Crooked Brook

WATERSHED DESCRIPTION

This **TMDL** applies to a 10.6 mile section of Crooked Brook, located in the Towns of Charleston and Corinth, Maine. Crooked Brook begins in the northern portion of the watershed in a predominantly forested area, crosses Garland Road and continues southeast crossing West Road and Bacon Road adjacent to several agricultural fields. Crooked Brook then enters a wetland and re-crosses Bacon Road. Just north of Exeter Road, Crooked Brook makes a u-turn, flowing north and then south again in a predominantly agricultural area. The brook then crosses Exeter Road and continues through a forest flowing adjacent to several agricultural fields until it meets Kenduskeag Stream. The Crooked Brook watershed covers an area of 18.84 square miles. The majority of the watershed is located within the Town of Charleston, however, portions also lie within the surrounding towns of Garland and Corinth.

- Runoff from agricultural land located throughout the central and southern portions of the watershed are likely the largest source of **nonpoint source (NPS) pollution** to Crooked Brook. Runoff from cultivated lands, active hay lands, and grazing areas transport nitrogen and phosphorus to the nearest section of the stream.
- The Crooked Brook watershed is predominately non-developed (95%). Forested areas (67.5%) within the watershed absorb and filter pollutants helping protect both water quality in the stream and stream channel stability. Wetlands (9.5%) may also help filter nutrients.
- Non-forested areas within the watershed are predominantly agricultural (17%) and are located in the central and southern portions of the watershed.
- Developed areas (5%) with impervious surfaces in close proximity to the steam may impact water quality.
- Crooked Brook is on the list of Maine's Impaired Streams (Maine DEP, 2013).

Definitions

- ***Total Maximum Daily Load (TMDL)*** *represents the total amount of a pollutant 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: ME0102000510_224R07

Town: Charleston and Corinth, ME

County: Penobscot

Impaired Segment Length: 10.6 miles

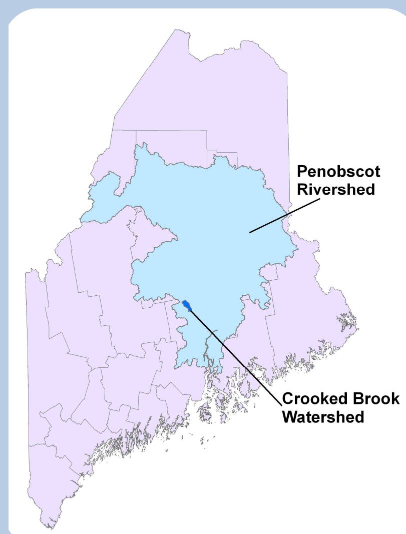
Classification: Class B

Direct Watershed: 18.84 mi^2 (12,058 acres)

