Trout Brook

WATERSHED DESCRIPTION

This **TMDL** applies to a 7.7 mile section of Trout Brook, located in the Towns of Alna and Wiscasset, Maine. The impaired segment of Trout Brook begins in the southwestern portion of the watershed in a forest at the West Alna Road stream crossing. The stream continues to flow northeast though mixed agriculture and forest, crossing Alna Road and Peaslee Road before flowing into the Sheepscot River. The Trout Brook watershed covers an area of 8.2 square miles. The majority of the watershed is located within the Town of Alna, however, small portions of the watershed lie within the surrounding towns of Wiscasset, Whitefield and Pittston.

- Runoff from agricultural land located in the northeastern portion of the watershed concentrated along Alna Road is likely the largest sources of **nonpoint source (NPS) pollution** to Trout Brook. Runoff from cultivated lands, active hay lands, and pasture can transport nitrogen and phosphorus to the nearest section of the stream.
- The Trout Brook watershed is predominately non-developed (98.8%). Forested areas (92.9%) within the watershed absorb and filter pollutants helping protect both water quality in the stream and stream channel stability. Wetlands (2.7%) may also help filter nutrients.
- Non-forested areas within the watershed are predominantly agricultural (3%) and are concentrated in the northeastern portion of the watershed.
- Developed areas (1.2%) with impervious surfaces in close proximity to the steam may impact water quality.
- Trout Brook is on Maine's 303(d) list of Impaired Streams (Maine DEP, 2013).

Definitions

- ***Total Maximum Daily Load (TMDL)*** *represents the total amount of pollutants that a waterbody can receive and still meet water quality standards.*
- **Nonpoint Source Pollution** *refers to pollution that comes from many diffuse sources across the landscape, and is typically transported by rain or snowmelt runoff.*

Waterbody Facts

Segment ID: ME0105000305_528R04

Town: Alna and Wiscasset, ME

County: Lincoln

Impaired Segment Length: 7.7 miles

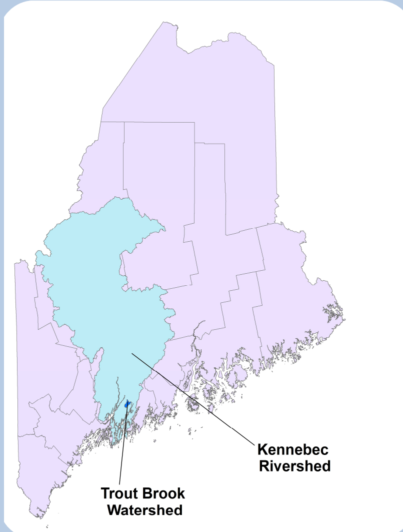
Classification: Class A

Direct Watershed: 8.2 mi^2 (5248 acres)

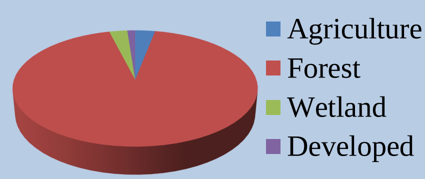
Impairment Listing Cause: Dissolved Oxygen

