Sasco Brook Watershed Summary

Sasco Brook (Tributaries 1 and 2), Great Brook (Segments 1 and 2)

WATERSHED DESCRIPTION AND MAPS

The Sasco Brook watershed covers an area of approximately 6,534 acres in the southwestern corner of Connecticut (Figure 1). The watershed is located in eastern Westport and western Fairfield, CT, and extends into Easton, CT.

The Sasco Brook watershed includes four segments impaired for recreation due to elevated bacteria levels. These segments were assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and included in the CT 2010 303(d) list of impaired waterbodies. Although Great Brook (Segment 2, CT7109-06_02) was fully supporting designated uses for recreation in 2010 and Sasco Brook (Tributary 2, CT7109-02_01) was unassessed for recreation in 2010, recent water quality testing will place these segments on the CT 2012 303(d) list of impaired waterbodies. An excerpt of the Integrated Water Quality Report is included in Table 1 to show the status of other waterbodies in the watershed (CTDEEP, 2010).

The main stem of Sasco Brook begins in northwest Fairfield, flows south to bisect the Merritt Parkway (Route 15), follows the Westport-Fairfield border just downstream of the Great Brook tributary, and ends at its outlet to Long Island Sound. The bacteria impaired segment, Sasco Brook (Tributary 1, CT7109-00-trib_01), consists of 0.34 miles of river in Westport (Figure 2). Sasco Brook (Tributary 1) begins upstream of the Bulkley Avenue crossing in Westport and flows 0.34 miles downstream to its mouth along the main stem of Sasco Brook just upstream of Old Road crossing at the Westport-Fairfield town border. The bacteria impaired segment, Sasco Brook (Tributary 2, CT7109-02_01) consists of 0.61 miles of river in Fairfield. Sasco Brook (Tributary 2) begins at the confluence to an unnamed tributary just downstream of the Merwins Lane crossing, and

Impaired Segment Facts

Impaired Segments:

1. Sasco Brook (Tributary 1) (CT7109-00-trib_01)
2. Sasco Brook (Tributary 2) (CT7109-02_01)
3. Great Brook (Segment 1) (CT7109-06_01)
4. Great Brook (Segment 2) (CT7109-06_02)

Municipalities: Westport, Fairfield

Impaired Segment Length (miles): 7109-00-trib_01 (0.34), 7109-02_01 (0.61), 7109-06_01 (0.72), 7109-06_02 (2.20)

Water Quality Classification: Class A

Designated Use Impairment: Recreation

Sub-regional Basin Name and Code: Sasco Brook, 7109

Regional Basin: Southwest Eastern

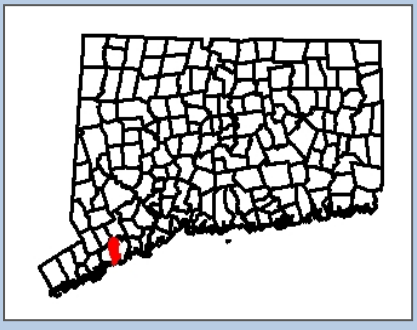
Major Basin: Southwest Coast

Watershed Area (acres): 6,534

MS4 Applicable? Yes

Applicable Season: Recreation Season (May 1 to September 30)

Figure 1: Watershed location in Connecticut



ends at the confluence with Sasco Brook just downstream of the Route 15 crossing in Fairfield. The bacteria impaired segment, Great Brook (Segment 1, CT7109-06_01), consists of 0.72 miles of river in Fairfield. Great Brook (Segment 1) begins at the first confluence with an unnamed brook just upstream of the Morehouse Lane crossing in Fairfield and flows 0.72 miles downstream to the confluence with Sasco Brook just upstream of the Hulls Farm Road crossing in Fairfield. The bacteria impaired segment Great Brook (Segment 2, CT7109-06_02) consists of 2.20 miles of river in Fairfield. Great Brook (Segment 2) begins at a marsh just upstream of the Congress Street crossing southwest of the Cross Highway and Hillside Road intersection, and ends at the confluence with an unnamed brook just upstream of the Morehouse Lane crossing in Fairfield.

The four impaired segments of the Sasco Brook watershed have a water quality classification of A. Designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. As there are no designated beaches in these segments of the Sasco Brook watershed, the specific recreation impairment is for non-designated swimming and other water contact related activities.

Table 1: Impaired segments and nearby waterbodies from the Connecticut 2010 Integrated Water Quality Report

Waterbody ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation	Fish Consumption
CT7109-00-trib_01	Unnamed tributary, Sasco Brook-01	From mouth at Sasco Brook (US of Old Road crossing), Westport/Fairfield town border, US to headwaters (US of Bulkley Avenue crossing), Westport.	0.34	U	NOT	FULL
CT7109-02_01	Unnamed Tributary, Sasco Brook (Fairfield)-01	From mouth at confluence with Sasco Brook (DS Route 15 crossing), US to confluence with unnamed tributary, just DS of Merwins Lane crossing, Fairfield.	0.61	FULL	U	FULL
CT7109-06_01	Great Brook (Fairfield)-01	From mouth at confluence with Sasco Brook (just US of Hulls Farm Road crossing of Sasco Brook, east bank), US to first confluence with unnamed brook (just US of Morehouse Lane crossing, DS of marsh), Fairfield.	0.72	U	NOT	FULL
CT7109-06_02	Great Brook (Fairfield)-02	From first confluence with unnamed brook (just US of Morehouse Lane crossing, DS of marsh), US to headwaters at marsh (US of Congress Street crossing, southwest of Cross highway and Hillside road intersection), Fairfield.	2.20	U	FULL	FULL

