Lake Champlain, VT Watershed Nutrient Tracking System	Removed	Several tools under development; one by TetraTech via EPA Region 1; another via NRDC for agricultural control measures
UCONN/URI/EPA N-Sink Nitrogen Removal Tool	Partial	Under development; contains potentially applicable elements for calculating control measure nutrient reduction and spatial analysis
LIS PRedICT Tool	Partial	Contains potentially applicable elements for calculating control measure nutrient reduction and watershed spatial analysis
Maine DEP NPS Site Tracker	Removed	Simple and qualitative. Not directly applicable.
Chesapeake Bay-Related Programs		
USEPA CBP Nutrient and Sediment Scenario Builder and Watershed Model	Accepted	Highly-complex database management tool and model for calculating and tracking nutrient reductions within a TMDL framework
Chesapeake Assessment and Scenario Tool (CAST)	Accepted	User-friendly tool to provide control measure load reductions; simplified and compatible version of Scenario Builder/Watershed Model
Chesapeake Stat	Combined	Interactive public website that displays TMDL implementation progress in visually compelling forms. Part of integrated tracking system
USEPA Chesapeake Bay TMDL Tracking and Accounting System (BayTAS)	Combined	Works in combination with the Watershed Model and Chesapeake Stat to track and display TMDL implementation progress
Maryland Assessment and Scenario Tool (MAST)	Combined	Similar to CAST and customized for Maryland
Virginia Assessment and Scenario Tool (VAST)	Combined	Similar to CAST and customized for Virginia
Chesapeake Stormwater Network - BMP Effectiveness Tools	Combined	Generates control measure load reductions, partially incorporated into the systems above

6.0 Final Screening Process and Tracking System Selection

The goal of the final screening process was to closely compare final candidate tracking systems to LIS needs and select an appropriate tracking system and components for the LIS watershed. The final candidate tracking systems were organized as follows:

1. *New England-based Systems and Tools*
   - Region 1 BMP Performance Enhancement Tool
   - Great Bay Nitrogen MS4 Permit Tool
   - MassDEP LIS TMDL NPS and stormwater BMP analysis approach
2. *Chesapeake Bay Watershed Model-based Systems and Tools*
   - Scenario Builder
   - Chesapeake Bay Model
   - Chesapeake Stat and Chesapeake Bay TMDL Tracking and Accounting System (Bay TAS)
3. *Chesapeake Bay Assessment and Tracking Tools*
   - Chesapeake Assessment and Scenario Tool (CAST)
   - Maryland (MAST) and Virginia (VAST) versions of CAST

The final screening process resulted in selection of a primary tracking system and suggestions for adapting specific components from other candidate tracking systems, as described below.

6.1 New England-based Tracking Tools

The EPA Region 1 BMP Performance Enhancement Tool (BMP PET) calculates phosphorus and suspended sediment removal efficiencies for a small set of BMPs. BMP PET is designed to calculate single BMP removal efficiencies, rather than sets of BMPs within a sub-basin. BMP PET does not yet calculate nitrogen removal efficiencies, so it is not currently directly applicable for the LIS tracking system application. We recommend monitoring the development of BMP PET and potentially utilizing BMP PET nitrogen removal efficiency modules within the selected tracking system as they become available.

The *Great Bay Nitrogen MS4 Permit Approach* calculates nitrogen removal efficiencies for eight urban BMPs in New England. We recommend evaluating and potentially adapting the eight urban BMPs from the Great Bay nitrogen MS4 permit approach as nitrogen removal efficiency modules in the selected LIS tracking system.

The *MassDEP LIS TMDL NPS and stormwater BMP analysis* provides a good example of a spreadsheet-based input and output framework applied to large areas in LIS watershed. The MassDEP tool demonstrates an approach for gathering the required BMP data for large areas within the LIS watershed and for applying CBP method for calculating nitrogen reductions associated with NPS controls. The MassDEP tool does not include a user interface for data entry or an output framework. We recommend further evaluating the MassDEP tool and adapting parts of the spreadsheet formats and the methods for obtaining and inventorying BMPs by sub-basin within the selected tracking system.