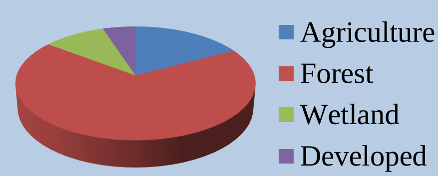
Impairment Listing Cause: Periphyton

Watershed Agricultural Land Use: 16.9%

Major Drainage Basin: Penobscot River



Watershed Land Uses



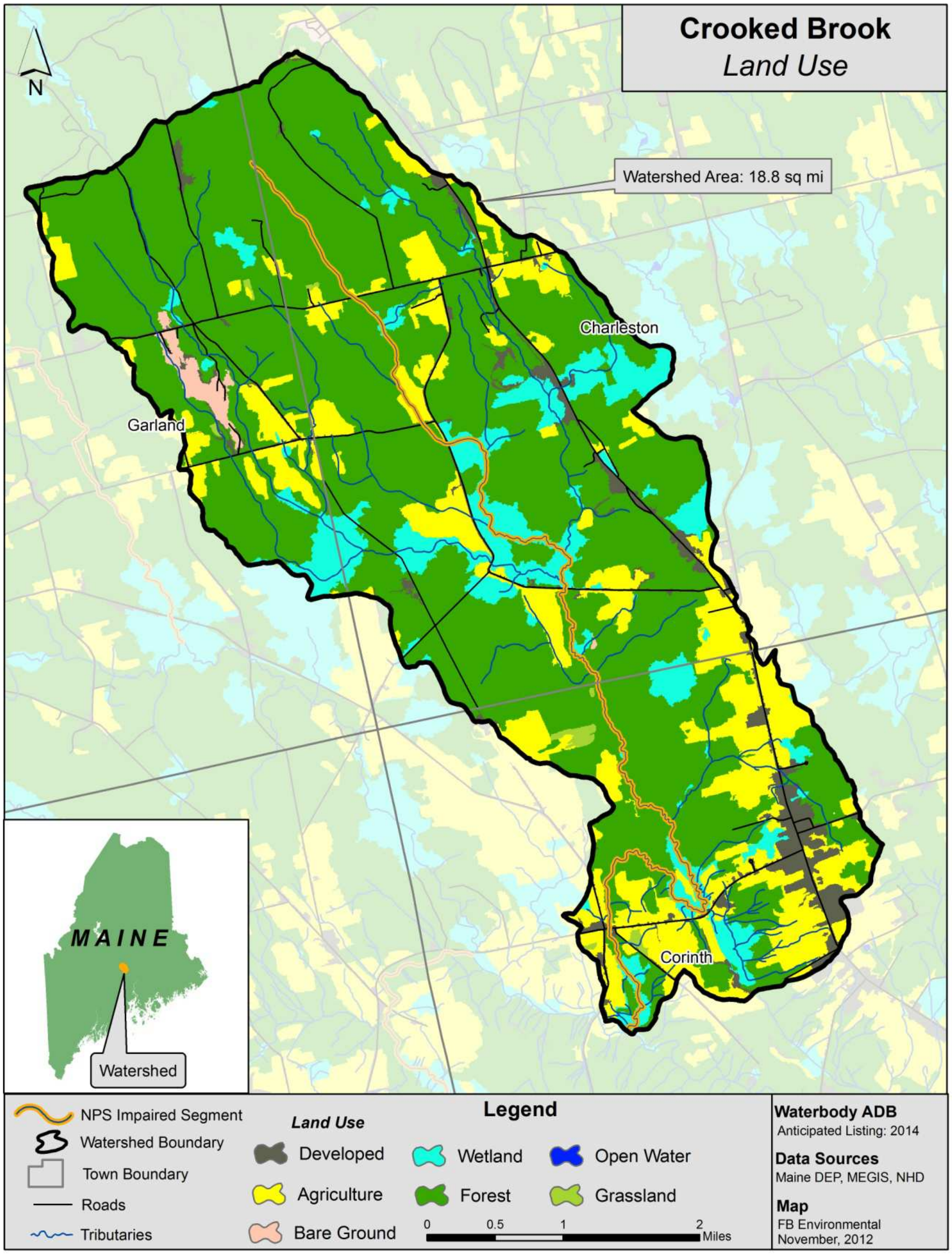


Figure 1: Land Use in the Crooked Brook Watershed

WHY IS A TMDL ASSESSMENT NEEDED?

Crooked Brook, a Class B 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 Total Maximum Daily Load (TMDL) assessment that describes the impairments and establishes a target to guide the measures needed to restore water quality.

***Crooked Brook** downstream of the Route 11/Garland Road crossing - sample station 510*
Photo: FB Environmental

Agriculture makes up 16.9% of the Crooked Brook watershed area. Developed areas are relatively small, making up only 5% of the watershed. Approximately 65% of the impaired stream segment length is adjacent to agricultural land (Figure 1). The close proximity of many agricultural lands to the stream further increases the likelihood that nutrients from disturbed soils, manure, and fertilizers will reach the stream.

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 Crooked Brook is based on algae data collected at station S-510 in 2001, 2006, and 2011.

Table 1: Assessment Data for Crooked Brook

Site	Assessment Parameter	Year	Statutory Class	Assessment Result
S-510	Algae	2001	B	C
S-510	Algae	2006	B	C
S-510	Algae	2011	B	C

DEP makes aquatic life use determinations using a statistical model that incorporates 30 variables of data collected from rivers and streams, including the richness and abundance of streambed organisms, to determine the probability of a sample meeting Class A, B, or C conditions. Biologists use the model results and supporting information to determine if samples comply with the numeric aquatic life criteria of the class assigned to the stream or river (Davies and Tsomides, 2002). Maine DEP uses an analogous model to aid in the assessment of algal communities but makes aquatic life use determinations based on narrative standards.

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 2.

Table 2: 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**

RAPID WATERSHED ASSESSMENT

Habitat Assessment

A habitat assessment survey was conducted for both the impaired and attainment streams. The assessments include a general description of the site, including a physical characterization and visual assessment of in-stream and riparian habitat quality 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.

Based on Rapid Bioassessment protocols for low-gradient streams, Crooked Brook received a score of 169 out of a total 200 for quality of habitat. Higher scores indicate better habitat for fish and other aquatic life. The range of habitat assessment scores for attainment streams was 155 to 179.

The habitat assessment for Crooked Brook was conducted on a relatively short sample reach (about 100-200 meters for a typical small stream), and was located near the most downstream Maine DEP sample station. For both impaired and attainment streams, the assessment location was usually near a road crossing for ease of access. In the Crooked Brook watershed, the downstream sample station was located downstream of the Route 11/43 road crossing in Corinth. Just upstream and to the north of the sample reach, a cow farm was observed with the potential of direct access by cattle to Crooked Brook. Much of the stream and its tributaries flow near and through agricultural lands with minimal buffers. However, the sample reach was located within a forested portion of the stream. A manure smell was documented during the assessment. Some areas of the stream banks were eroding, but overall, were moderately stable.

