Maine Statewide
Total Maximum Daily Load (TMDL)
for Nonpoint Source (NPS) Pollution

Maine Statewide
Total Maximum Daily Load (TMDL)
for Nonpoint Source (NPS) Pollution

Melissa Evers, Susanne Meidel & Don Witherill
Division of Environmental Assessment
Maine Department of Environmental Protection
Augusta, Maine

June 2016

Prepared by:

FB Environmental Associates, Inc.
97A Exchange Street, Suite 305
Portland, Maine 04101

Cover photos: *Top left – Brook trout in Burnham Brook, Garland, ME; Middle left - Dyer River, Newcastle, ME; Bottom left – Jock Stream, Wales, ME; Top right – Merritt Brook, Presque Isle, ME; Bottom right – Stetson Brook, Lewiston, ME (Photo credits: Merritt Brook photo by Kathy Hoppe, Maine DEP; all others by FB Environmental).*

Executive Summary

This *Maine Statewide Total Maximum Daily Load (TMDL) for Nonpoint Source (NPS) Pollution* report has been developed to address water quality impairments in 21 rural/suburban streams in Maine that are affected by nonpoint source (NPS) runoff. This report is issued to satisfy Section 303(d) of the Federal Clean Water Act and 40 CFR § 130.7 that require states to establish the total maximum daily load of pollutants for those impaired waters. These waterbodies were listed as impaired in *Maine's 2012 Integrated Water Quality Monitoring and Assessment Report* and have been assessed as not meeting the criteria in Maine's water quality standards (WQS) for aquatic life protection. The TMDL is an assessment of the maximum loading that a waterbody can receive without exceeding its WQS. NPS pollution, which includes stormwater runoff, cannot readily be traced back to a specific source within a watershed. One of the major constituents of NPS pollution is sediment, which contains nutrients that stimulate algal growth. Excessive algal growth depresses dissolved oxygen (DO) and sedimentation impacts stream habitat suitability for aquatic life.

This TMDL evaluates NPS pollution using a regionally calibrated land-use model that calculates pollutant loads for nutrients (nitrogen and phosphorus) and sediment. Maine's WQS do not contain numeric criteria for nutrients and sediment, therefore a comparative attainment approach was used to establish pollution reduction targets for impaired waters. This approach requires identical modeling procedures be applied to both impaired watersheds and corresponding watersheds that attain WQS. Pollutant load reductions are then calculated based on the difference between impaired and attainment watersheds. The pollutant reductions needed to attain WQS vary greatly with watershed condition and the ranges are: sediment from 0% to 94%, nitrogen from 0% to 70% and phosphorus from 0% to 78%. Watersheds that needed no reductions in pollutants were dominated by forested lands and the observed impairments are likely due to natural conditions, such as the presence of wetlands. The overall median reduction values were 24% for sediment, 26% for nitrogen and 24% for phosphorus.

Each watershed in this TMDL underwent a field assessment that included documenting conditions within the stream and on the surrounding terrain that may contribute to the observed impairment. These assessments included measuring instream habitat, sampling water quality and documenting areas of significant runoff (hot spots) in the watershed. A detailed description of these assessments and the modelling results are presented for each watershed in a separate appendix. The information in each appendix is designed to support communities and stakeholders in developing a Watershed Management Plan (WMP) that will describe the steps needed to achieve pollution reduction targets and to attain WQS.

DEP received extensive comments on the TMDL, which are detailed in Appendix 5. Many stakeholders were concerned about the implications of MS4 regulations that may result from the approval of the TMDL. In response, DEP decided to map the overlap between these watersheds and regulated MS4 areas, as shown in Appendix 4. The result is that many of these watersheds have a small overlap between the two areas, while only one stream is completely contained in the regulated area. This information may have implications for setting stream restoration priorities under the MS4 program.

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Appendices Cont.

1. Introduction

This *Maine Statewide Total Maximum Daily Load (TMDL) for Nonpoint Source (NPS) Pollution* report has been developed to address water quality impairments in multiple small rural/suburban streams in Maine that are affected by nonpoint source (NPS) runoff and accompanying pollutants. The waterbodies in this report, as listed in Table 1, have been assessed as not meeting the criteria for aquatic life use protection contained within Maine's water quality standards (WQS). The waterbodies were included on the 2012 list of impaired waters based on the results of various assessment criteria for aquatic life use support in freshwater streams. This report is issued to satisfy Section 303(d) of the Federal Clean Water Act and 40 CFR § 130.7 that require states to establish the total maximum daily load of pollutants for those impaired waters previously identified in the state. The TMDL represents the maximum loading that a waterbody can receive without exceeding water quality standards.

The waterbodies addressed in this document are impaired by NPS pollution as a result of anthropogenic activities within their watersheds. NPS pollution, also known as stormwater runoff, cannot be traced back to a specific source; rather it often comes from a number of diffuse sources within a watershed. Stormwater runoff is water that doesn't soak into the ground during a rain storm and instead flows over the surface of the ground until it reaches a stream, lake, estuary, or the ocean, picking up pollutants such as soil, fertilizers, pesticides, manure, and petroleum products along the way. One of the major constituents of NPS pollution is sediment, which contains a mixture of nutrients (such as phosphorus and nitrogen), inorganic and organic material that stimulate algal growth. Excess algal growth consumes oxygen during respiration and leads to a decrease in levels of dissolved oxygen (DO) in a stream. Phosphorus and nitrogen are the limiting nutrients for algal growth and sediment-laden runoff carries these nutrients into streams.