Watershed Agricultural Land Use: 3.03%

Major Drainage Basin: Kennebec River



Watershed Land Uses



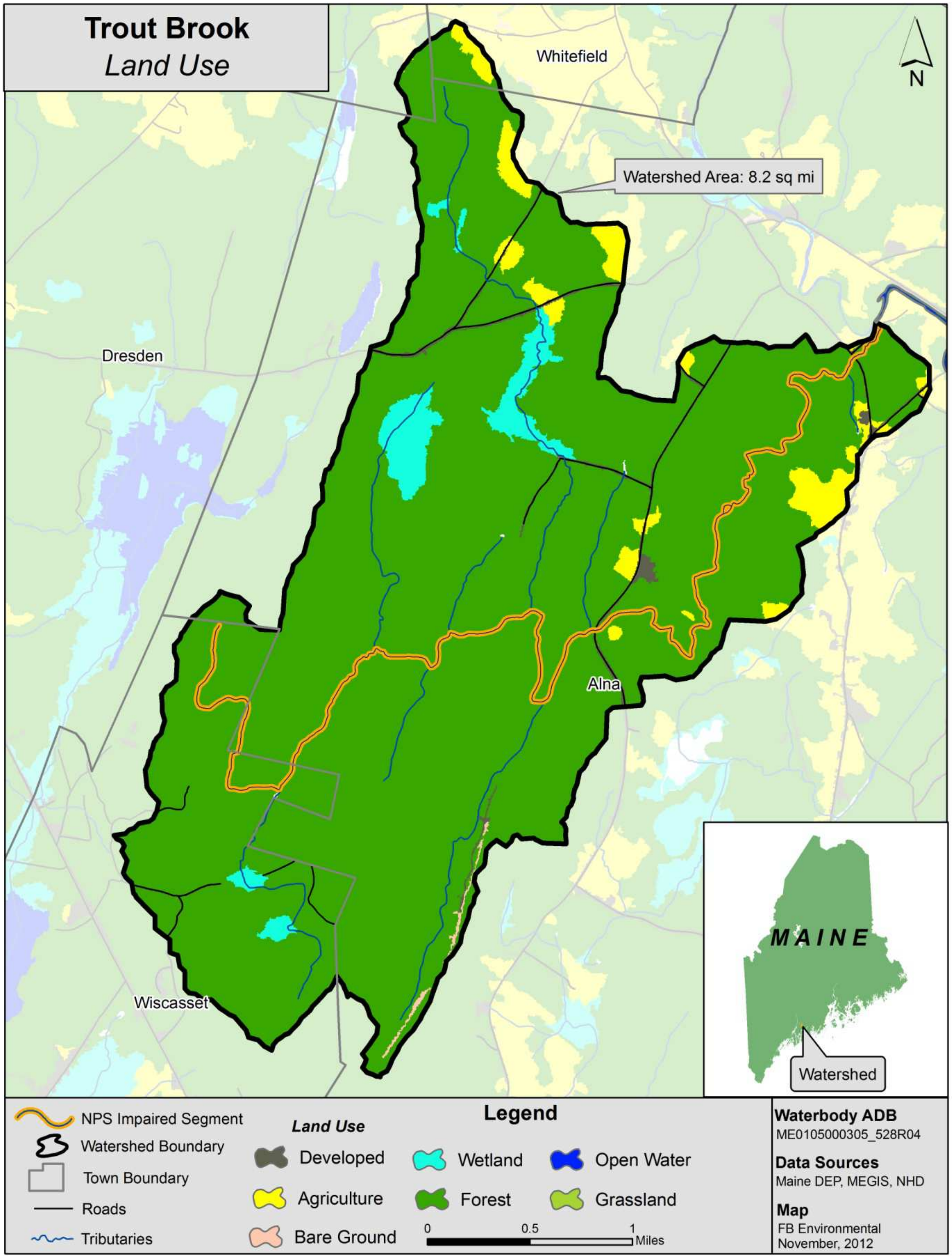


Figure 1: Land Use in the Trout Brook Watershed

WHY IS A TMDL ASSESSMENT NEEDED?

Trout Brook, a Class A freshwater stream, has been assessed by Maine DEP as not meeting water quality standards for the designated use of aquatic life, and placed on the 303(d) list of impaired waters under the Clean Water Act. The Clean Water Act requires that all 303(d)-listed waters undergo a TMDL assessment that describes the impairments and establishes a target to guide the measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards.

Trout Brook *in the Trout Brook Preserve upstream of the Route 218 Road crossing. Photo: FB Environmental*

Agricultural land area in Trout Brook is only about 3% of the watershed area. However, agriculture accounts for more than twice the area of developed land which makes up a little over 1% of the watershed. Wetlands account for about 3% of the Trout Brook watershed, and are located at the origins of, and along multiple tributaries to the stream (Figure 1). Therefore, agriculture may be the largest contributor of sediment and nutrient enrichment to the stream, especially along Alna Road. The presence of wetlands may also contribute to impairment based on naturally occurring low dissolved oxygen levels in Trout Brook.

WATER QUALITY DATA ANALYSIS

Maine DEP uses a variety of data types to measure the ability of a stream to adequately support aquatic life, including; dissolved oxygen, benthic macroinvertebrates, and periphyton (algae). The aquatic life impairment in Trout Brook is based on historic dissolved oxygen data. Additionally, dissolved oxygen data collected at station KSRTR02 in 2007, station KSRTR34 in 2005, and station TRBK002-F in 2005-2008 corroborates the impairment.

TMDL ASSESSMENT APPROACH: NUTRIENT MODELING OF IMPAIRED AND ATTAINMENT STREAMS

NPS pollution is difficult to measure directly, because it comes from many diffuse sources spread across the landscape. For this reason, a nutrient loading model, MapShed, was used to estimate the sources of pollution based on well-established hydrological equations; detailed maps of soil, land use, and slope; many years of daily weather data; and direct observations of agriculture and other land uses within the watershed.

The nutrient loading estimates for the impaired stream were compared to similar estimates for five non-impaired (attainment) streams of similar watershed land uses across the state. The TMDL for the impaired stream was set as the mean nutrient loading estimate of these attainment stream watersheds, and units of mass per unit watershed area per year (kg/ha/year) were used. The difference in loading estimates between the impaired and attainment watersheds represents the percent reduction in nutrient loading required under this TMDL. The attainment streams and their nutrient and sediment loading estimates and TMDL are presented below in Table 1.

Table 1: Numeric Targets for Pollutant Loading Based on MapShed Model Outputs for Attainment Streams

Attainment Streams	Town	TP load (kg/ha/yr)	TN load (kg/ha/yr)	Sediment load (1000 kg/ha/yr)
Martin Stream	Fairfield	0.14	3.4	0.008
Footman Brook	Exeter	0.33	6.4	0.058
Upper Kenduskeag Stream	Corinth	0.29	5.6	0.047
Upper Pleasant River	Gray	0.22	4.6	0.016
Moose Brook	Houlton	0.25	5.9	0.022
Total Maximum Daily Load		**0.24**	**5.2**	**0.030**

Habitat Assessment

A Habitat Assessment survey was conducted on both the impaired and attainment streams. The assessment approach is based on the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et al., 1999), which integrates various parameters relating to the structure of physical habitat. The habitat assessments include a general description of the site, physical characterization and visual assessment of in-stream and riparian habitat quality.

Based on Rapid Bioassessment protocols for low gradient streams, Trout Brook received a score of 161 out of a total 200 for quality of habitat. Higher scores indicate better habitat. The range in habitat assessment scores for attainment streams was 155 to 179.

Habitat assessments were conducted on a relatively short sample reach (about 100-200 meters for a typical small stream) near the most downstream Maine DEP sample station in the watershed. For both impaired and attainment streams, the assessment location was usually near a road crossing for ease of access. In the Trout Brook watershed, the downstream sample station was located within the Trout Brook Preserve upstream of the Route 218 road crossing. Road construction prevented a habitat assessment at the more downstream location. The sample reach was forested with a thick buffer similar to other parts of the stream as the Trout Brook watershed is 93% forested.