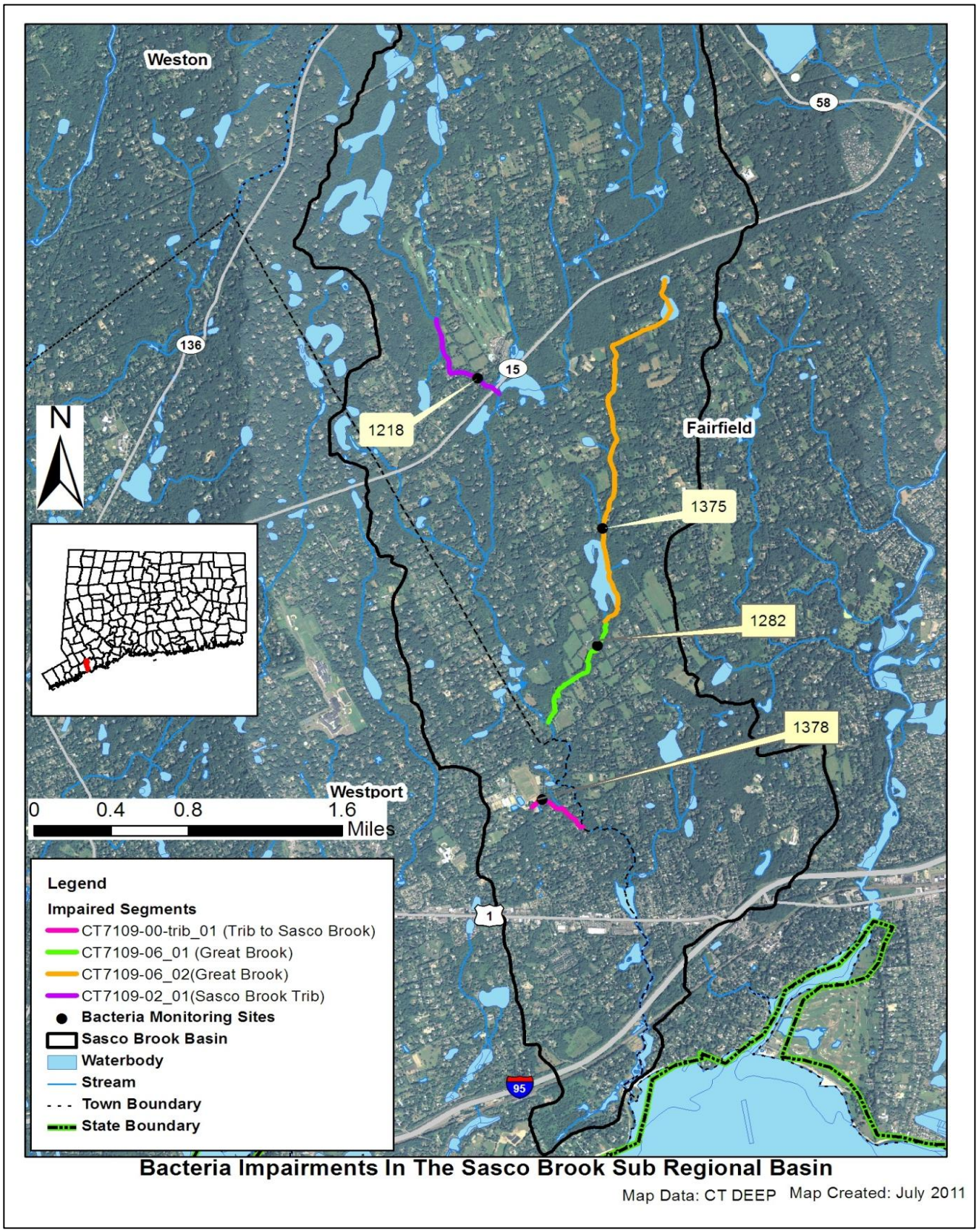
Shaded cells indicate impaired segment addressed in this TMDL
FULL = Designated Use Fully Supported
NOT = Designated Use Not Supported
U = Unassessed

Additional studies have been conducted and published by CT DEEP in the Sasco Brook watershed. Three TMDLs on different segments and various impairments have been developed by CT DEEP and approved by EPA. In 2007, a TMDL dealing with Shellfish areas in Southport Harbor was completed and approved. This document can be reviewed at http://www.ct.gov/dep/lib/dep/water/tmdl/tmdl_final/southport_h_final.pdf.

In 2005, a TMDL for Sasco Brook, Rooster River, and Mill River was completed and approved for indicator bacteria. The affected segments were Mill River (CT7108-00_02), Rooster River (CT7106-00_01), and Sasco Brook mainstem (CT7109-00_01) and (CT7109-00_02). This document can be found at http://www.ct.gov/dep/lib/dep/water/tmdl/tmdl_final/swebasintmdlfinal.pdf.

Finally in 1999, a TMDL was completed dealing with fecal coliform indicator bacteria. This document does discuss specific segments, but instead targets sub-watersheds in the Sasco Brook watershed. The document is available at http://www.ct.gov/dep/lib/dep/water/tmdl/tmdl_final/sascofinal.pdf. The difference between the 1999 and 2005 documents was the use of different indicator bacteria and a shift in approach from watershed wide reductions to a segment specific approach.

Figure 2: GIS map featuring general information of the Sasco Brook watershed at the sub-regional level



Land Use

Existing land use can affect the water quality of waterbodies within a watershed (USEPA, 2011c). Natural processes, such as soil infiltration of stormwater and plant uptake of water and nutrients, can occur in undeveloped portions of the watershed. As impervious surfaces (such as rooftops, roads, and sidewalks) increase within the watershed landscape from commercial, residential, and industrial development, the amount of stormwater runoff to waterbodies also increases. These waterbodies are negatively affected as increased pollutants from nutrients and bacteria from failing and insufficient septic systems, oil and grease from automobiles, and sediment from construction activities become entrained in this runoff. Agricultural land use activities, such as fertilizer application and manure from livestock, can also increase pollutants in nearby waterbodies (USEPA, 2011c).