This TMDL addresses nutrients (nitrogen and phosphorus) and sediment in NPS pollution, which have been identified as the primary contributors to the observed and measured degradation of aquatic life use in the impaired waterbodies. Because Maine’s WQS do not contain numeric criteria specifically for phosphorus, nitrogen, or sediment, a regionally calibrated land-use model known as MapShed, and a comparative attainment approach were used to establish pollution reduction targets for each of the impaired waterbodies, with pollutant loads estimates listed in Appendix 1.

The comparative attainment approach to TMDL development requires identical modeling procedures be applied to impaired watersheds and corresponding watersheds that attain WQS for aquatic life and DO. The attainment watersheds share similar characteristics to the impaired watersheds regarding geographic area, climate, soil, topography, watershed size, landscape, development, and land-use patterns. TMDL loading capacity for each of the three surrogate pollutants for each waterbody is calculated by comparing loading results for impaired streams to the appropriate attainment stream values.

TMDLs provide a scientific basis for the development and application of a Watershed Management Plan (WMP), which describes the control measures necessary to achieve WQS. Public participation during the subsequent preparation of the WMPs is vital to the success of resolving water quality impairments. This report includes recommended next steps and contains information to support communities and stakeholders in developing a WMP in a phased manner that will ultimately result in attainment of water quality standards.

2. Aquatic-Life Impaired Waters and Priority Ranking

This Maine Statewide TMDL for NPS Pollution report serves as TMDL documentation for multiple fresh waters in Maine impaired for aquatic life use. The report addresses impairments in 21 streams that have varying attainment goals (Class A, B, or C) and are located in different geographic areas across the state. Figure 1 shows the locations of the impaired segments by major river basin, with the highest number of impaired segments in the Kennebec and Androscoggin river basins. Table 1 lists watershed and waterbody information for each impaired segment. Watershed-specific TMDL summaries containing watershed descriptions, maps and calculations to support the TMDL for each of these impaired streams are included in Appendix 6 of this report.

Priority Ranking and TMDL Schedules

Section 303(d) of the Clean Water Act requires that waters on the 303(d) list be ranked in order of TMDL development priority. The Maine Department of Environmental Protection (Maine DEP) sets priority rankings based on a variety of factors, including severity of degradation, duration of the impairment, and opportunities for remediation. Maine DEP has designated the streams in this TMDL report for completion in 2016 (Table 1).

Future TMDL Applicability

Under appropriate circumstances in the future, Maine DEP may submit additional TMDLs to the U.S. Environmental Protection Agency (USEPA) for specific waterbodies to be added for NPS TMDL coverage without resubmitting the approved core document (i.e. this document) at such times. The future submittals will provide detailed information on the additional impaired waterbodies and their TMDLs. Maine will provide public notice for review of the additional TMDLs either alone, or as part of the public notice process associated with the biannual review of the State's Integrated Water Quality Monitoring and Assessment Report. If previously unlisted waterbodies are involved, Maine DEP will clearly state its intent to list the newly assessed waterbodies as impaired, and to apply the appropriate waterbody-specific TMDLs.