Figure 2 (right) shows the range of habitat assessment scores for all attainment and impaired streams, as well as for Trout Brook. The overlapping attainment and impaired stream scores indicate that factors other than habitat should be considered when addressing the impairments in Trout Brook. Consideration should be given to major "hot spots" in the Trout Brook watershed as potential sources of NPS pollution contributing to the water quality impairment.

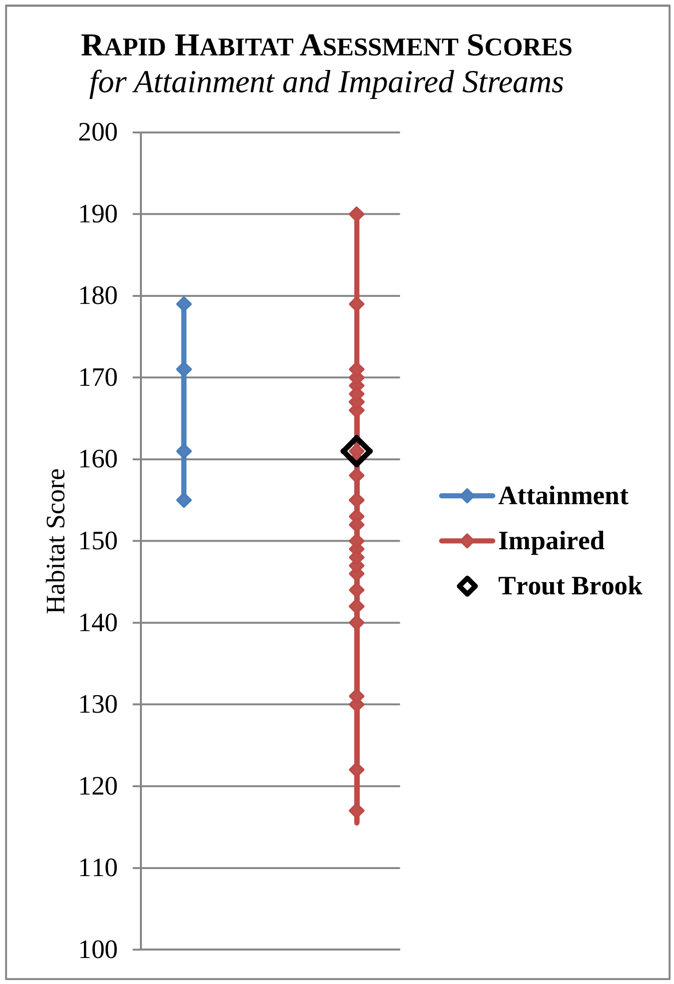


Figure 2: Habitat Assessment Scores

Pollution Source Identification

Pollution source identification assessments were conducted for both Trout Brook (impaired) and the attainment streams. The source identification work is based on an abbreviated version of the Center for Watershed Protection's Unified Subwatershed and Site Reconnaissance method (Wright, et al., 2005). The abbreviated method includes both a desktop and field component. The desktop assessment consists of generating and reviewing maps of the watershed boundary, roads, land use and satellite imagery, and then identifying potential NPS pollution locations, such as road crossings, agricultural fields, and large areas of bare soil. When available, multiple sources of satellite imagery were reviewed. Occasionally, the high resolution of the imagery allowed for observations of livestock, row crops, eroding stream banks, sediment laden water, junkyards, and other potential NPS concerns that could affect stream quality. As many potential pollution sources as possible were visited, assessed and documented in the field. Field visits were limited to NPS sites that were visible from roads or a short walk from a roadway. Neighborhoods were assessed for NPS pollution at the whole neighborhood level including streets and storm drains (where applicable). The assessment does not include a scoring component, but does include a detailed summary of findings and a map indicating documented NPS sites throughout the watershed.

The watershed source assessment for Trout Brook was completed on July 3, 2012. In-field observations of erosion, lack of vegetated stream buffer, extensive impervious surfaces, high-density neighborhoods and agricultural activities were documented throughout the watershed (Table 2, Figure 3).

Table 2: Pollution Source ID Assessment for the Trout Brook Watershed

Potential Source			**Notes**
ID#	**Location**	**Type**	
2	Alna Road @ Peaslee Road	Road Crossing	• The Alna Road crossing downstream of our habitat assessment stream reach was undergoing construction during our visit.
3	Alna Road	Agriculture	• A large lawn and hay fields were lush, green and cut very short. • A pond located on this property had little buffer from surrounding fields. • A strong manure smell was documented here.
3b	Alna Road	Agriculture	• Fields located along Alna Road used for hay and pasture for horses.
5	West Alna Road	Agriculture	• Hay fields and pasture. • Horse paddocks observed.
6	West Alna Road	Road crossing	• West Alna Road crossing at Trout Brook's origin. • Water appeared clear, but stained.