As shown in Figures 3 and 4, the Sasco Brook watershed consists of 53% urban, 37% forest, 6% agriculture, and 4% water land uses. The upper reaches of the Sasco Brook watershed north of Merritt Parkway (Route 15) are characterized by forested and open space areas, including Brett Woods Open Space, Brett Woods Park, and Patterson Golf Club, mixed with large plot residential development and hayfields. South of Merritt Parkway (Route 15), forested land cover decreases and urban development density increases. Great Brook (Segment 1) flows through an agricultural sector of hayfields and cultivated row crops buffered by mixed forested tracts. Great Brook (Segment 2) also flows through hayfields and row crops and residential development. Sasco Brook (Tributary 1) flows through a densely populated area with suburban residential development and commercial areas just upstream of US Route 1. Sasco Brook (Tributary 2) flows through a mixed forested area sandwiched between the Patterson Club golf course and dense suburban development.

Figure 3: Land use within the Sasco Brook watershed

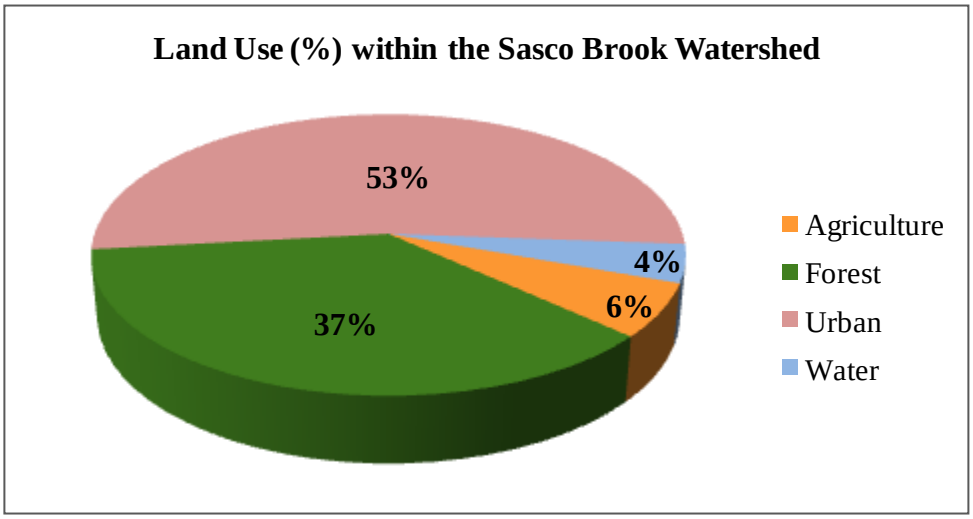
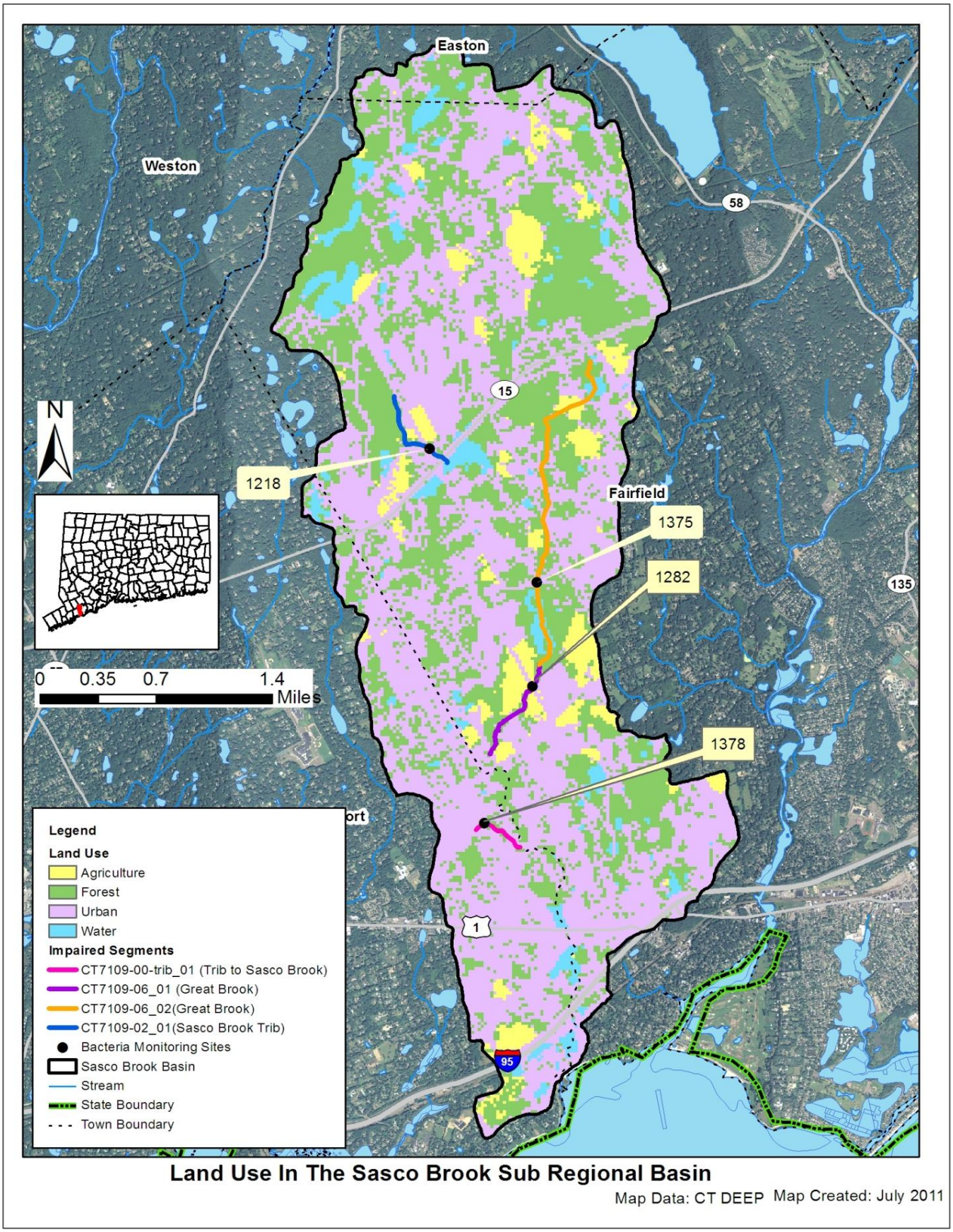


Figure 4: GIS map featuring land use for the Sasco Brook watershed at the sub-regional level



WHY IS A TMDL NEEDED?