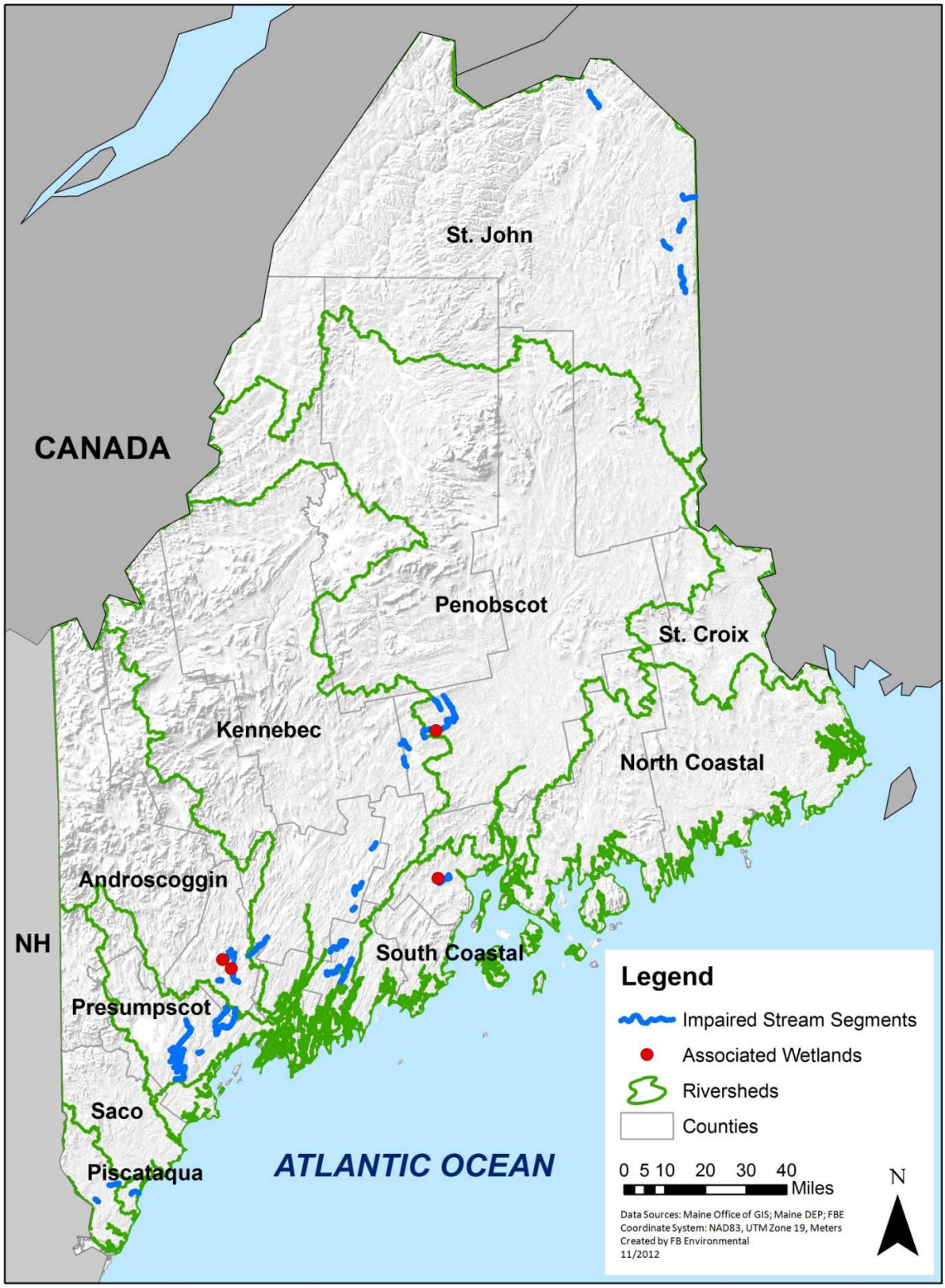

Figure 1: *Locations of impaired waterbody segments included in this report*

Table 1. *TMDL waterbody and watershed information*

Note that only the towns in which the impaired waterbodies are located are listed here. Other towns that have portions of a watershed are noted in the stream appendices.

Stream	Town	ADB#	Receiving Waterbody	Listing Cause	Size (miles)	Class	TMDL Priority	TMDL Schedule
St. John								
Coloney Brook	Fort Fairfield	ME0101000413_146R02	Limestone Stream	Benthic-Macroinvertebrate Bioassessments and Periphyton (Aufwuchs) Indicator Bioassessments	4.5	B	H	2016
Everett Brook	Fort Fairfield	ME0101000412_143R01	Aroostook River	Dissolved Oxygen	3.53	B	H	2016
Merritt Brook	Presque Isle	ME0101000412_143R02	Aroostook River	Benthic-Macroinvertebrate Bioassessments and Periphyton (Aufwuchs) Indicator Bioassessments	2.8	B	H	2016
Penobscot / North Coastal								
Burnham Brook	Garland	ME0102000510_224R01	Kenduskeag Stream	Dissolved Oxygen	3.73	B	H	2016
Crooked Brook	Charleston / Corinth	ME0102000510_224R07	Kenduskeag Stream	Periphyton (Aufwuchs) Indicator Bioassessments	10.6	B	H	2016
Warren Brook	Morrill / Belmont / Belfast	ME0105000218_521R01	Passagassawakeag River	Dissolved Oxygen	6.04	B	H	2016
Kennebec								
Brackett Brook	Palmyra / Newport	ME0103000308_325R02	East Branch Sebasticook River	Dissolved Oxygen	2.74	B	H	2016
Carlton Brook	Whitefield	ME0105000305_528R06	Sheepscot River	Dissolved Oxygen	5.5	B	H	2016

Stream	Town	ADB#	Receiving Waterbody	Listing Cause	Size (miles)	Class	TMDL Priority	TMDL Schedule
Chamberlain Brook	Whitefield / Pittston	ME0105000305_528R08_01	Sheepscot River	Dissolved Oxygen	3.7	B	H	2016
Choate Brook	Windsor	ME0105000305_528R07	West Branch Sheepscot River	Dissolved Oxygen	1.33	A	H	2016
Dyer River	Jefferson / Newcastle	ME0105000305_528R03	Sheepscot River	Dissolved Oxygen	9.35	B	H	2016
Jock Stream	Wales / Monmouth	ME0103000311_334R03	Cobbossecontee Lake	Nutrient/Eutrophication Biological Indicators & Dissolved Oxygen	9.43	B	H	2016
Meadow Brook	China	ME0105000305_528R05	West Branch Sheepscot River	Dissolved Oxygen	5.94	B	H	2016
Mill Stream	Albion	ME0103000309_327R01	Fifteenmile Stream	Dissolved Oxygen	2.17	B	H	2016
Mulligan Stream	St. Albans / Corinna / Newport	ME0103000308_325R03	Sebasticook Lake	Dissolved Oxygen	4.8	B	H	2016
Trout Brook	Alna / Wiscasset	ME0105000305_528R04	Sheepscot River	Dissolved Oxygen	7.7	A	H	2016
Piscataqua / Saco / Presumpscot / Androscoggin								
Chandler River	Duram / Pownal / North Yarmouth	ME0106000102_603R02	Royal River	Dissolved Oxygen	27.19	B	H	2016
Hobbs Brook	Cumberland / Falmouth	ME0106000103_607R06	Piscataqua River	Dissolved Oxygen	1.54	B	H	2016
Penley Brook	Auburn	ME0104000210_413R02	Androscoggin River	Dissolved Oxygen	1.57	B	H	2016
Thayer Brook	Gray	ME0106000103_607R10	Pleasant River	Dissolved Oxygen	4.7	B	H	2016
West Brook	Wells / North Berwick	ME0106000304_625R03	Great Works River	Dissolved Oxygen	3.22	B	H	2016

Maine's Nonpoint Source Program and Rural/Suburban Impaired Streams

Maine's NPS Management Program works toward protecting and restoring surface and groundwater impaired by pollutants associated with both nonpoint sources and stormwater runoff. The overall objective of the NPS Program is to prevent, control, or abate NPS pollution to lakes, streams, rivers and coastal waters so that beneficial uses of those waters are maintained or improved.