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

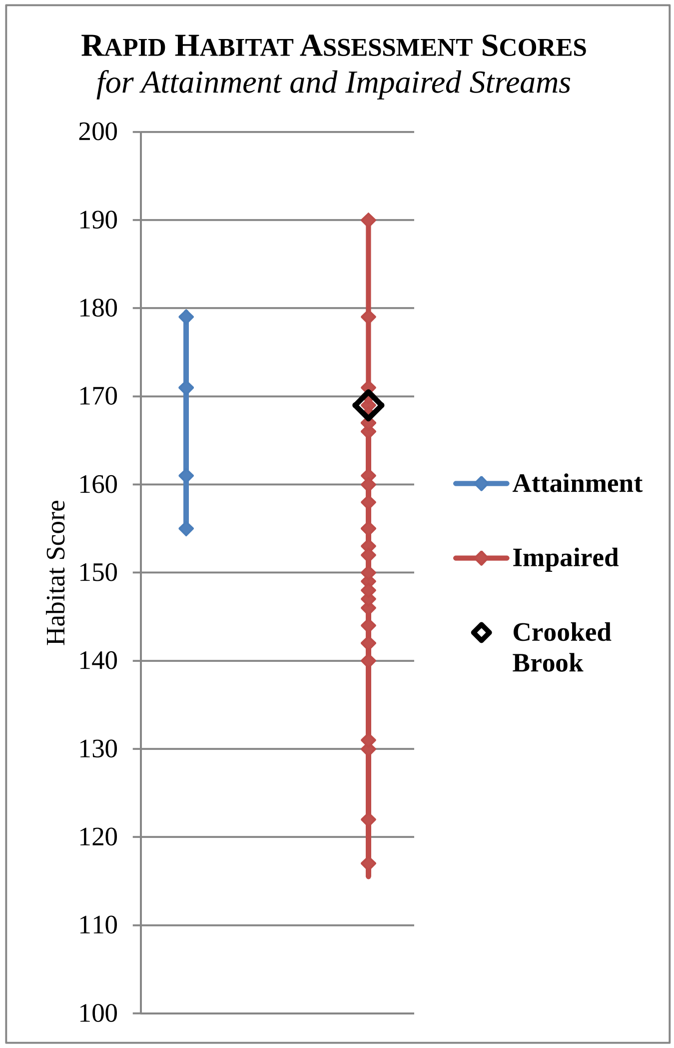


Figure 2: Habitat Assessment Scores

Pollution Source Identification

Pollution source identification assessments were conducted for both Crooked 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 Crooked Brook was completed on July 16, 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 3, Figure 3).

Table 3: Pollution Source ID Assessment for the Crooked Brook Watershed

Potential Source			Notes
ID#	**Location**	**Type**	
1	Exeter Road	Road Crossing DEP Sample Station	• A cow farm is located upstream of crossing with graze lands adjacent to stream; strong manure smell throughout reach area. • Many manure trucks passing by during habitat assessment traveling south on Beans Mills Road and north on Garland Road.
2	Exeter Road & Garland Road in Corinth	Agriculture	• An estimated 20 cows were observed grazing. • This property is upstream from the sample reach location where the habitat assessment was conducted. A strong manure smell was noted downstream of the Route 11 crossing as well.
2b	Visible from Garland Road	Livestock/ stream crossing	• A bridge crosses Crooked Brook and connects two grazing areas. • Strong manure smell in this area. • Direct access to the stream by cattle is undetermined.
5	Between Garland Road and Main Street	Agriculture/ Gravel Pits	• Multiple sand/gravel pits are located adjacent to Crooked Brook. • Could not gain access to these locations. • A large field is also accessed via private road to the west side of Crooked Brook. A limited buffer is visible in aerial photographs in at least one point along the field.
6a **6b** **6c**	Main Street	Agriculture	• Active corn crops to the west of Main Street close to tributaries. • Hay fields and one potato field were observed to the east.
7	Bacon Road	Agriculture	• A large corn field is located on the south side of Bacon Road adjacent to Crooked Brook to the east and a tributary to the west.
7b	Bacon Road	Road Crossing	• Located northwest of a large corn field (Source ID#7); this crossing is experiencing moderate sedimentation. Water is very turbid.
8	Bacon Road	Agriculture	• A tributary flows through an active corn field on the south side of Bacon Road.
9	Bacon Road	Agriculture	• Active hay fields along the west side of Bacon Road. • Forested buffer exists between stream and fields. Impact to stream undetermined.
12a	Campbell/West Road	Agriculture	• An estimated 50+ cows observed grazing. • A large tributary flows along the west side of property.
12b	Campbell/West Road @ Lower Notch Road	Agriculture	• Active potato fields to the north and south of Campbell/West Road. • A tributary flows through the middle of this property. • An impounded tributary is visible to the south from roadway.
14	Garland Road in Charleston	Agriculture	• An active cornfield intercepts a tributary on the south side of Garland Road in Charleston.
19a **19b**	Intersection of Bacon Road and West Road	Road Crossing	• Multiple Road crossing at the intersection of West Road and Bacon Road; Water is turbid. • Sediment deposits observed at the downstream crossing.
20	Bacon Road	Road Crossing	• Stream widening at culvert. Possibly undersized. • Water was noted as very turbid at crossing.
21a **21b** **21c**	Dover Road	Agriculture	• Multiple active hay fields to the west of Dover Road. • Liquid manure spreading was observed during survey.
22	Main Street	Agriculture	• Agricultural fields to the west of Main Street with multiple tributaries nearby.