E. coli is the indicator bacteria used for comparison with the CT State criteria in the CT Water Quality Standards (WQS) (CTDEEP, 2011). All data results are from CT DEEP, USGS, Bureau of Aquaculture, or volunteer monitoring efforts at stations located on the impaired segments.

Table 2: Sampling station location description for impaired segments in the Sasco Brook watershed

Waterbody ID	Waterbody Name	Station	Station Description	Municipality	Latitude	Longitude
CT7109-00-trib_01	Sasco Brook, tributary to	1378	Bulkley Avenue Adjacent to Fairfield County Hunt Club	Westport	41.147922	-73.307275
CT7109-02_01	Sasco Brook, tributary to	1218	Merwins Lane	Fairfield	41.1816722	-73.3139361
CT7109-06_01	Great Brook	1282	Morehouse Lane	Fairfield	41.160303	-73.301828
CT7109-06_02	Great Brook	1375	Merwins Lane and Fair Oak Drive intersection	Fairfield	41.1696917	-73.3013917

The impaired segments of the Sasco Brook watershed are Class A freshwater rivers (Figure 5). Their applicable designated uses are potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Water quality analyses were conducted using data from one sampling location on Sasco Brook (Tributary 1, Station 1378) from 2004 – 2005, one sampling location on Sasco Brook (Tributary 2, Station 1218) from 1999-2005, and 2011, one sampling location on Great Brook (Segment 1, Station 1282) from 2004 – 2005, and one sampling location on Great Brook (Segment 2, Station 1375) from 2000-2003, and 2011 (Table 2).

For Sasco Brook (Tributary 1), the water quality criteria for *E. coli*, along with bacteria sampling results for Station 1378 from 2004 – 2005 are presented in Table 11. The annual geometric mean was calculated for Station 1378 and exceeded the WQS for *E. coli* in 2004 and 2005. Single sample values at this station also exceeded the WQS for *E. coli* multiple times in 2004 and 2005.

For Sasco Brook (Tributary 2), the water quality criteria for *E. coli*, along with bacteria sampling results for Station 1218 from monitoring years 1999-2005 and 2011 are presented in Table 12. The annual geometric mean was calculated for Station 1218 and exceeded the WQS for *E. coli* in 2011. Single sample values at this station also exceeded the WQS for *E. coli* at least once during all sampling years.

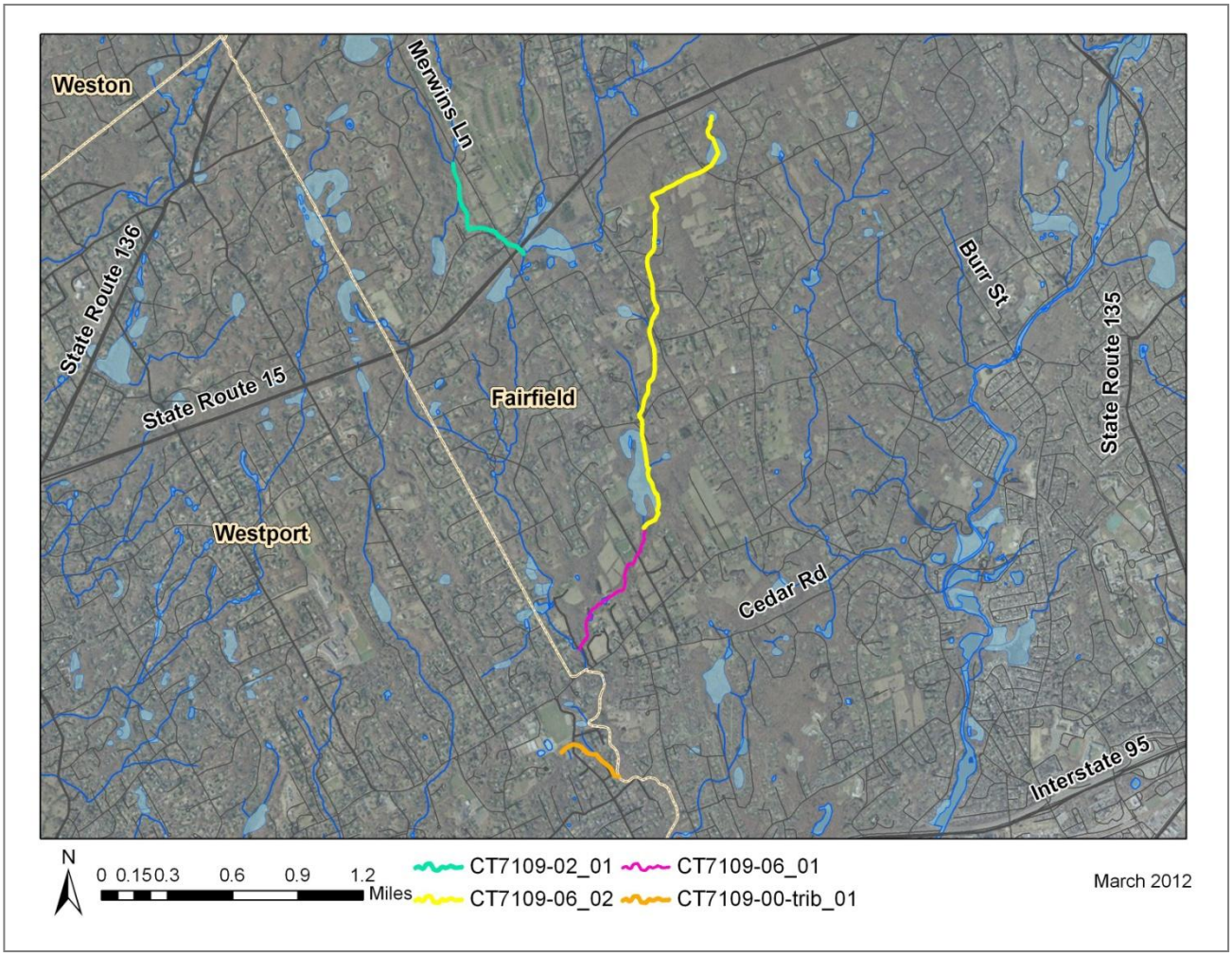
For Great Brook (Segment 1), the water quality criteria for *E. coli*, along with bacteria sampling results for Station 1282 from 2004 – 2005 are presented in Table 13. The annual geometric mean was calculated for Station 1282 and exceeded the WQS for *E. coli* in 2004 and 2005. Single sample values at this station also exceeded the WQS for *E. coli* multiple times in 2004 and 2005.