6.2 Chesapeake Bay Watershed Model-based Systems and Tools

The Chesapeake Bay Program-related tools, Scenario Builder and the Chesapeake Bay HSPF Model, are components of a complex tracking system featuring direct interaction with a complex predictive model. Modifying and applying these tools for the Long Island Sound region would likely require many years, a high-level of effort, and a prohibitive level of funding. For these reasons, the CBP Watershed Model and the model-dependent tool, Scenario Builder, were removed from further consideration.

Chesapeake Stat and the Chesapeake Bay TMDL Tracking and Accounting System (BayTAS) provide high-quality, fully-developed examples of tracking system accounting and output data visualization techniques. We recommend continued evaluation of these tools and potentially adapting them for inclusion in the selected tracking system.

6.3 Chesapeake Bay Assessment and Tracking Tool (CAST)

We recommend selecting the CAST framework for use as a LIS tracking system. The existing CAST program provides strong input and output features that are compatible with the LIS tracking system needs. CAST has been fully vetted and is currently widely used by a variety of stakeholders in the Chesapeake Bay region. CAST could be readily modified for use in Long Island Sound region. CAST's developers are available to support customization of CAST for use as Long Island Sound tracking system.

CAST appears to be complex enough to meet LISS program needs without being overly complex. The LIS study area could be represented as a set of sub-basins in CAST and the user could specify numerous types of urban and agricultural NPS control measures (e.g., BMPs) within each sub-basin. CAST could also host removal efficiency calculation modules for each type of control measure that have been adapted from other sources. Customized removal efficiency modules would be placed in CAST for use in the Long Island Sound tracking system.

CAST is:

- Capable of tracking control measures by sub-basin in a manner compatible with the management zones identified in the LIS TMDL;
- Tested and applied by agency personnel and currently widely used by stakeholders;
- A comprehensive framework that:
    - Uses a user-friendly web-based interface for inputting data and reviewing results;
    - Has the flexibility to incorporate modular nitrogen reduction calculation methods for each type of control measure; and
    - Includes a database and output displays that can be readily enhanced using components adapted from other sources.

- Does not explicitly include spatial characterization of BMPs within sub-basins (e.g., GIS location and distance to stream) and may need to be modified to include this information.

Modifying and applying CAST to the Long Island Sound region would be relatively cost-effective. As a result, a high-quality, comprehensive system could be acquired for relatively low cost. In addition we recommend adapting components from other candidate tracking systems, as outlined above, to be used in conjunction with CAST.

7.0 Summary

The evaluation of NPS control measure tracking systems for the LIS watershed featured a LIS NPS control measure tracking system needs assessment, an inventory and review of available tracking systems, and a screening process for potentially suitable tracking systems. The objective of the evaluation was to select a quantitative tracking system that would support long-term evaluation of NPS and stormwater nitrogen reductions required as part of the LIS TMDL implementation plan. The LISS NPS and Watersheds Workgroup and LIS TMDL Workgroup, working in cooperation with NEIWPCC, successfully guided this evaluation project by participating in webinars, reviewing memos, and providing recommendations throughout the process.

A tracking system that quantitatively tracks change in nitrogen from NPS control measures, such as urban stormwater and agricultural BMPs, is required to assess the progress of LIS TMDL implementation. A suitable tracking system needs to be able to accurately estimate pollutant load reductions from a wide variety of NPS control measures within a common framework. The selected tracking system must be capable of aggregating sets of NPS control measures and calculating the resulting total pollutant load reductions within specific watershed areas. The tracking system must also be capable of supporting calculation of pollutant loads reductions to LIS (i.e. accounting for attenuation during transport from specific sub-basins to LIS). This watershed-level pollutant load reduction estimate will then be updated periodically to provide an assessment of progress toward NPS load reduction targets. Ideally, the selected tracking system may also support watershed planning and cost-benefit analysis by providing estimates of pollution reduction and associated costs for specific candidate BMPs.