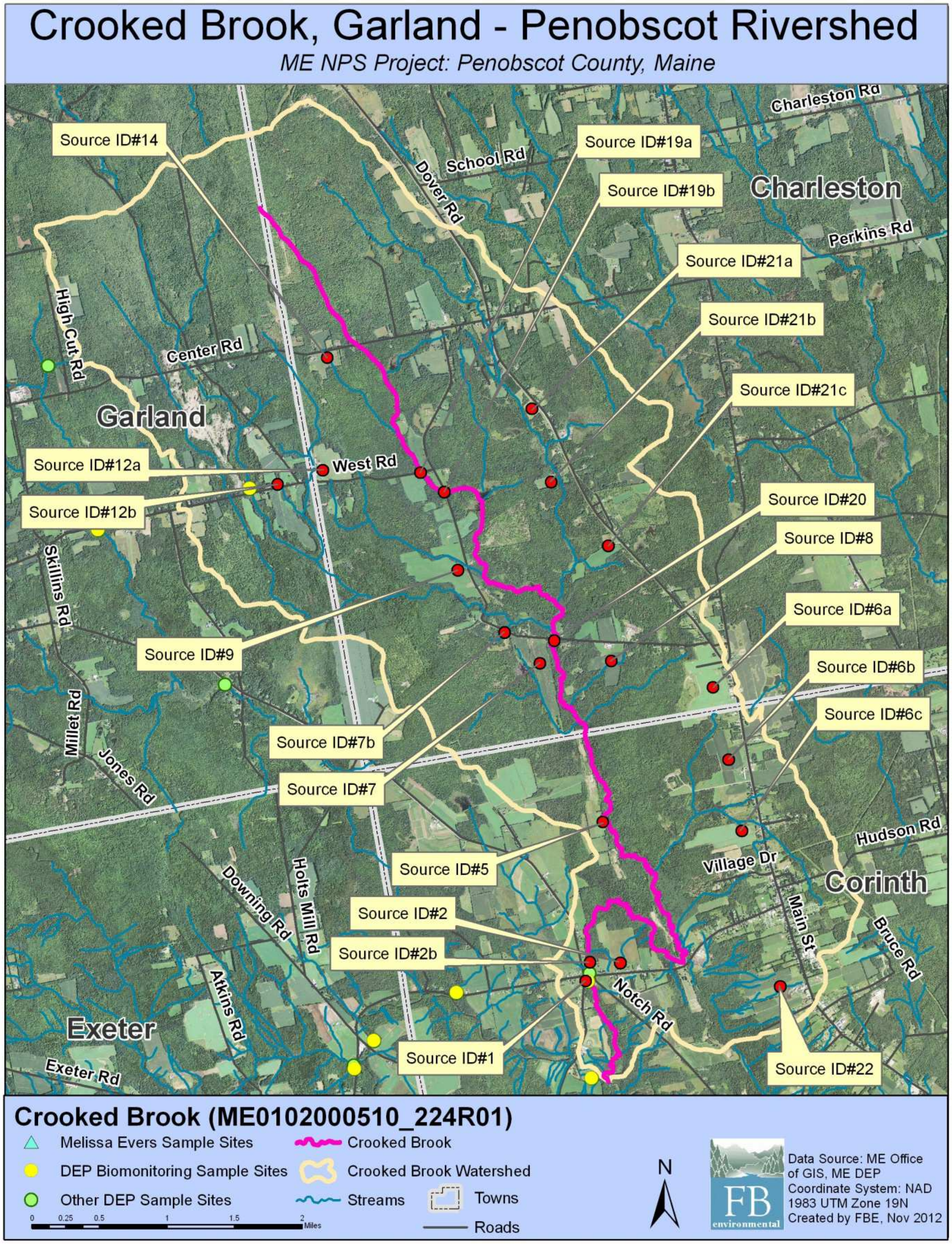


Figure 3: Aerial Photo of Source ID Locations in the Crooked Watershed

NUTRIENT LOADING – MAPSHED ANALYSIS

The MapShed model was used to estimate stream loading of sediment, total nitrogen and total phosphorus in Crooked 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 4 (right) provides estimates of livestock (numbers of animals) in the watershed, based on direct observations made in the watershed, plus other publicly available data.

Table 4: Livestock Estimates in the Crooked Brook Watershed

Type	Crooked Brook
Dairy Cows	50
Beef Cows	20
Broilers	
Layers	
Hogs/Swine	
Sheep	
Horses	
Turkeys	
Other	
Total	**70**

The Crooked Brook watershed is predominantly forested, with substantial mixed agricultural land uses. Large areas of potato and corn fields were documented throughout the watershed, as well as a dairy farm on West/Campbell Road with an estimated 50 cows. A tributary to Crooked Brook flows along the west side of the dairy. A smaller cattle operation was also observed upstream of the sample reach location near the intersection of Route 11/43, Beans Mill Road, and Garland Road. Twenty cows were estimated at this location. Cows may have direct access to the Crooked Brook at this location, and a bridge for cattle was observed over Crooked Brook upstream from the intersection and visible from Garland Road.