For Great Brook (Segment 2), the water quality criteria for *E. coli* along with bacteria sampling results for Station 1375 from monitoring years 2000-2003 and 2011 are presented in Table 14. The annual geometric mean was calculated for Station 1375 and exceeded the WQS for *E. coli* in 2001, 2002, and 2011. Single sample values are this station also exceeded the WQS for *E. coli* multiple times in 2001 and 2011.

To aid in identifying possible bacteria sources, the geometric mean was also calculated for each station for wet-weather and dry-weather sampling days, where appropriate (Tables 11 – 14). For Sasco Brook (Tributary 1), Sasco Brook (Tributary 2), and Great Brook (Segment 1), the geometric mean values exceeded the WQS for *E. coli* during both wet and dry-weather conditions. For Great Brook (Segment 2), the geometric mean values exceeded the WQS for *E. coli* during only wet-weather conditions.

Due to the elevated bacteria measurements presented in Tables 11 – 14, these segments of the Sasco Brook watershed did not meet CT's bacteria WQS, were identified as impaired, and were placed on the CT List of Waterbodies Not Meeting Water Quality Standards, also known as the CT 303(d) Impaired Waters List. The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with State WQS.

Figure 5: Aerial map of Great Brook and Sasco Brook tributaries



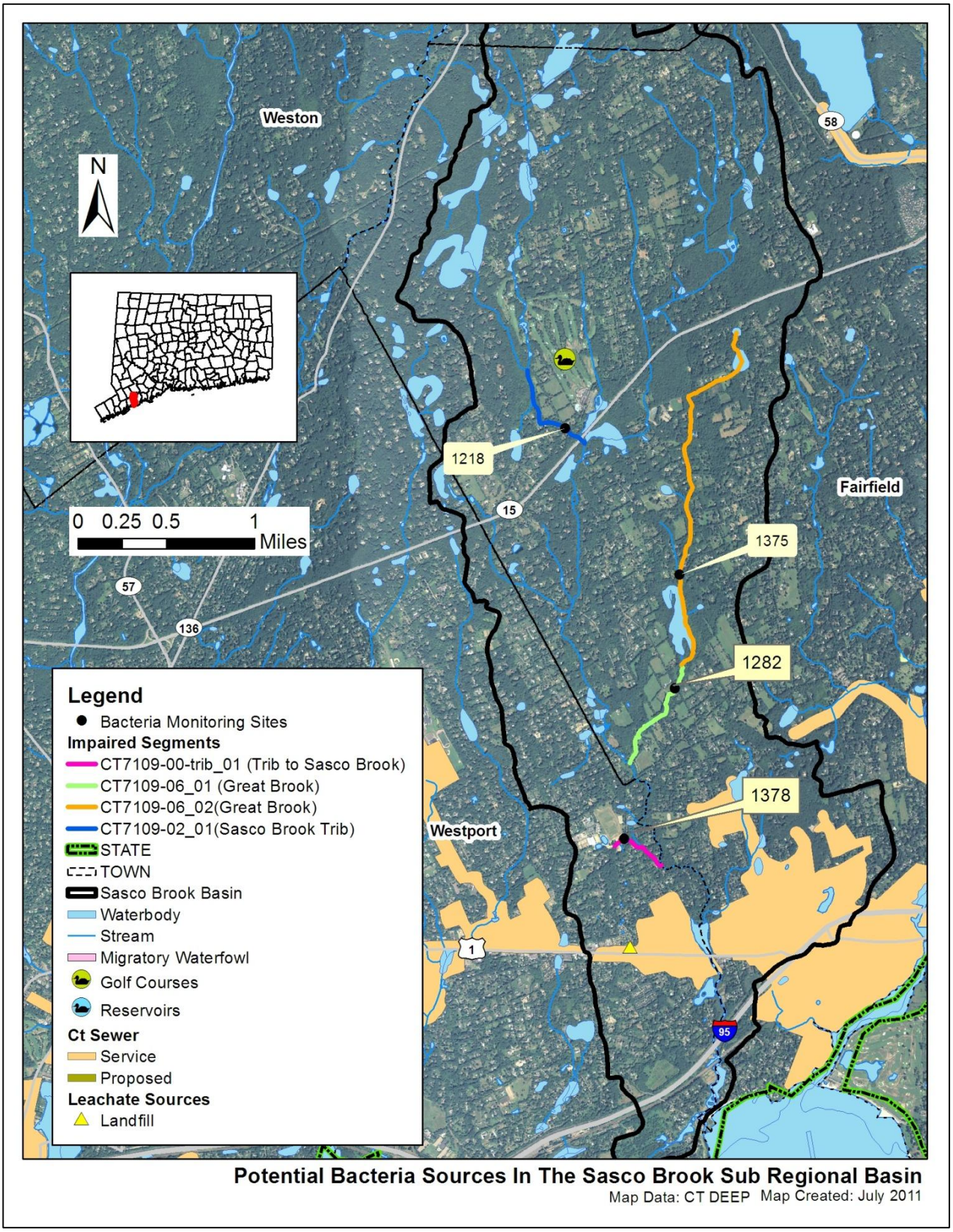
POTENTIAL BACTERIA SOURCES

Potential sources of indicator bacteria in a watershed include point and non-point sources, such as stormwater runoff, agriculture, sanitary sewer overflows (collection system failures), illicit discharges, and inappropriate discharges to the waterbody. Potential sources that have been tentatively identified in the Sasco Brook watershed based on land use (Figures 3 and 4) and a collection of local information for the impaired waterbody is presented in Table 3 below. However, the list of potential sources is general in nature and should not be considered comprehensive. There may be other sources not listed here that contribute to the observed water quality impairment in the study segment. Further monitoring and investigation will confirm listed sources and discover additional sources. For some segments, there are data from permitted sources, and CT DEEP recommends that any elevated concentrations found from those permitted sources be addressed through voluntary reduction measures. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement these TMDLs.

Table 3: Potential bacteria sources in the Sasco Brook watershed

Impaired Segment	Permit Source	Illicit Discharge	CSO/SSO Issue	Failing Septic System	Agricultural Activity	Stormwater Runoff	Nuisance Wildlife/Pets	Other
Sasco Brook (Tributary 1) CT7109-00-trib_01		**x**		**x**	**x**	**x**	**x**	
Sasco Brook (Tributary 2) CT7109-02_01		**x**		**x**	**x**	**x**	**x**	
Great Brook (Segment 1) CT7109-06_01		**x**		**x**	**x**	**x**	**x**	
Great Brook (Segment 2) CT7109-06_02		**x**		**x**	**x**	**x**	**x**	

Figure 6: Potential sources in the Sasco Brook watershed at the sub-regional level