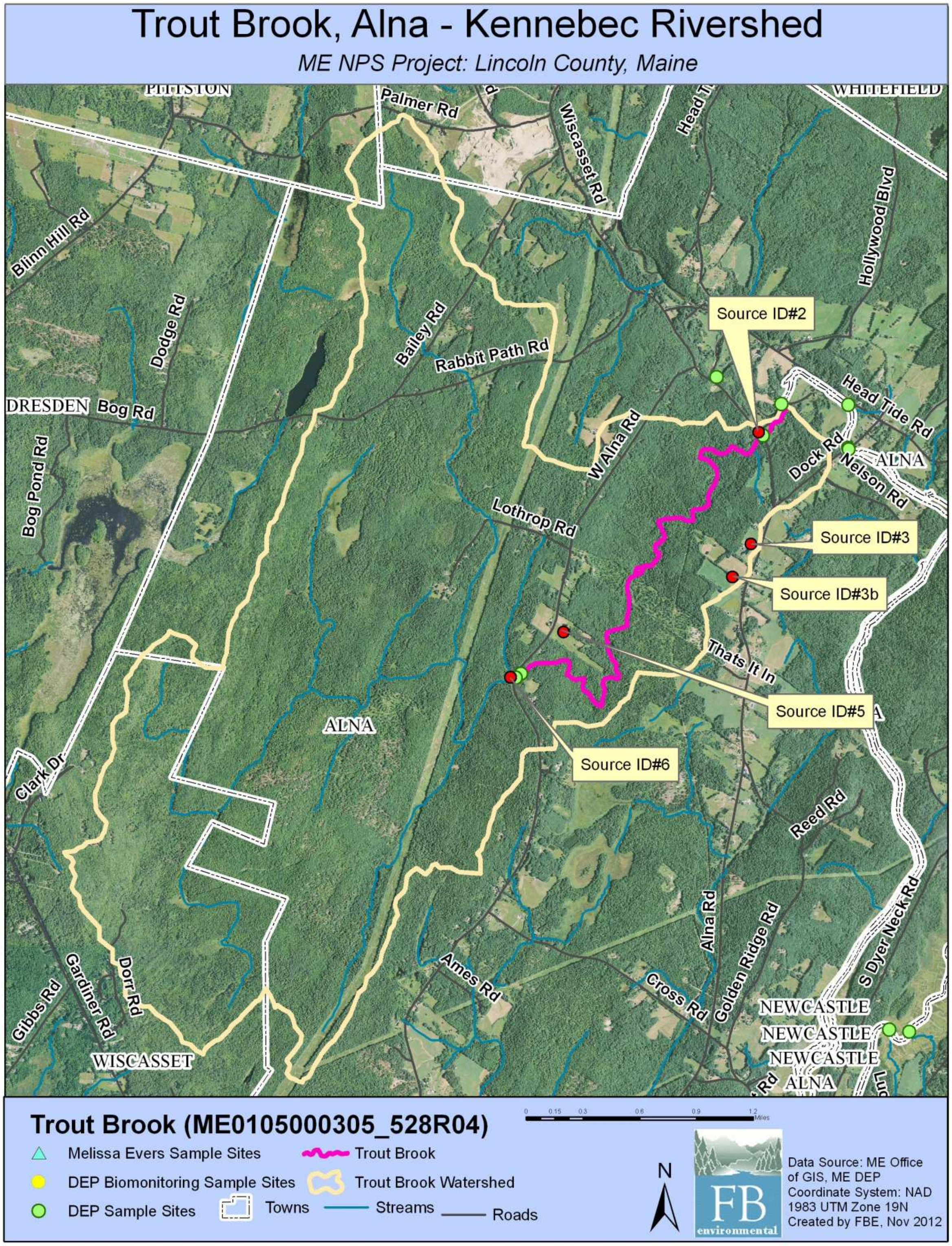


Figure 3: Aerial Photo of Source ID Locations in the Trout Brook Watershed. Note that due to a mapping error only about half of the impaired stream segment is shown. See Figures 1 and 4 for full extent.

NUTRIENT LOADING – MAPSHED ANALYSIS

The MapShed model was used to estimate stream loading of sediment, total nitrogen and total phosphorus in Trout Brook (impaired), plus five attainment watersheds throughout the state.. The model estimated nutrient loads over a 15-year period (1990-2004), which was determined by the available weather data provided within MapShed. This extended period captures a wide range of hydrologic conditions to account for variations in nutrient and sediment loading over time.

Many quality assured and regionally calibrated input parameters are provided with MapShed. Additional input parameters were manually entered into the model based on desktop research and field observations, as described in the sections on Habitat Assessment and Pollution Source Identification. These manually adjusted parameters included estimates of livestock animal units, agricultural stream miles with intact vegetative buffer, Best Management Practices (BMPs), and estimated wetland retention and/or drainage areas.

Livestock Estimates

Livestock waste contains nutrients which can cause water quality impairment. The nutrient loading model considers numbers and types of animals. Table 3 (right) provides estimates of livestock (numbers of animals) in the watershed, based on direct observations made in the watershed, plus other publicly available data.

The Trout Brook watershed is predominantly forested, with very little agriculture or development. Nine horses were observed in two locations within the watershed. These hobby style farms were not within close proximity to Trout Brook or its associated tributaries.

Table 3: Livestock Estimates in the Trout Brook Watershed

Type	Trout Brook
Dairy Cows	
Beef Cows	
Broilers	
Layers	
Hogs/Swine	
Sheep	
Horses	9
Turkeys	
Other	
Total	**9**

Vegetated Stream Buffer in Agricultural Areas

Vegetated stream buffers are areas of trees, shrubs, and/or grasses adjacent to streams, lakes, ponds or wetlands which provide nutrient loading attenuation (Evans & Corradini, 2012). MapShed considers natural vegetated stream buffers within agricultural areas as providing nutrient load attenuation. The width of buffer strips is not defined within the MapShed manual, and was considered to be 75 feet for this analysis. Geographic Information System (GIS) analysis of recent aerial photos along with field reconnaissance observations were used to estimate the number of agricultural stream miles with and without vegetative buffers, and these estimates were directly entered into the model.

Trout Brook is a 7.7 mile-long impaired segment as listed by Maine DEP. As modeled, the total stream miles (including tributaries) within the watershed was calculated as 24.6 miles. Of this total, 0.01 stream miles are located within agricultural areas; of this length, 0.01 miles (100%) show a 75-foot or greater vegetated buffer (Table 4, Fig. 4). By contrast, agricultural stream miles (as modeled) with a 75-foot vegetated buffer in the attainment stream watersheds ranged from 34% to 92%, with an average of 61%.