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.

Table 5: Summary of Vegetated Buffers in Agricultural Areas

Crooked Brook
• 34.7 stream miles in watershed (includes ephemeral streams) • 6.9 stream miles in agricultural areas • 25% of agricultural stream miles have a vegetated buffer

Crooked Brook is a 10.6 mile-long impaired segment. As modeled, the total stream miles (including tributaries) within the watershed was calculated by MapShed to be 34.7 miles. Of this total, 6.9 stream miles are located within agricultural areas; of this length, 1.7 miles (25%) show a 75-foot or greater vegetated buffer (Table 5, 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%.

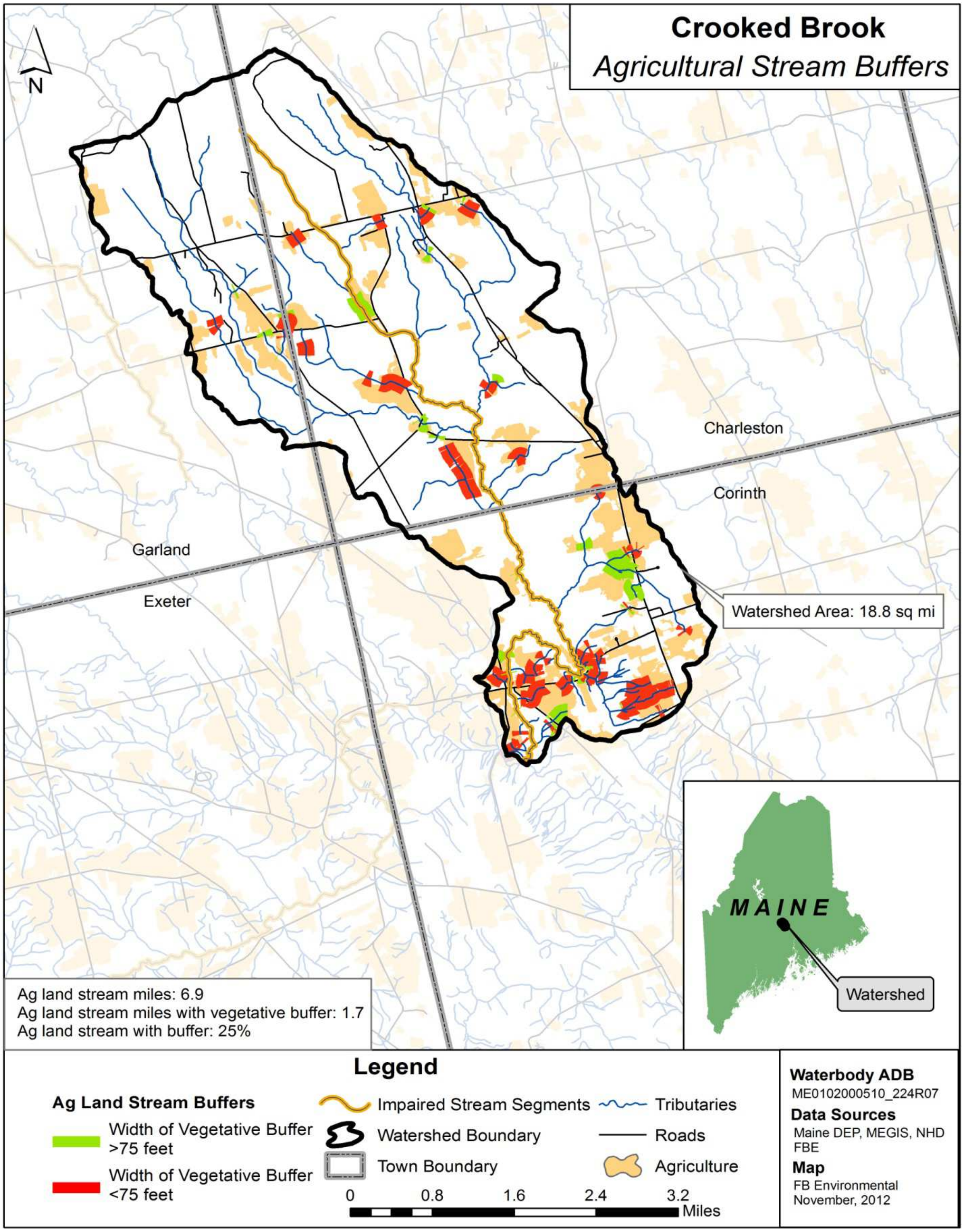


Figure 4: Agricultural Stream Buffers in the Crooked Brook Watershed

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 an attainment streams. 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 Crooked Brook watershed is 9.5% wetland, and overall 10% of the watershed drains to wetlands. Percent 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 Crooked Brook indicate that significant 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 Crooked Brook watershed is primarily attributed to crop land which accounts for 82% of the total load (Table 6 and Figure 5). Total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Crooked Brook* (below) for loading estimates that have been normalized by watershed area.