Through this program, Maine DEP funds and administers grant projects to prevent or reduce NPS pollutants from entering Maine's water resources. Projects are funded with grant money provided to Maine DEP by the (USEPA) under Section 319 of the Clean Water Act. Maine public organizations such as state agencies, soil and water conservation districts, regional planning agencies, watershed districts, municipalities, and nonprofit [501(c)(3)] organizations are eligible to receive NPS grants. Annually in April, the NPS Program issues a Request for Proposals (RFP) for competitive NPS Water Pollution Control Projects. NPS projects help local communities recognize water pollution sources in watersheds and take action to restore impaired waterbodies. Projects geared toward restoring impaired waters may include:

- *Watershed Surveys* - A watershed survey is designed to identify NPS pollution sources (primarily soil erosion) in a watershed.
- *Watershed-Based Planning.* A watershed-based plan (WBP) describes overall actions and pollution reduction measures needed in a watershed to help restore water quality. Planning organizes public and private sector efforts to identify, prioritize, and then implement activities to address priority water-related problems within the watershed. Active participation in the WBP process will include evaluating how to best restore the stream, identify critical source areas needing best management practices (BMPs), and identify the most appropriate funding mechanisms.
- *Implementing Pollution Reduction Measures.* Communities, agencies, and individuals take action to apply conservation practices or BMPs to eliminate or control sources of NPS pollution. Usually work needs to be focused within a watershed over five to 10 years or more to restore an impaired waterbody. Maine DEP can provide technical assistance and limited financial assistance through opportunity for NPS water pollution control grants to help communities improve watersheds and restore NPS impaired waters.

More information about the Maine NPS Program can be found at Maine DEP's website: http://www.maine.gov/dep/water/grants/319.html.

3. Pollutant Sources and Description of Impairments

Sediment from Merritt Brook in Presque Isle flows into the Aroostook River after a rain storm in September 2012. (Photo: Sean Bernard, Maine DEP)

This TMDL addresses waterbodies impaired by NPS runoff primarily from anthropogenic activities within the watershed. All land disturbances have the potential to contribute runoff, but the degree of disturbance associated with agricultural and some suburban land uses is likely the greatest contributor of silt and nutrient enrichment to the waters. The close proximity of these land uses to the stream increases the likelihood that the disturbed and bare soil, containing phosphorus, nitrogen and sediment will reach the waterbody. Three common pollutants in nonpoint source runoff [total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS)] serve as surrogates for the stressors that contribute to the impairment of aquatic life use in the waterbodies addressed by this TMDL.

Elevated nutrient loading and sediment accumulation contribute to excess algal growth, which consumes oxygen during respiration and depresses DO levels. Excess soil runoff provides sediment that contains a mixture of nutrients, and inorganic and organic material which contributes to enriched macroinvertebrate communities. Phosphorus and nitrogen are the limiting nutrients for algal growth and sediment-laden runoff carries these adsorbed nutrients into streams.

Excess sediment contributions to streams may lead to habitat degradation and reduced suitability for a wide spectrum of aquatic life. Over time sedimentation alters habitat by filling in pools, embedding substrate in riffles and contributing nutrients. These factors change the habitat suitability, which in turn shifts the composition of organisms adapted to living in the stream. While sediment is not the only factor affecting habitat in a dynamic stream environment, it is a significant contributor and provides a reasonable surrogate for aquatic habitat degradation in this TMDL.

Maine DEP uses a variety of assessment methods and criteria to determine whether a waterbody supports aquatic life use in a stream or wetland. For example, measurements of dissolved oxygen or temperature and surveys of habitat suitability provide physical and chemical assessments of waterbody health. Biomonitoring techniques are used to evaluate the structure and function of a resident biological

community in a stream or wetland. For example, analyzing samples of benthic macroinvertebrates or algae in streams provides different ways to assess the extent to which a waterbody supports aquatic life use.

Atmospheric Deposition

Atmospheric deposition of nutrients that fall within a watershed will reach a waterbody through runoff from land-deposited material, and direct contact with rain and dry airborne material that settles on the waterbody surface. It is assumed that the soil serves to buffer and absorb most atmospherically deposited nutrients before they reach the waterbody through the runoff processes.

Natural Background Levels

As is true of all watersheds with a history of human habitation, the stream watersheds included in this TMDL are not pristine and NPS loading has resulted from human activities. Natural environmental background levels for the impaired streams were not separated from the total NPS load because of the limited and general nature of available information. Without more and detailed site-specific information on NPS loading, it is very difficult to separate natural background from the total NPS load (USEPA, 1999).

4. Applicable Water Quality Standards and Numeric Water Quality Target

Water quality standards for all surface waters of the State of Maine have been established by the Maine Legislature (Title 38 MRSA §464-470). Maine's WQS are composed of three parts: classification and designated uses, criteria, and antidegradation regulations. Each of these parts is described below as it pertains to the impaired waters included in this report.

Under Maine's Water Classification Program, the State of Maine has four tiers of water quality classifications for freshwater rivers and streams and associated wetlands (AA, A, B, C), each with designated uses and water quality criteria providing different levels of protection.

The designated uses for each classification of freshwater rivers and streams, according to State statute, are described in Table 2.

Table 2: *Designated uses for each classification of Maine's fresh surface waters*

Water Class	Designated Uses
Class AA	Drinking water supply after disinfection, recreation in and on the water, fishing, agriculture, navigation and habitat for fish and other aquatic life.
Class A	Drinking water supply after disinfection, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation[1], navigation and habitat for fish and other aquatic life.
Class B	Drinking water supply after treatment, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation[1], navigation and habitat for fish and other aquatic life.
Class C	Drinking water supply after treatment, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation[1], navigation and habitat for fish and other aquatic life.