Table 4: Summary of Vegetated Buffers in Agricultural Areas

Trout Brook
• 24.6 stream miles in watershed (includes ephemeral streams) • 0.01 stream miles in agricultural areas • 100% of agricultural stream miles have a vegetated buffer

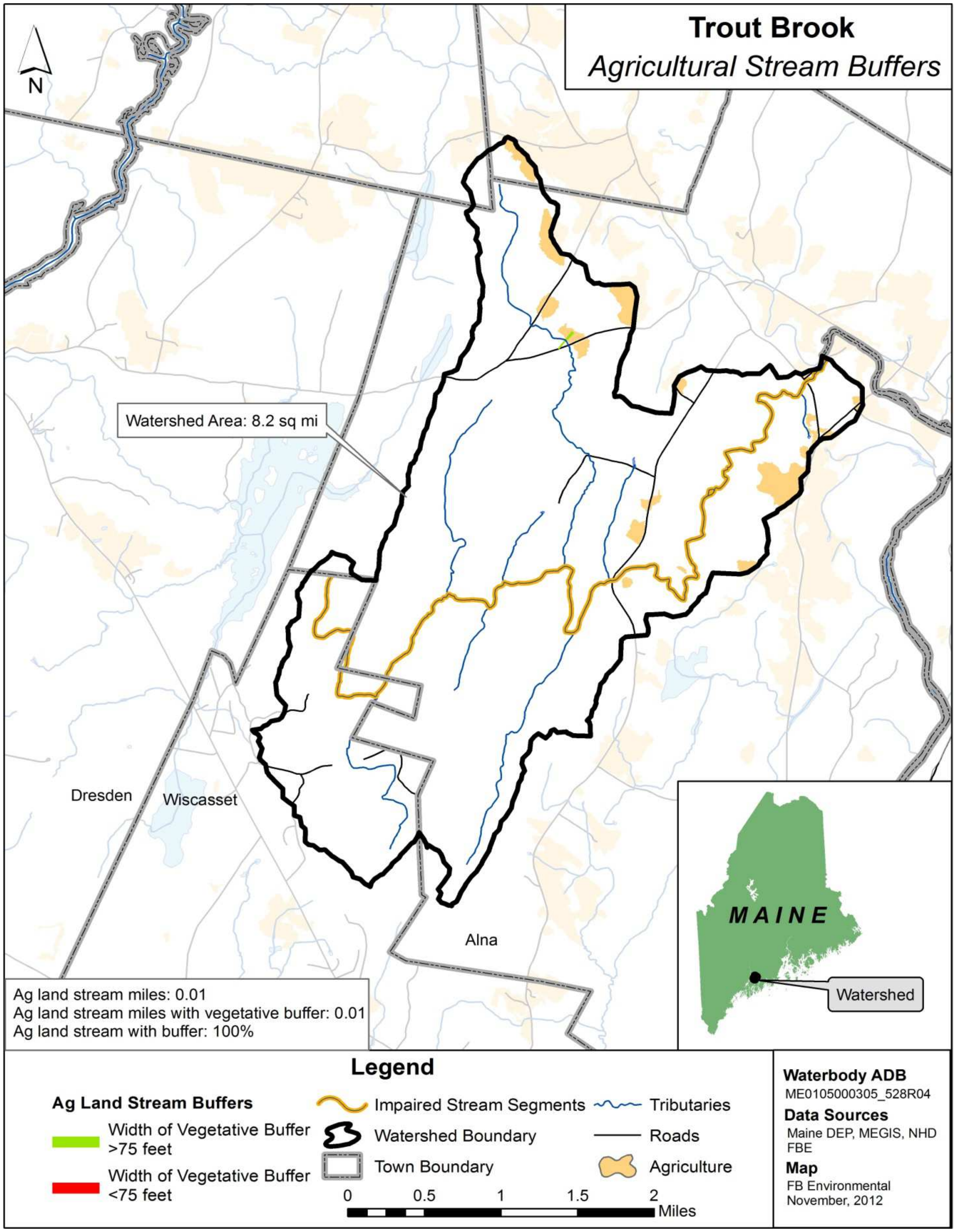


Figure 4: Agricultural Stream Buffer in the Trout Brook Watershed

Best Management Practices (BMPs)

For this modeling effort, four commonly used BMPs were entered based on literature values. These estimates were applied equally to impaired and attainment stream watersheds. More localized data on agricultural practices would improve this component of the model.

- *Cover Crops:* Cover crops are the use of annual or perennial crops to protect soil from erosion during time periods between harvesting and planting of the primary crop. The percent of agricultural acres cover crops used within the model is estimated at 4%. This figure is based on information from the 2007 USDA Census stating that 4.1% of cropland acres is left idle or used for cover crops or soil improvement activity, and not pastured or grazed (USDA, 2007b).
- *Conservation Tillage:* Conservation tillage is any kind of system that leaves at least 30% of the soil surface covered with crop residue after planting. This reduces soil erosion and runoff and is one of the most commonly used BMPs. This BMP was assumed to occur in 42% of agricultural land. This figure is based on a number given by the Conservation Tillage Information Center’s 2008 Crop Residue Management Survey stating that 41.5% of U.S. acres are currently in conservation tillage (CTIC, 2000).
- *Strip Cropping / Contour Farming:* This BMP involves tilling, planting and harvesting perpendicular to the gradient of a hill or slope using high levels of plant residue to reduce soil erosion from runoff. This BMP was assumed to occur in 38% of agricultural lands, based on a study done at the University of Maryland (Lichtenberg, 1996).
- *Grazing Land Management:* This BMP consists of ensuring adequate vegetation cover on grazed lands to prevent soil erosion from overgrazing or other forms of over-use. This usually employs a rotational grazing system where hays or legumes are planted for feed and livestock is rotated through several fenced pastures. In this TMDL, a figure of 75% of hay and pasture land is assumed to utilize grazing land management. This figure is based on a study by Farm Environmental Management Systems of farming operations in Canada (Rothwell, 2005).