Table 6: Total Sediment Loads by Source

Crooked Brook	Sediment (1000kg/year)	Sediment (%)
Source Load		
Hay/Pasture	7.48	3%
Crop land	212.33	82%
Forest	14.76	6%
Wetland	2.05	1%
Disturbed Land	0	0%
Low Density Mixed	3.07	1%
Medium Density Mixed	0	0%
High Density Mixed	16.72	6%
Low Density Residential	1.24	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	0	0%
Septic Systems	0	0%
Source Load Total:	**257.65**	**100%**
Pathway Load		
Stream Banks	67.48	-
Subsurface / Groundwater	0	-
Total Watershed Mass Load:	**325.13**	

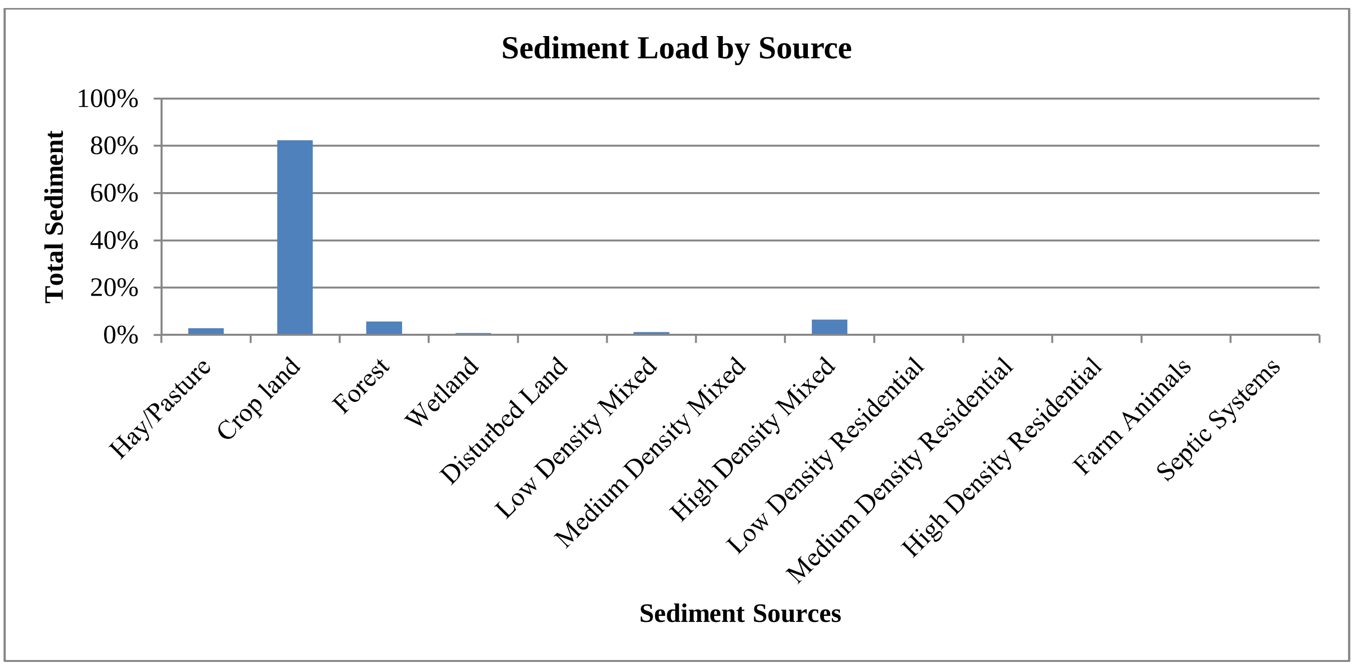


Figure 5: Total Sediment Loads by Source in the Crooked Brook Watershed

Total Nitrogen

Nitrogen loading in the Crooked Brook watershed is primarily attributed to crop land which accounts for 54% of the total nitrogen load. Total agricultural sources attribute 66% of the total nitrogen load. Forested lands also contribute a significant nitrogen load at 16%. Table 7 and Figure 6 display estimated total nitrogen load in terms of mass and percent of total, and by source. 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 Crooked Brook* below for loading estimates that have been normalized by watershed area.