The water quality standards relevant to this TMDL report include the designated use of "habitat for fish and other aquatic life" (aquatic life use support) for each of the classification levels, and the relevant water quality criteria assigned to each class, as summarized in Table 3. For example, narrative criteria for aquatic life use support differ for each water quality classification level. The standards for habitat range from the highest goal (AA, "free flowing and natural"; A, "natural"), to allowing some level of risk from discharges (B, "unimpaired"), to allowing an increased level of risk from discharges with some impact (C, as long as aquatic life habitat is maintained). The classes providing the most protection and least risk of impairment have the most stringent water quality criteria.

[1] Except as prohibited under Title 12, section 403

Table 3: *Applicable narrative and numeric water quality standards for Maine's fresh surface waters*

Water Class	Dissolved Oxygen Numeric Criteria	Habitat Narrative Criteria	Aquatic Life (Biological) Narrative Criteria[1]
Class AA	As naturally occurs	Free flowing and natural	No direct discharge of pollutants; as naturally occurs
Class A	7 ppm; 75% saturation	Natural	As naturally occurs
Class B	7 ppm; 75% saturation	Unimpaired	Discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.
Class C	5 ppm; 60% saturation; 6.5 ppm (monthly average) at 22° and 24°F	Habitat for fish and other aquatic life	Discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

[1] *Numeric biocriteria in Maine rule Chapter 579; Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.*

In addition, Maine WQS have an antidegradation provision designed to protect and maintain all water uses and water quality whether or not stated in the waterbody's classification as of November 28, 1975 [38 MRSA §464.4.F.]. Uses include aquatic life, habitat, recreation, water supply, commercial activity, and ecological, historical or social significance. The antidegradation provision ensures that waste discharge licenses or a water quality certification are issued only when there will be no significant impact on the existing use or failure of the waterbody to meet standards of classification.

5. Loading Capacity: Linking Water Quality and Pollutant Sources

Loading Capacity & Linking Pollutant Loading to a Numeric Target

The loading capacity of a waterbody is the mass of constituent pollutants that the water can receive over time and still meet WQS. Loading capacity for nonpoint source pollutants is best expressed as an annual load, in order to normalize the spatial and temporal variation associated with instream NPS pollutant concentrations. The loading capacity for the impaired streams is based on a comparative reference approach to set the allotment for existing and future nonpoint sources that will ensure support for existing and designated aquatic life uses. The MapShed model output (Appendix 2) expresses pollutants in terms of land-based loads which have been broken down into a unit area basis for comparative purposes. Appendix 1 lists the estimated pollutant loads in the NPS-impaired waters, compared to TMDL load allocations in attainment watersheds shown below in Table 4. The comparison of modeled pollutant loads

in impaired waters to the modeled pollutant loads in the appropriate attainment watershed(s) provides the essential link between pollutant loadings in impaired waters to the numeric targets for TP, TN, and TSS associated with the appropriate attainment watershed(s). Eventual attainment of WQS will be assessed according to Maine's current listing methodology and use of the appropriate assessment indicators for aquatic life use support, as defined in Maine's water quality standards (see Table 3 above).

Table 4: *Numeric loading estimates for pollutants of concern in attainment watersheds based on MapShed modeling results (Appendix 2)*

Stream	**Region**	**POLLUTANTS**[1] (Annual Unit Area Loads)		
		Phosphorus Load (kg/ha/yr)	**Nitrogen Load** (kg/ha/yr)	**Sediment Load** (1000kg /ha/yr)
Martin Stream	Kennebec	0.14	3.37	0.01
Footman Brook	Penobscot / North Coastal	0.33	6.40	0.06
Upper Kenduskeag Stream	Penobscot / North Coastal	0.29	5.60	0.05
Upper Pleasant River	South Coastal / Piscataqua / Saco / Presumpscot / Androscoggin	0.22	4.64	0.02
Moose Brook	St. John	0.25	5.90	0.02
Statewide TMDL: Average of Attainment Streams--> (Applicable to both WLAs and LAs)		**0.24**	**5.18**	**0.03**

[1] *The TMDL loads can be expressed as a daily maximum load by dividing the numeric targets above by 365.*

Supporting Documentation - TMDL Approach

This NPS TMDL approach includes measuring various environmental assessment parameters, and developing a water quality model for each watershed to estimate pollutant loadings, comparing modeled loading levels of TP, TN, and TSS in impaired and attainment watersheds, and calculating reductions that will ensure attainment of Maine's WQS. The Maine NPS TMDL analysis uses the MapShed model to estimate pollutant loadings. MapShed is an established midrange modeling tool first developed as the Generalized Watershed Loading Function (GWLF) model by Haith and Shoemaker (1987), and Haith et al. (1992). The model was refined regularly by Evans and others at Penn State into a ArcView GIS-based model called AVGWLF (Evans et al., 2002); it has recently transitioned to the open-source MapWindow GIS and is now called MapShed (Evans& Corradini, 2012). A key benefit of using MapShed is the availability of a high quality data set developed under a Quality Assurance Project Plan (NEIWPCC,

2005), and calibrated to the New England region (Penn State University, 2007).

The model uses geographic data (e.g. soils, watershed boundaries, land uses), land-use runoff coefficients, daily weather (temperature and rainfall), and universal soil loss equations, to compute flow and pollutant loads. The model was run for each of the 21 impaired stream segments and five attainment streams for a 10 to 15 year period (depending on weather data availability). Running the model over this time span covered a wide range of hydrologic conditions to account for variations in nutrient and sediment loading over time. To estimate the TMDL reductions needed to attain WQS, the MapShed model results are used to estimate the existing load in each of the impaired stream segments and the attainment streams. The difference in estimated pollutant loads between the impaired and attainment watersheds is the reduction needed to achieve WQS for all NPS pollutants of concern.