Pollutant Load Attenuation by Lakes, Ponds and Wetlands

Depositional environments such as ponds and wetlands can attenuate watershed sediment loading. This information is entered into the nutrient loading model by a simple percentage of watershed area draining to a pond or a wetland. The Trout Brook watershed is 3% wetland, and overall 5% of the watershed drains to wetlands. The percentage of watershed draining to a wetland in the attainment watersheds ranged from 15% to 60%, with an average of 35%.

NUTRIENT MODELING RESULTS

The MapShed model simulates surface runoff using daily weather inputs of rainfall and temperature. Erosion and sediment yields are estimated using monthly erosion calculations and land use/soil composition values for each source area. Below, selected results from the watershed loading model are presented. The TMDL itself is expressed in units of kilograms per hectare per year. The additional results shown below assist in better understanding the likely sources of pollution. The model results for Trout Brook indicate no reductions of sediment and nutrients are needed to improve water quality. Below, loading for sediment, nitrogen and phosphorus are discussed individually.

Sediment

Sediment loading in the Trout Brook watershed is mainly derived from forested land which accounts for half of the total sediment load. Agricultural sources and development are secondary sources at 26% and 24%, respectively (Table 5 and Figure 5). Note that total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Trout Brook* below for loading estimates that have been normalized by watershed area.

Table 5: Total Sediment Loads by Source

Trout Brook	Sediment (1000kg/year)	Sediment (%)
Source Load		
Hay/Pasture	0.61	5%
Crop land	2.63	21%
Forest	6.30	50%
Wetland	0.03	0%
Disturbed Land	0.03	0%
Low Density Mixed	0.10	1%
Medium Density Mixed	0	0%
High Density Mixed	2.72	22%
Low Density Residential	0.10	1%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	0	0%
Septic Systems	0	0%
Source Load Total:	**12.52**	**100%**
Pathway Load		
Stream Banks	8.91	-
Subsurface / Groundwater	0	-
Total Watershed Mass Load:	**21.43**	

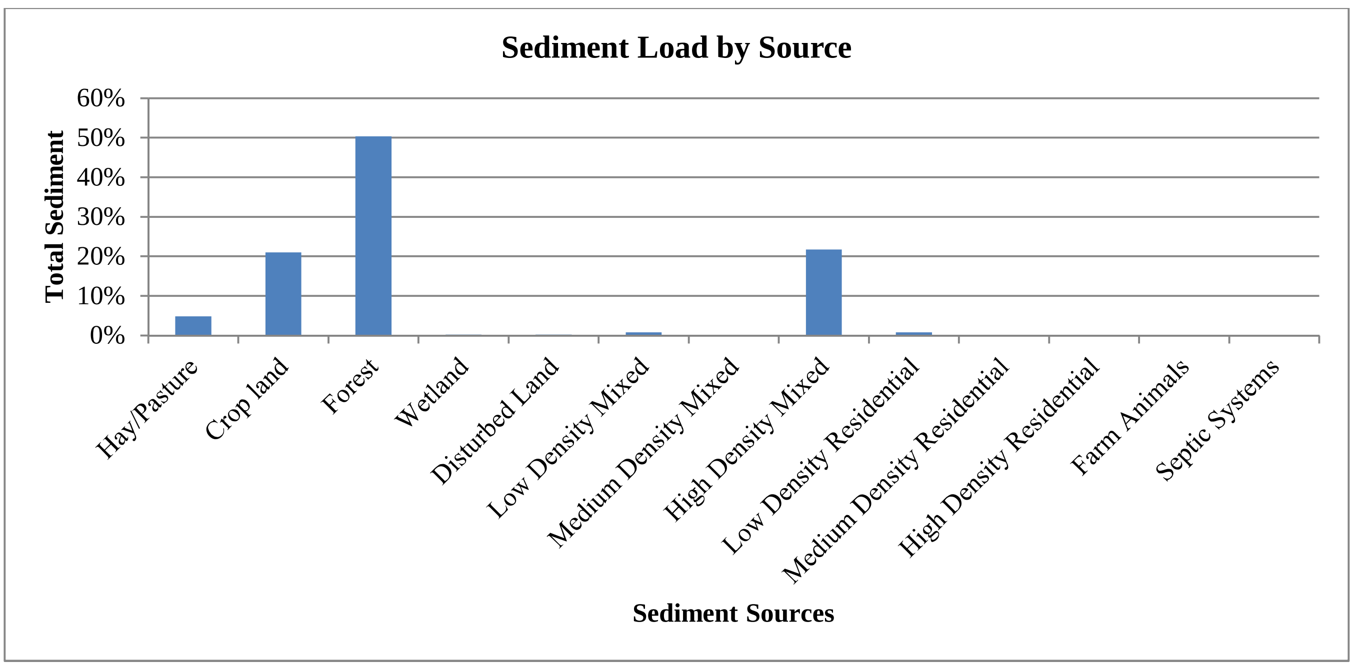


Figure 5: Total Sediment Loads by Source in the Trout Brook Watershed

Total Nitrogen

Nitrogen loading in the Trout Brook watershed is attributed primarily to forested land which accounts for 55% of the total load. Agricultural sources are secondary and make up 20% of the nitrogen load. Table 6 and Figure 6 show estimated total nitrogen load in terms of mass and percent of total, and by source in Trout Brook. Note that total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Trout Brook* below for loading estimates that have been normalized by watershed area.