Table 7: Total Nitrogen Loads by Source

Crooked Brook	Total N (kg/year)	Total N (%)
Source Load		
Hay/Pasture	438.4	4%
Crop land	5481.4	54%
Forest	1633.3	16%
Wetland	438.8	4%
Disturbed Land	0	0%
Low Density Mixed	82.2	1%
Medium Density Mixed	0	0%
High Density Mixed	699.8	7%
Low Density Residential	33.1	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	756.7	8%
Septic Systems	494.1	5%
Source Load Total:	**10057.8**	**100%**
Pathway Load		
Stream Banks	39.5	-
Subsurface / Groundwater	17630.6	-
Total Watershed Mass Load:	**27727.8**	

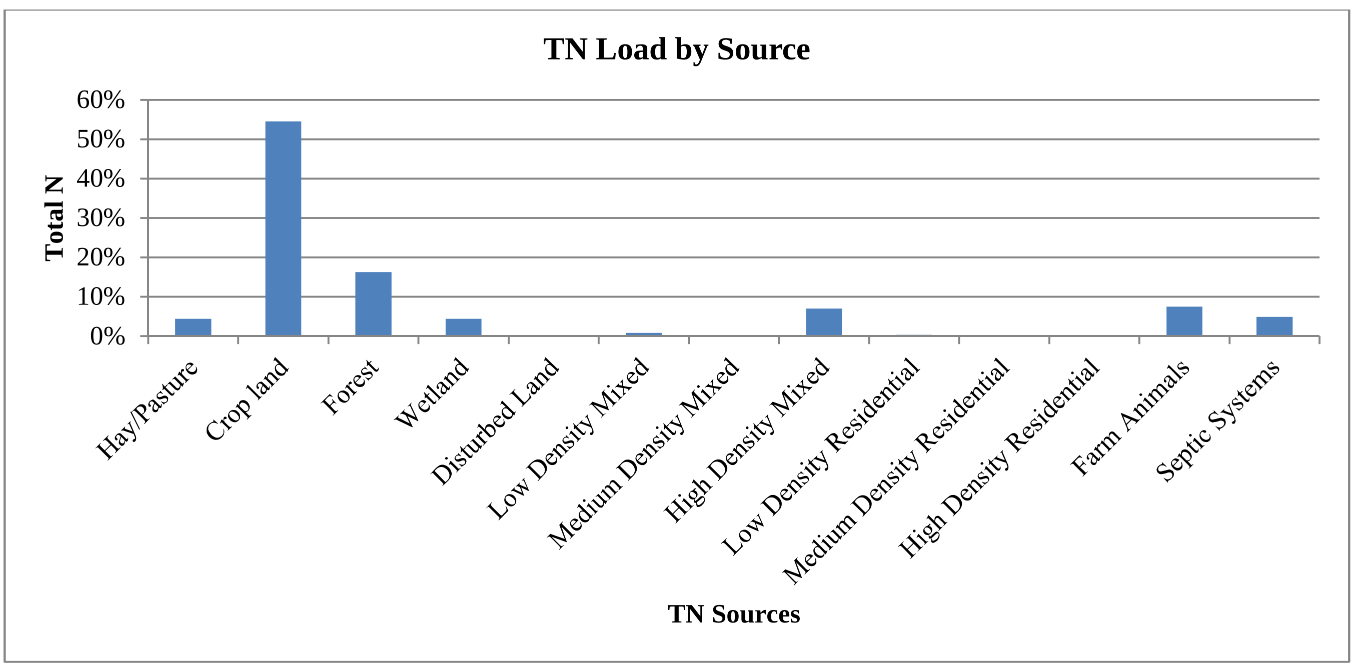


Figure 6: Total Nitrogen Loads by Source in the Crooked Brook Watershed

Total Phosphorus

Phosphorus loading in the Crooked Brook watershed is attributed primarily to crop land (53%), with combined agricultural sources contributing 80% of the total load. Phosphorus loads are presented in Table 8 and Figure 7 (below). Total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Crooked Brook* (below) for loading estimates that have been normalized by watershed area.

Table 8: Total Phosphorus Loads by Source

Crooked Brook	Total P (kg/year)	Total P (%)
Source Load		
Hay/Pasture	162.2	14%
Crop land	613.8	53%
Forest	94.2	8%
Wetland	24.0	2%
Disturbed Land	0	0%
Low Density Mixed	9.1	1%
Medium Density Mixed	0	0%
High Density Mixed	72.2	6%
Low Density Residential	3.7	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	151.2	13%
Septic Systems	17.9	2%
Source Load Total:	**1148.2**	**100%**
Pathway Load		
Stream Banks	13.6	-
Subsurface / Groundwater	484.6	-
Total Watershed Mass Load:	**1646.4**	