The inventory and targeted review of available BMP tracking systems began on a national scale and eventually focused on systems currently used in the Chesapeake Bay region and systems currently under development in New England and New York. The features of available BMP tracking systems were compared to the requirements of the LIS BMP tracking system. Several available BMP tracking systems were found to have readily adaptable components. Several key factors emerged as important in evaluating BMP tracking systems. These factors included the user interface, the variety and specificity of pollutant removal efficiency calculations, and data management and output features.

The evaluation was successful in selecting a suitable tracking system, CAST, and several separate system components that may be adapted for use in the CAST framework. The resulting CAST-based LIS nitrogen reduction tracking system for the LIS watershed would then be sufficiently robust to support the TMDL implementation process. The Long Island Sound tracking system would likely need to be developed in an iterative and highly cost-efficient manner. Initial tasks would include establishing baseline conditions and control measures used in the tracking system and applying the tracking system to a pilot watershed. Initial tasks that could be conducted to support LIS tracking system development and implementation are outlined below.

Task A. Establish tracking system baselines. This task would establish a base year for land use data and for control measure installation dates needed as a basis of comparison to control measure reductions. This task would also establish nitrogen export coefficients for use in the tracking system. The NPS nitrogen export coefficients used in the 2000 LIS DO TMDL and other sets of coefficients would be reviewed and evaluated. This task would result in a scientific explanation and defensible rationale for selecting of a base year and a set of nitrogen export coefficients for the LIS tracking system.

Task B. Adopt a set of nitrogen removal efficiency calculation methods for control measures. This task will focus on review, evaluation, and selection of an initial set of control measures and calculation methods. CBP expert panel reports, EPA Region 1 research, and numerous other sources will be reviewed and evaluated to support identification of a set of urban and agricultural control measures to include in the first version of the tracking system. Nitrogen removal efficiency methods would be selected for each of the selected control measure types used. Documentation, including technical rationale, for each nitrogen removal efficiency method would be provided.

Task C. Select a pilot sub-basin and obtain required data. The tracking system would be implemented in a pilot sub-basin. An appropriate sub-basin would be selected and used as a pilot or test platform for the first version of the LIS tracking system. Required land use data layers would be obtained for the pilot sub-basin including both a base year layer and current year (e.g., 2014) data layer. Nitrogen export coefficients for land use types (e.g., forest, urban, and agricultural) would be identified and applied. Next, an inventory urban and agricultural control measures installed since the base year would be compiled for use in the tracking system. This task would provide the data required to apply the tracking system to a pilot watershed.

Task D. Adapt CAST as a framework and apply to the pilot watershed. The CAST system would be customized, as needed, to serve as an LIS tracking system framework. The baseline data and control measure calculation methods modules, outlined above, would be loaded into the CAST-like tracking system. The CAST-like tracking system would be applied for the pilot LIS sub-basin. Nitrogen load reduction would be calculated in the sub-basin and as delivered to LIS (accounting for attenuation between the sub-basin and LIS). The results of the CAST-like tracking system pilot watershed application would be summarized in a brief report and submitted for review.

Once these initial tasks were completed, the LIS tracking system could be efficiently applied to other sub-basins throughout the LIS watershed. The four initial tasks outlined above could be completed at an estimated contractor support cost of $140,000 to $190,000. The contractor cost estimates are uncertain and would vary depending on several factors including the level of complexity of the tracking system requirements and the level of agency participation (e.g., in providing baseline data and control measure inventory data).

8.0 References

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U.S. EPA, 2013. *General Permit for Stormwater Discharges From Small MS4s – New Hampshire – 2013.* Appendix H Requirements Related to Nitrogen-Impaired Waters in the Great Bay Estuary and Chloride-Impaired Waters. Attachment 1: Estimates of Nitrogen Load Reductions resulting from BMP Installation and Illicit Connection Removal.

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