Table 6: Total Nitrogen Loads by Source

Trout Brook	**Total N (kg/year)**	**Total N (%)**
Source Load		
Hay/Pasture	44.1	5%
Crop land	95.9	10%
Forest	510.6	55%
Wetland	36.9	4%
Disturbed Land	0.2	0%
Low Density Mixed	2.5	0%
Medium Density Mixed	0	0%
High Density Mixed	109.8	12%
Low Density Residential	2.5	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	45.8	5%
Septic Systems	87.1	9%
Source Load Total:	**935.2**	**100%**
Pathway Load		
Stream Banks	5.0	-
Subsurface / Groundwater	6241.0	-
Total Watershed Mass Load:	**7181.2**	

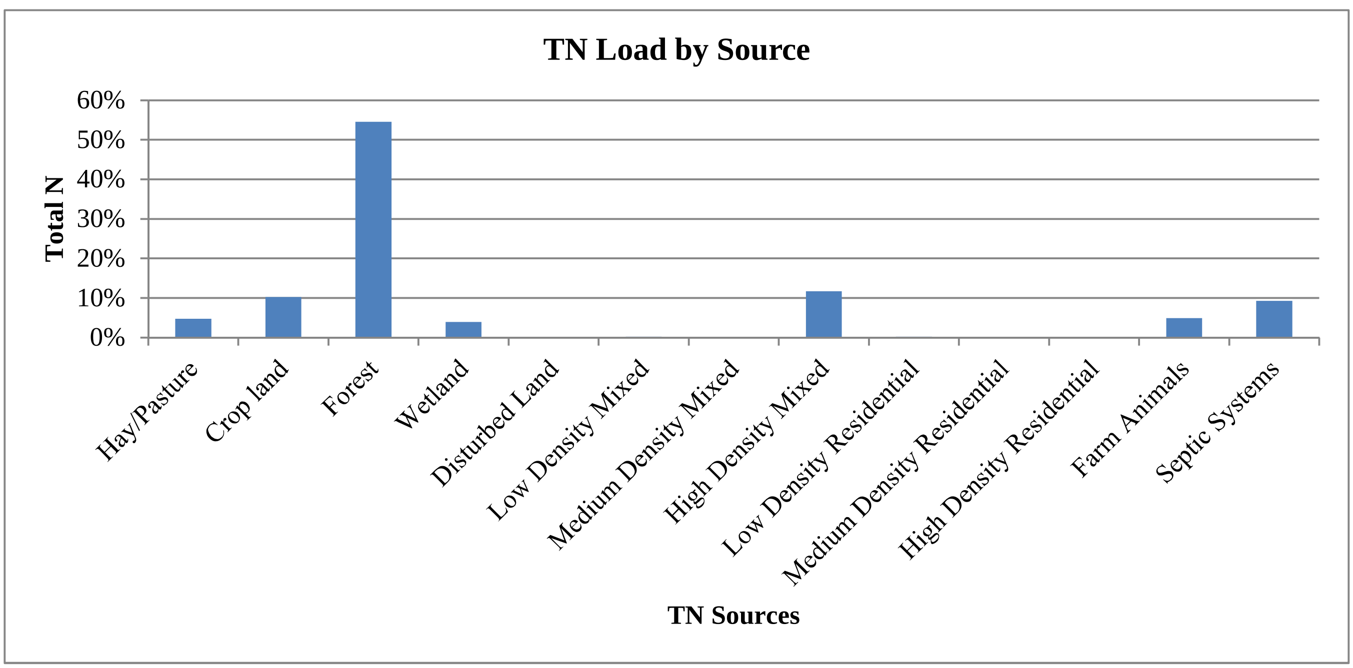


Figure 6: Total Nitrogen Loads by Source in the Trout Brook Watershed

Total Phosphorus

Phosphorus loading in the Trout Brook watershed is attributed primarily to agricultural sources which make up 45% of the total load in Trout Brook. Forest is a secondary source accounting for 38% of the total load. Phosphorus loads are presented in Table 7 and Figure 7. Note that total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Trout Brook* below for loading estimates that have been normalized by watershed area.

Table 7: Total Phosphorus Loads by Source

Trout Brook	Total P (kg/year)	Total P (%)
Source Load		
Hay/Pasture	15.4	19%
Crop land	9.4	12%
Forest	30.3	38%
Wetland	1.9	2%
Disturbed Land	0.1	0%
Low Density Mixed	0.3	0%
Medium Density Mixed	0	0%
High Density Mixed	11.4	14%
Low Density Residential	0.3	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	11.6	14%
Septic Systems	0	0%
Source Load Total:	**80.6**	**100%**
Pathway Load		
Stream Banks	2.0	-
Subsurface / Groundwater	266.5	-
Total Watershed Mass Load:	**349.1**	