The potential sources map for the impaired basin was developed after thorough analysis of available data sets. If information is not displayed in the map, then no sources were discovered during the analysis. The following is the list of potential sources that were evaluated: problems with migratory waterfowl, golf course locations, reservoirs, proposed and existing sewer service, cattle farms, poultry farms, permitted sources of bacteria loading (surface water discharge, MS4 permit, industrial stormwater, commercial stormwater, groundwater permits, and construction related stormwater), and leachate and discharge sources (agricultural waste, CSOs, failing septic systems, landfills, large septic tank leach fields, septage lagoons, sewage treatment plants, and water treatment or filter backwash).

Point Sources

Permitted sources within the watershed that could potentially contribute to the bacteria loading are identified in Table 4. This table includes permit types that may or may not be present in the impaired watershed. Additional investigation and monitoring may reveal the presence of additional discharges in the watershed. Available effluent data from each of these permitted categories found within the watershed are compared to the CT State WQS for the appropriate receiving waterbody use and type.

Table 4: General categories list of other permitted discharges

Permit Code	Permit Description Type	Number in watershed
CT	Surface Water Discharges	0
GPL	Discharge of Swimming Pool Wastewater	0
GSC	Stormwater Discharge Associated with Commercial Activity	0
GSI	Stormwater Associated with Industrial Activity	0
GSM	Part B Municipal Stormwater MS4	3
GSN	Stormwater Registration – Construction	0
LF	Groundwater Permit (Landfill)	0
UI	Underground Injection	0

Permitted Sources

As shown in Table 5, the only permitted discharges in the Sasco Brook watershed are MS4 permits for Easton, Fairfield, and Westport. Since the MS4 permits are not targeted to a specific location, but the geographic area of the regulated municipality, there is no one accurate location on the map to display the location of these permits. One dot will be displayed at the geographic center of the municipality as a reference point. Sometimes this location falls outside of the targeted watershed and therefore the MS4 permit will not be displayed in the Potential Sources Map. Using the municipal border as a guideline will show which areas of an affected watershed are covered by an MS4 permit.

Table 5: Permitted facilities within the Sasco Brook watershed

Town	Client	Permit ID	Permit Type	Site Name/Address	Map #
Easton	Town of Easton	GSM000059	Part B Municipal Stormwater MS4	Easton, Town of	N/A
Fairfield	Town of Fairfield	GSM000012	Part B Municipal Stormwater MS4	Fairfield, Town of	N/A
Westport	Town of Westport	GSM000026	Part B Municipal Stormwater MS4	Westport, Town of	N/A

Municipal Stormwater Permitted Sources

Per the EPA Phase II Stormwater rule all municipal storm sewer systems (MS4s) operators located within US Census Bureau Urbanized Areas (UAs) must be covered under MS4 permits regulated by the appropriate State agency. There is an EPA waiver process that municipalities can apply for to not participate in the MS4 program. In Connecticut, EPA has granted such waivers to 19 municipalities. All participating municipalities within UAs in Connecticut are currently regulated under MS4 permits by CT DEEP staff in the MS4 program.