Strengths and Limitations:

Model Strengths:

- MapShed is an established midrange model that is commonly accepted to estimate pollutant loads in river and stream TMDLs.
- The MapShed model was created using regional input data to reflect local watershed conditions to the greatest extent possible.
- The model makes best use of available GIS land-use coverages to estimate NPS loads.
- The model was run for a 10 to 15 year period to account for a wide range of hydrologic conditions among years.
- A reference approach is a reasonable mechanism to establish criteria for pollutants of concern, where no regulatory numeric criteria exist.
- The MapShed model and data set have been calibrated at the New England regional scale.
- The model allows for the manual input of values based on field observations.

Model Limitations:

- The MapShed model is a screening-level model that provides a general estimate of watershed nutrient-loading conditions.
- The model and data set have not been calibrated to the watershed-specific scale.

General Critical Assumptions Used in the MapShed Modeling Report:

- All land use of the same category is assumed to have the same phosphorus and nitrogen loading coefficients.
- If no meteorological data are available from within the watershed, the average values from the two nearest weather stations are assumed to be representative of the watersheds.

- Land uses were reviewed in the field. However, no changes were made to the GIS land-use coverage.
- Limited field reconnaissance was undertaken to develop estimates of livestock, pasture, and agricultural practices. The associated input parameters could be improved by additional observation and surveying natural resource agencies or farmers.
- Streams in agricultural areas were assumed to be reaches of the stream that directly abutted agricultural land on at least one bank.

Critical Conditions

The loading capacity for the impaired segments is set to protect water quality and support uses during critical conditions, which are defined as environmental conditions that induce a stress response in aquatic life. Environmentally stressful conditions involving nonpoint sources may occur throughout the year and depend on the biological requirements of the life stage of resident aquatic organisms. Traditionally, summer low flow periods are considered critical for aquatic organisms due the combination of low velocity, high temperatures and low dissolved oxygen. However, aquatic organisms that reside in streams often confront harsh winter conditions and winter often determines the success or failure of native salmonid species, such as brook trout. Seasonally, low flows occur in the winter and native fish are under stress as they compete for limited winter habitat, as defined by water velocity and unembedded substrate. Additionally, trout eggs are incubating in the gravel during the winter and have specific velocity and dissolved oxygen requirements that may be compromised by the addition of excess sediment. Some species of stoneflies emerge and develop during the winter and remain vulnerable to chronic sediment input. In summary, critical conditions are complex in flowing water and a major consideration in using an average annual load approach for these NPS TMDLs.

TMDL Loading Calculations

The existing loads for nutrients (kg/ha/year) and sediments (1000 kg/ha/year) in the impaired segments are listed in Appendix 1 (‘Table of Estimated Pollutant Loads (TMDL Allocations)’). Appendix 2, the ‘Modeling Report to Support TMDL Development’, describes the MapShed modeling results and calculations used to define TMDL reductions, and compares existing nutrient and sediment loads in the impaired streams to TMDL endpoints (loading capacities) derived from the attainment streams listed in Table 4. An annual time frame provides a mechanism to address the daily and seasonal variability associated with NPS loads. As previously mentioned, it was not possible to separate natural background from nonpoint pollution sources in any watersheds because of the limited and general nature of the available information.

The reduction in pollutants discussed in this TMDL reflects reductions from estimated existing conditions. Expansion of agricultural and other development activities in watersheds have the potential to

increase runoff and associated pollutants. To ensure that the TMDL targets are attained, future activities will need to meet the TMDL targets. Future population growth should be assessed and addressed on a watershed-basis to account for new development.

Seasonal Analysis

Seasonal variation is considered in the allowable annual loads of nutrients and sediment which protect macroinvertebrates and other aquatic life under the influence of seasonal fluctuations in environmental conditions such as flow, rainfall and runoff. All unregulated streams in Maine experience seasonal fluctuations in flow, which influences the concentration of nutrients and sediment. Typically, high flows occur during spring and fall, and low flows occur during the summer and winter. Snow and rainfall runoff may contribute variable amounts of nutrients and sediment. Large volumes of runoff may also dilute instream nutrients and sediment concentrations, depending on the source.

NPS pollution events that occur over the entire year contribute to the aquatic life impairments documented in the impaired streams. Therefore, the numeric targets are applicable year round. Furthermore, benefits realized from pollutant reductions will occur in all seasons. There is no need to apply different targets on a seasonal basis because the measures implemented to meet the numeric targets will reduce adverse impacts for the full spectrum of storms throughout the year. Therefore, the TMDL adequately accounts for all seasons.

6. TMDL Allocations and Margin of Safety

According to the Code of Federal Regulations (CFR) that govern water quality and management [40 CFR Part 130.2], the TMDL for a waterbody is equal to the sum of the individual loads from point or National Pollutant Discharge Elimination System (NPDES[2]) regulated sources (i.e., waste load allocations, WLAs), and load allocations (LAs) from nonpoint or non-NPDES regulated sources (including natural background conditions). Section 303(d) of the Clean Water Act also states that the TMDL must be established at a level necessary to implement the applicable WQS with seasonal variations and a margin of safety (MOS) which takes into account any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality.

The **Maine Pollutant Discharge Elimination System (MEPDES)** *permit program controls water pollution by regulating point sources that discharge pollutants into surface waters. (**Point sources** are any single identifiable source of pollution from which pollutants are discharged.)*

[2] Maine is delegated to issue its own NPDES permits, which are then called “MEPDES”.