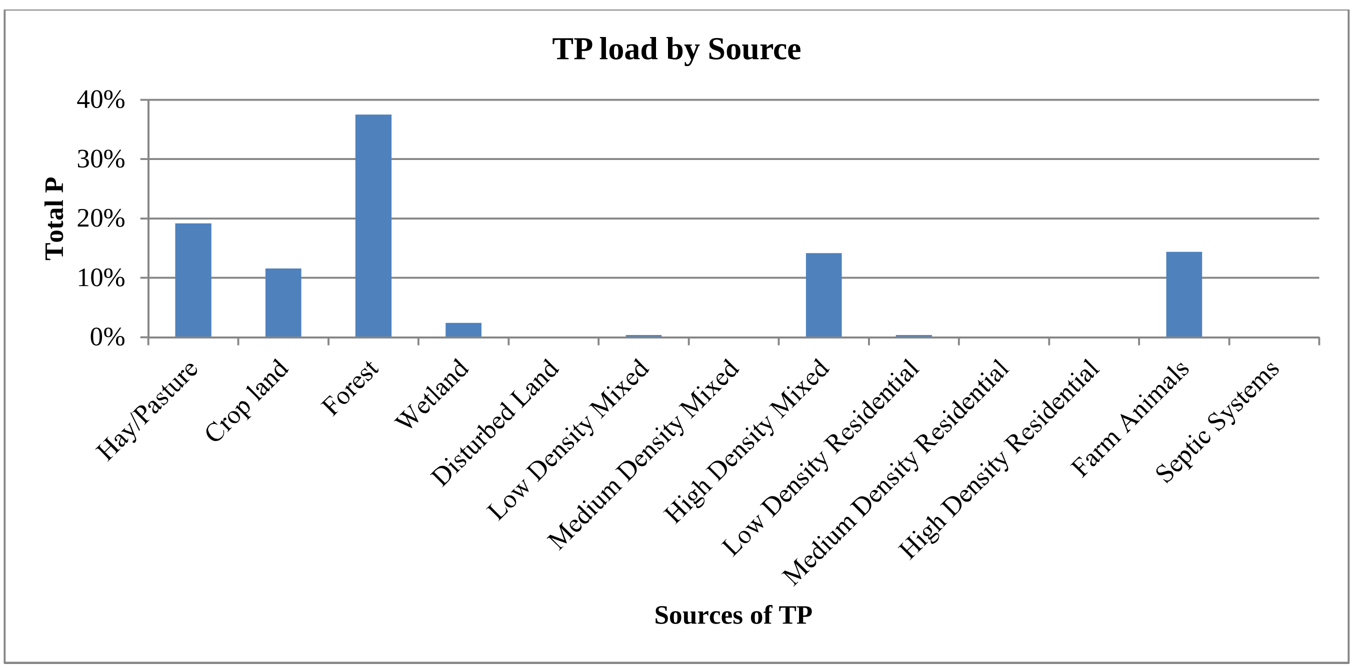


Figure 7: Total Phosphorus Loads by Source in the Trout Brook Watershed

TMDL: TARGET NUTRIENT LEVELS FOR TROUT BROOK

The existing loads for sediments and nutrients in the impaired segment of Trout Brook are listed in Table 8, along with the TMDL numeric target which was calculated from the average loading estimates of five attainment watersheds throughout the state. Table 9 presents a more detailed view of the modeling results and calculations used in Table 8 to define TMDL reductions, and compares the existing sediment and nutrient loads in Trout Brook to TMDL endpoints derived from the attainment waterbodies. An annual time frame provides a mechanism to address the daily and seasonal variability associated with nonpoint source loads.

Table 8: TMDL Targets Compared to Trout Brook Pollutant Loading

TMDL POLLUTANT LOADS Annual Loads per Unit Area	**Estimated Loads Trout Brook**	**Total Maximum Daily Load Numeric Target**	**TMDL % REDUCTIONS Trout Brook**
Sediment Load *(1000 kg/ha/year)*	**0.010**	**0.030**	**No Reduction Needed**
Nitrogen Load *(kg/ha/year)*	**3.35**	**5.2**	**No Reduction Needed**
Phosphorus Load *(kg/ha/year)*	**0.16**	**0.24**	**No Reduction Needed**

Future Loading

The prescribed reduction in pollutants discussed in this TMDL reflects reduction from estimated existing conditions. Expansion of agricultural and development activities have the potential to increase runoff and associated pollutant loads to Trout Brook To ensure that the TMDL targets are attained, future agriculture or development activities in the watershed will need to meet the TMDL targets. Future growth from population increases is a moderate threat in the Trout Brook watershed because Lincoln County has increasing population trends, with a 3% increase between 2000 and 2008 (USM MSAC, 2009). The growth in agricultural lands is also increasing, with a 24% increase in the total number of farms in Lincoln County between 2002 and 2007. However, a decrease of 2% was seen in the land (acres) in farms between 2002 and 2007, and a 21% decrease occurred in the average farm size in this time period as well (USDA, 2007a). Future activities and BMPs that achieve TMDL reductions are addressed below.

Next Steps

The use of agricultural and developed area BMPs can reduce sources of polluted runoff in Trout Brook. It is recommended that municipal officials, landowners, and conservation stakeholders in Alna and Wiscasset work together to develop a watershed management plan to:

- Encourage greater citizen involvement through the development of a watershed coalition to ensure the long term protection of Trout Brook;
- Address existing nonpoint source problems in the Trout Brook watershed by instituting BMPs where necessary; and

- Prevent future degradation of Trout Brook through the development and/or strengthening of a local Nutrient Management Ordinance.

Table 9: Modeling Results Calculations for Derived Numeric Targets and Reduction Loads for Trout Brook

Trout Brook				
	Area ha	**Sediment 1000kg/yr**	**TN kg/yr**	**TP kg/yr**
Land Uses				
Hay/Pasture	49	0.6	44.1	15.4
Crop land	14	2.6	95.9	9.4
Forest	1991	6.3	510.6	30.3
Wetland	58	0.0	36.9	1.9
Disturbed Land	1	0.0	0.2	0.1
Low Density Mixed	3	0.1	2.5	0.3
High Density Mixed	23	2.7	109.8	11.4
Low Density Residential	3	0.1	2.5	0.3
Other Sources				
Farm Animals			45.8	11.6
Septic Systems			87.1	0.0
Pathway Loads				
Stream Banks		8.9	5.0	2.0
Groundwater			6241.0	266.5
Total Annual Load		21 x 1000 kg	7181 kg	349 kg
Total Area	2142 ha			
Total Maximum Daily Load		**0.010 1000kg/ha/year**	**3.35 kg/ha/year**	**0.16 kg/ha/year**

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