The US Census Bureau defines a UA as a densely settled area that has a census population of at least 50,000. A UA generally consists of a geographic core of block groups or blocks that exceeds the 50,000 people threshold and has a population density of at least 1,000 people per square mile. The UA will also include adjacent block groups and blocks with at least 500 people per square mile. A UA consists of all or part of one or more incorporated places and/or census designated places, and may include additional territory outside of any place. (67 FR 11663)

For the 2000 Census a new geographic entity was created to supplement the UA blocks of land. This created a block known as an Urban Cluster (UC) and is slightly different than the UA. The definition of a UC is a densely settled area that has a census population of 2,500 to 49,999. A UC generally consists of a geographic core of block groups or blocks that have a population density of at least 1,000 people per square mile, and adjacent block groups and blocks with at least 500 people per square mile. A UC consists of all or part of one or more incorporated places and/or census designated places; such a place(s) together with adjacent territory; or territory outside of any place. The major difference is the total population cap of 49,999 people for a UC compared to >50,000 people for a UA. (67 FR 11663)

While it is possible that CT DEEP will be expanding the reach of the MS4 program to include UC municipalities in the near future they are not currently under the permit. However, the GIS layers used to create the MS4 maps in this Statewide TMDL did include both UA and UC blocks. This factor creates some municipalities that appear to be within an MS4 program that are not currently regulated through an MS4 permit. This oversight can explain a municipality that is at least partially shaded grey in the maps and there are no active MS4 reporting materials or information included in the appropriate appendix. While these areas are not technically in the MS4 permit program, they are still considered urban by the cluster definition above and are likely to contribute similar stormwater discharges to affected waterbodies covered in this TMDL.

As previously noted, EPA can grant a waiver to a municipality to preclude their inclusion in the MS4 permit program. One reason a waiver could be granted is a municipality with a total population less than 1000 people, even if the municipality was located in a UA. There are 19 municipalities in Connecticut that have received waivers, this list is: Andover, Bozrah, Canterbury, Coventry, East Hampton, Franklin, Haddam, Killingworth, Litchfield, Lyme, New Hartford, Plainfield, Preston, Salem, Sherman, Sprague, Stafford, Washington, and Woodstock. There will be no MS4 reporting documents from these towns even if they are displayed in an MS4 area in the maps of this document.

The list of US Census UCs is defined by geographic regions and is named for those regions, not necessarily by following municipal borders. In Connecticut the list of UCs includes blocks in the following Census Bureau regions: Colchester, Danielson, Lake Pocotopaug, Plainfield, Stafford, Storrs, Torrington, Willimantic, Winsted, and the border area with Westerly, RI (67 FR 11663). Any MS4 maps showing these municipalities may show grey areas that are not currently regulated by the CT DEEP MS4 permit program.

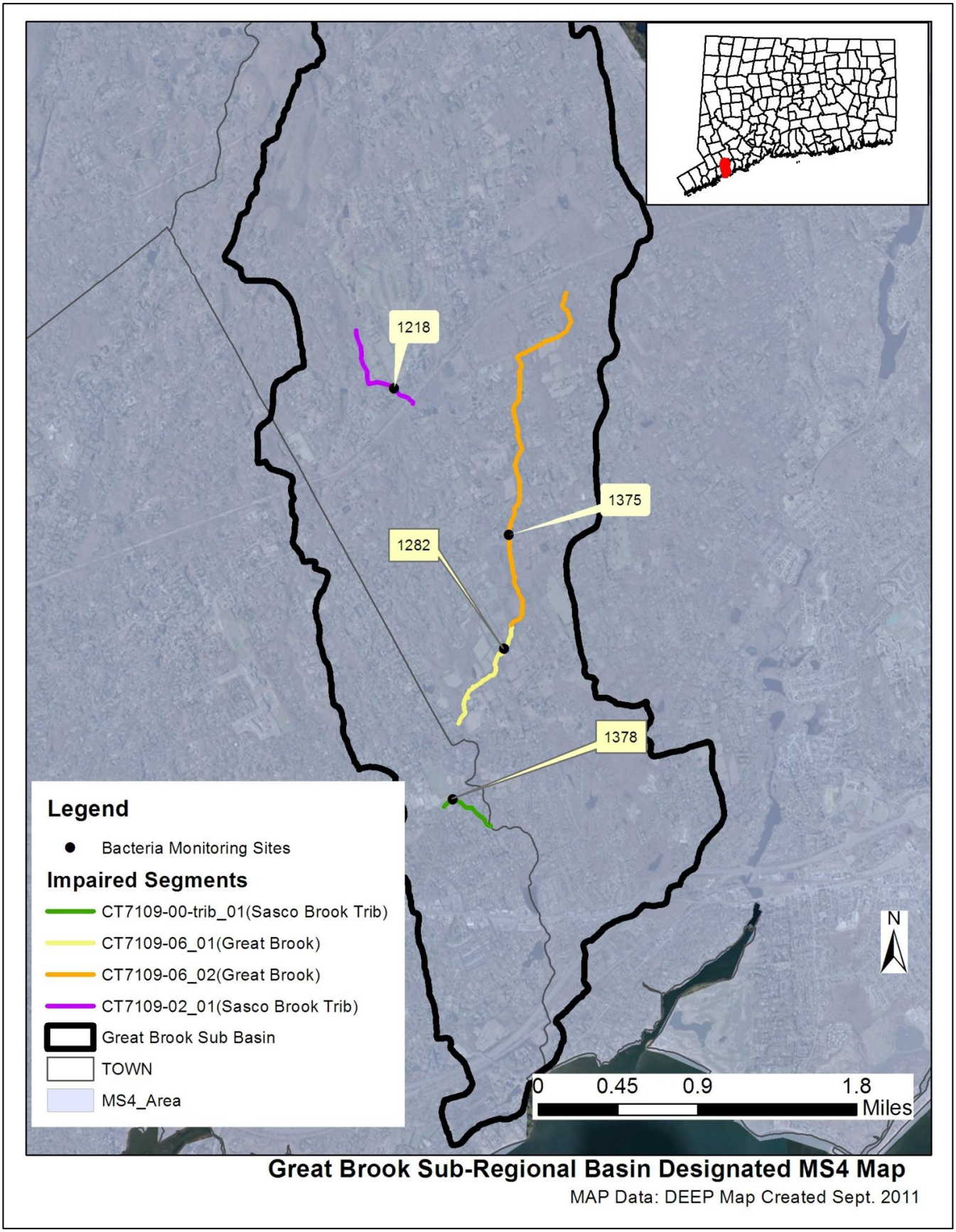
The impaired segments of the Sasco Brook watershed are located within the Towns of Westport and Fairfield, CT. The municipalities are largely urbanized, as defined by the U.S. Census Bureau, and are required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 permit) issued by the Connecticut Department of Energy and Environmental Protection (DEEP) (Figure 7). This general permit is only applicable to municipalities that are identified in Appendix A of the MS4 permit that contain designated urban areas and discharge stormwater via a separate storm sewer system to surface waters of the State. The permit requires municipalities to develop a Stormwater Management Plan (SMP) to reduce the discharge of pollutants and protect water quality. The MS4 permit is discussed further in the "TMDL Implementation Guidance" section of the core TMDL document. Additional information regarding stormwater management and the MS4 permit can be obtained on CTDEEP's website (http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325702&depNav_GID=1654).