In equation form, a TMDL is expressed as follows:

TMDL	=	*WLA + LA + MOS*

where:

WLA	=	Waste Load Allocation (i.e. loadings from point sources or NPDES/MEPDES regulated sources)
LA	=	Load Allocation (i.e., loadings from nonpoint sources or non-NPDES/MEPDES regulated sources including natural background)
MOS	=	Margin of Safety

TMDLs may be expressed in terms of either mass per time, concentration or other appropriate measure [40 CFR Part 130.2 (i)].

Margin of Safety

TMDL analyses are required by law to include a MOS to account for uncertainties regarding the relationship between load and wasteload allocations, and water quality. The MOS can either be explicit or implicit. If an explicit MOS is used, a portion of the total allowable loading is actually allocated to the MOS. If the MOS is implicit, a specific value is not assigned to the MOS. Use of an implicit MOS is appropriate when assumptions used to develop the TMDL are believed to be so conservative that they are sufficient to account for the MOS.

An implicit margin of safety was incorporated into the NPS TMDL through conservative assumptions associated with the selection of the numeric water quality targets based on watersheds that attain Maine WQS: (1) MapShed calculates pollutant loads with minimal losses to the absorptive capacity of landscape conditions that reduces the runoff the stream receives; (2) Some of the impaired watersheds contain riparian buffers and undocumented agricultural BMPs, which effectively reduce loading, but were not factored into the modeling process; (3) A land-use runoff model, like MapShed, also does not account for instream processes that attenuate nutrients and settle sediments during transit, which reduce the pollutant load that moves through the system. These factors provide a MOS to account for uncertainty and reasonably ensure that WQS will be attained in the impaired streams.

Load Allocation (LA) and Wasteload Allocation (WLA)

For each impaired waterbody addressed by these TMDLs, LAs (for background sources, nonpoint sources, and non-regulated stormwater) are given the same TP, TN, and TSS allocations as the WLAs (for MEPDES regulated sources) because the TMDLs are expressed in terms of annual unit area loads. (Nutrients are expressed in terms of kg/ha/year; sediment is expressed in terms of 1,000 kg/ha/year.)

This approach is used because, while WLAs and LAs must be accounted for, it is not feasible to separate the loading contributions from nonpoint sources, non-regulated stormwater, and natural background. Since the streams addressed by this TMDL are small and do not have MEPDES regulated discharges, source-specific WLAs are not needed, and gross allocations for the WLAs and LAs can be used. The appropriate loads for TP, TN, and TSS for each impaired waterbody segment are listed in Appendix 1, and each is applicable to both WLAs and LAs. In response to public comments, a new Appendix 4 explains the overlap between NPS TMDL watersheds and regulated MS4 areas. Information is presented in a tabular form, listed both by town and by stream watershed name, and maps are also provided. Those streams with overlap were originally proposed to be included in this TMDL, but have been removed for further consideration as to how to account for the WLA contributions. The Department does expect to include these in a future update to this TMDL.

7. Implementation and Reasonable Assurance

Water Quality Monitoring Plan

Addressing water quality impairments in these streams will require the identification and assessment of individual NPS pollution sites in the watershed. Once sites are identified, but before Best Management Practices (BMPs) have been applied, stream monitoring should be conducted to establish pre application conditions. Additional water quality monitoring should be conducted following BMP implementation to gauge the effectiveness of the BMPs or engineered design solutions, as recommended in the 'Future Actions' section below. As restoration plans proceed, Maine Department of Environmental Protection (Maine DEP) staff will check on the progress towards attainment of Maine's Water Quality Standards (WQS) with both water chemistry and biological monitoring evaluations. Also, Maine DEP's Biological Monitoring Program should check on water quality status or improvement in the future under the existing rotating basin sampling schedule.

Benthic macroinvertebrates are excellent indicators of water quality. The number of different kinds of organisms and the abundance of different groups provide information about a waterbody's health. The Biological Monitoring Program of Maine DEP analyzes macroinvertebrate data using a statistical model that incorporates 30 variables, including macroinvertebrate richness and abundance, to determine the probability of a sample attaining statutory Class A, B, or C conditions. Combining the model results with supporting information, biologists determine if streams and rivers are attaining the aquatic life goals assigned to them (Davies and Tsomides, 2002).

An ongoing monitoring program is critical to assess the effectiveness of implementation efforts. Implementation is expected to continue until monitoring shows attainment of aquatic life use goals (macroinvertebrates and/or algae) or dissolved oxygen (DO) WQS. Maine DEP will evaluate progress towards WQS attainment by monitoring aquatic communities and DO in the impaired streams. Depending on the existing impairment(s), benthic macroinvertebrates and/or algae, or DO will provide the primary

metric to measure progress towards attaining WQS.

Recommended Future Actions

The goal of the *Maine Statewide Total Maximum Daily Load (TMDL) for Nonpoint Source (NPS) Pollution* is to use a water quality model, MapShed (Appendix 2), to define pollutant loads and set water quality targets that will ensure compliance with Maine's WQS. The nutrient and sediment reductions listed in the TMDL Allocations (Appendix 1) represent averages over the year (given the seasonal variation of runoff and ambient conditions), and demonstrate the need to reduce nutrient and sediment loads as the key to water quality restoration. The load reductions provide a guide for restoration plans and engineered solutions that will lower the content of nutrient and sediment reaching the impaired streams, by either reducing the nutrient and sediment content of the runoff or by reducing the overall amount of runoff reaching the stream.