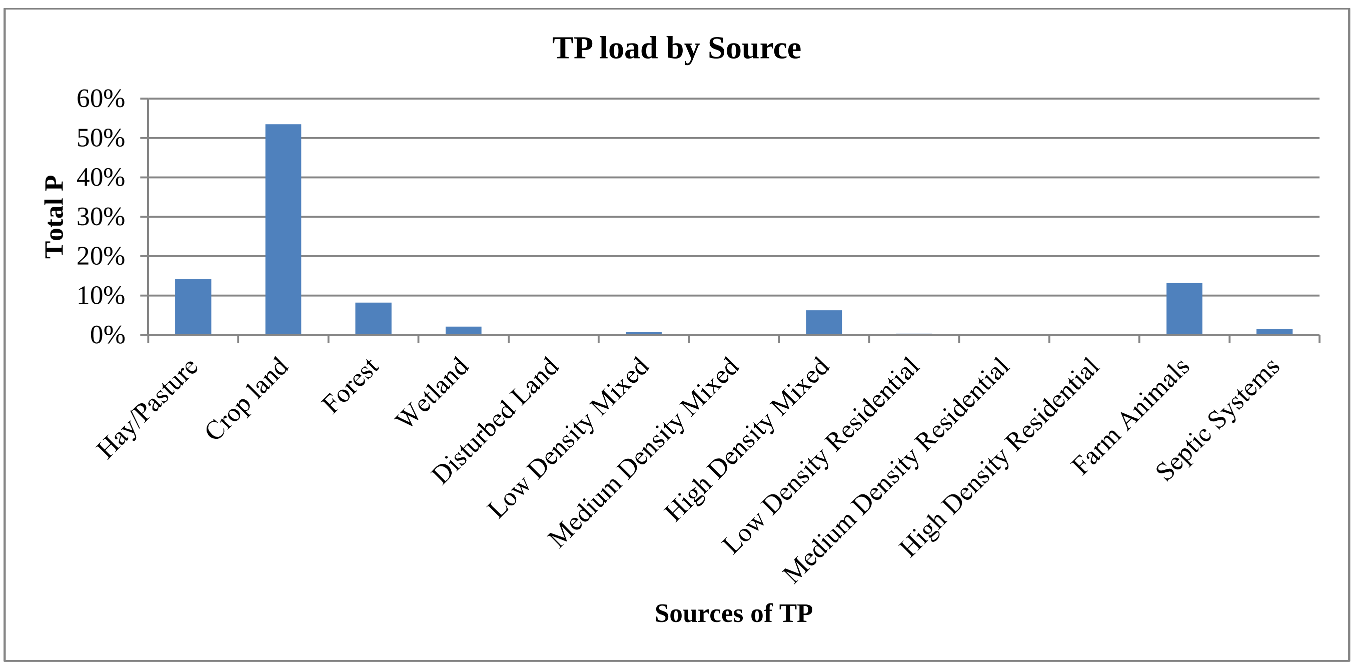


Figure 7: Total Phosphorus Loads by Source in the Crooked Brook Watershed

TMDL: TARGET NUTRIENT LEVELS FOR CROOKED BROOK

The existing sediment and nutrient loads for the impaired segment of Crooked Brook are listed in Table 9, along with the TMDL numeric targets which was calculated from the average loading estimates of five attainment watersheds throughout the state. Table 10 presents a more detailed view of the modeling results and calculations used in Table 9 to define TMDL reductions, and compares the existing sediment and nutrient loads in Crooked 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 9: TMDL Targets Compared to Crooked Brook Pollutant Loading

TMDL POLLUTANT LOADS Annual Loads per Unit Area	**Estimated Loads Crooked brook**	**Total Maximum Daily Load Numeric Target**	**TMDL % REDUCTIONS Crooked Brook**
Sediment Load *(1000 kg/ha/year)*	**0.065**	**0.030**	**54%**
Nitrogen Load *(kg/ha/year)*	**5.55**	**5.2**	**7%**
Phosphorus Load *(kg/ha/year)*	**0.33**	**0.24**	**26%**

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 Crooked 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 Crooked Brook watershed because of and increasing population trend in Penobscot County of 2.6% between 2000 and 2008 (USM MSAC, 2009). The growth in agricultural lands is also increasing, with a 23% increase in the total number of farms in Penobscot County between 2002 and 2007, and a 7% increase in the land (acres) in farms between 2002 and 2007. However, a 13% decrease occurred in the average farm size in this time period (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 Crooked Brook. It is recommended that municipal officials, landowners, and conservation stakeholders in Charleston and Corinth 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 Crooked Brook;
- Address existing nonpoint source problems in the Crooked Brook watershed by instituting BMPs where necessary; and
- Prevent future degradation of Crooked Brook through the development and/or strengthening of a local Nutrient Management Ordinance.

Table 10: Modeling Results Calculations for Derived Numeric Targets and Reduction Loads for Crooked Brook

Crooked Brook				
	Area ha	**Sediment 1000kg/yr**	**TN kg/yr**	**TP kg/yr**
Land Uses				
Hay/Pasture	272	7.5	438.4	162.2
Cropland	594	212.3	5481.4	613.8
Forest	3367	14.8	1633.3	94.2
Wetland	475	2.0	438.8	24.0
Disturbed Land	0	0.0	0.0	0.0
Low Density Mixed	97	3.1	82.2	9.1
High Density Mixed	151	16.7	699.8	72.2
Low Density Residential	39	1.2	33.1	3.7
Other Sources				
Farm Animals			756.7	151.2
Septic Systems			494.1	17.9
Pathway Loads				
Stream Banks		67.5	39.5	13.59
Groundwater			17630.5	484.6
Total Annual Load		325 x 1000 kg	27727 kg	1646 kg
Total Area	4995 ha			
Total Maximum Daily Load		**0.065 1000kg/ha/year**	**5.55 kg/ha/year**	**0.33 kg/ha/year**

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