Watershed Inventory and Developing a Watershed Plan

While TMDLs focus on specific waterbody segments and specific pollutant sources, watershed-based plans (WBP) should be holistic, incorporating the pollutant- and site-specific TMDLs into the larger context of the watershed, including additional water quality threats, pollutants, and sources. It is recommended that a detailed watershed plan be developed for each impaired waterbody to focus and prioritize appropriate restoration measures. Plans should incorporate on-the-ground mitigation measures and practices that will reduce pollutant loads and contribute in measurable ways to reducing impairments and to meeting WQS. WBPs should be designed to take into account information provided in this TMDL, particularly in the stream-specific appendices.

To begin the restoration process, additional investigation is necessary for all impaired watersheds to fully document problem areas for each WBP or restoration strategy. The usual strategy includes:

1) Conducting parcel-level field work to locate NPS pollution problems and identify sources of nutrient and sediment inputs;
2) Minimizing additional disturbance to maintain existing natural buffering capacity and/or reestablishing buffers where necessary; and
3) Installing BMPs and incorporating Low Impact Development (LID) techniques for future development to reduce the impact of NPS pollution on water hydrology and water quality.

Local stakeholders need to choose the appropriate BMPs and stream restoration techniques to reduce NPS runoff on a case-by case-basis. This TMDL report provides the following information, tools, and contacts for taking action:

- Results of preliminary watershed assessment results, including pollutant load reductions needed for nutrients and sediment (see Appendix 6).

- Information on watershed restoration projects, including watershed surveys, watershed-based planning, implementing pollution reduction measures, and grant funding opportunities from Maine's NPS Program: http://www.maine.gov/dep/water/grants/319.html.
- Examples of agricultural BMPs (see Appendix 3) and The Pollution Reduction Impact Comparison Tool (PRedICT) to estimate load reductions and their associated cost. More information about this tool can be found at: http://www.predict.psu.edu/. Sub-watershed models (using MapShed) have been developed for each impaired waterbody addressed by this TMDL (see Appendix 2). Once more detailed data for site-specific land uses are entered into the base model, various BMP scenarios can be generated by the PRedICT portion of the model. Copies of the model and technical support are available upon request from Maine DEP.
- NPS site tracking tool: The NPS Site Tracker, used to record and track watershed inventory or survey information about NPS sites identified in a watershed over time. Electronic copies of the MS Excel templates and technical support are available from ME DEP upon request.

8. Public Participation

USEPA regulations [40 CFR § 130.7(c)(1)(ii)] require that calculations to establish TMDLs be subject to public review. A description of the public participation process and response to public comments will be provided after the public comment period for this TMDL has ended. Paper and electronic forms of the report will be made available for public review (for a period of at least 30 days) on Maine DEP's website. Electronic notification will be sent to interested parties and ads will be placed in the legal advertising section of local papers regarding the comment period and a public meeting sponsored by Maine DEP. The TMDL and response to all comments will be sent to USEPA Region 1 in Boston for final approval. The following is the public notification used for this TMDL:

PUBLIC NOTICE FOR MAINE STATEWIDE NONPOINT SOURCE (NPS) POLLUTION TMDL – In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130, the Maine Department of Environmental Protection (DEP) has prepared a Total Maximum Daily Load (TMDL) report for waters in the State of Maine with dissolved oxygen and/or aquatic life impairments associated with NPS pollution. The TMDL report establishes the target nutrient and sediment loads for the watersheds of the impaired surface waters, provides documentation of impairment, and outlines the reductions needed to meet water quality standards. The report is posted at the Maine DEP website: http://www.maine.gov/dep/blwq/comment.htm. To receive hard copies, please contact Melissa Evers at 207-287-3901 or melissa.evers@maine.gov.

Send all comments by January 29, 2016 to Melissa Evers, DEP, State House Station #17, Augusta, ME 04333, or email: melissa.evers@maine.gov.

References

Evans, B.M., D.W. Lehning, K.J. Corradini, G.W. Petersen, E. Nizeyimana, J.M. Hamlett, P.D. Robillard, and R.L. Day. 2002. A Comprehensive GIS-Based Modeling Approach for Predicting Nutrient Loads in Watersheds. J. Spatial Hydrology, Vol. 2, No. 2.

Evans, B.M., and K.J. Corradini. 2012. Version 1.0 users guide. Penn State Institutes of Energy and the Environment. Retrieved from http://www..psu.edu/Downloads/Manual.pdf

Haith, D.A., and L.L. Shoemaker. 1987. Generalized Watershed Loading Functions for Stream Flow Nutrients. Water Resources Bulletin, 23(3), pp. 471-478.

Haith, D.A., R. Mandel, and R.S. Wu. 1992. GWLF: Generalized watershed loading functions version 2.0 user's manual. Cornell University Department of Agricultural & Biological Engineering. Retrieved from http://www..psu.edu/Downloads/GWLFManual.pdf

Maine Department of Environmental Protection (DEP). 2013. Draft 2012 Integrated Water Quality Monitoring and Assessment Report. Bureau of Land and Water Quality, Augusta, ME.

New England Interstate Water Pollution Control Commission (NEIWPCC). 2005. Calibration and Validation of the AVGWLF Model for New England and New York State. Quality Assurance Project Plan submitted to USEPA Region 1. Retrieved from http://www.neiwpcc.org/AVGWLF/resources.asp

Penn State Institutes of Energy and the Environment, Penn State University. 2007. Summary of Work Undertaken Related to Adaptation of AVGWLF for Use in New England and New York. Report submitted to New England Interstate Water Pollution Control Commission (NEIWPCC), February 2007. Retrieved from http://www.neiwpcc.org/AVGWLF/resources.asp

U.S. Environmental Protection Agency. 1999. Regional Guidance on Submittal Requirements for Lake and Reservoir Nutrient TMDLs. USEPA Office of Ecosystem Protection, New England Region, Boston, MA.