One MS4 outfall has been sampled for *E. coli* bacteria in the watershed (Table 6). This outfall, located in Fairfield, was sampled in 2005, 2006, 2007, and 2010. Of these samples, two exceeded the single sample water quality standard of 410 colonies/100 mL.

Table 6: List of MS4 sample locations and *E. coli* (colonies/100 mL) results in the Sasco Brook watershed

Town	Location	MS4 Type	Receiving Waters	Sample Date	Result
Fairfield	#4 Mill Hill Terrace	Residential	Sasco Brook	04/27/05	0
Fairfield	#4 Mill Hill Terrace	Residential	Sasco Brook	02/03/06	0
Fairfield	#4 Mill Hill Terrace	Residential	Sasco Brook	11/08/06	64
Fairfield	#4 Mill Hill Terrace	Residential	Sasco Brook	04/12/07	650
Fairfield	#4 Mill Hill Terrace	Residential	Sasco Brook	10/15/10	TNTC
Shaded cells indicate an exceedance of single-sample based water quality criteria (410 colonies/100 mL) **TNTC = Too numerous to count**					

Figure 7: MS4 areas of the Sasco Brook watershed



Non-point Sources

Non-point source pollution (NPS) comes from many diffuse sources and is more difficult to identify and control. NPS pollution is often associated with land-use practices. Examples of NPS that can contribute bacteria to surface waters include insufficient septic systems, pet and wildlife waste, agriculture, and contact recreation (swimming or wading). Potential sources of NPS within the Sasco Brook watershed are described below. The 2011 Sasco Brook Watershed Based Plan describes many of these sources in greater detail (www.ct.gov/dep/lib/dep/water/watershed_management/wm_plans/sasco_brook_wbp_abridged.pdf).

Stormwater Runoff from Developed Areas

The majority of the Sasco Brook watershed is developed. Approximately 53% of the land use in the watershed is considered urban, and the impaired segments of Sasco Brook watershed are located within the more populated residential area of the watershed (Figures 4 and 9). Urban areas are often characterized by impervious cover, or surface areas such as roofs and roads that force water to run off land surfaces rather than infiltrate into the soil. Studies have shown a link between increasing impervious cover and degrading water quality conditions in a watershed (CWP, 2003). In one study, researchers correlated the amount of fecal coliform to the percent of impervious cover in a watershed (Mallin *et al.*, 2000).

As shown in Figure 8, approximately 23% of the Sasco Brook watershed contains more than 12% impervious cover, particularly in the southern portion of the watershed near Sasco Brook (Tributary 1, Figure 9). Great Brook (Segment 1) is located within an area characterized by only 0-6% impervious cover due to the large-lot residential homes, agricultural hayfields and farms, and forested tracts that make up the surrounding area. Water quality data taken at Stations 1378, 1218, 1375 and 1282 were consistently high, especially during wet weather, which suggests that stormwater runoff from nearby horse farms and impervious surfaces may be a source of bacteria to Sasco Brook (Tables 11 – 14). Stormwater pollution sources include fertilizer runoff, failing and insufficient septic systems, horse farms, golf courses, and impervious surfaces.

Figure 8: Range of impervious cover (%) in the Sasco Brook watershed

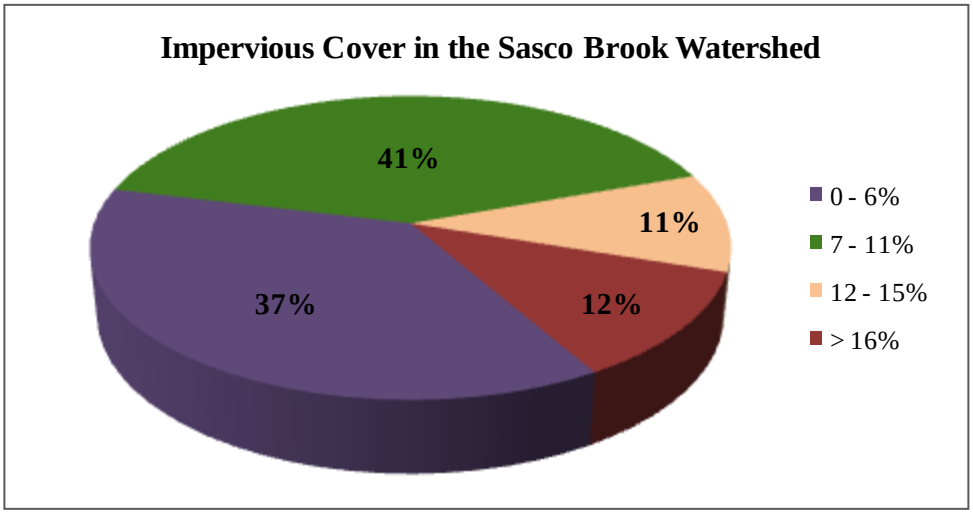
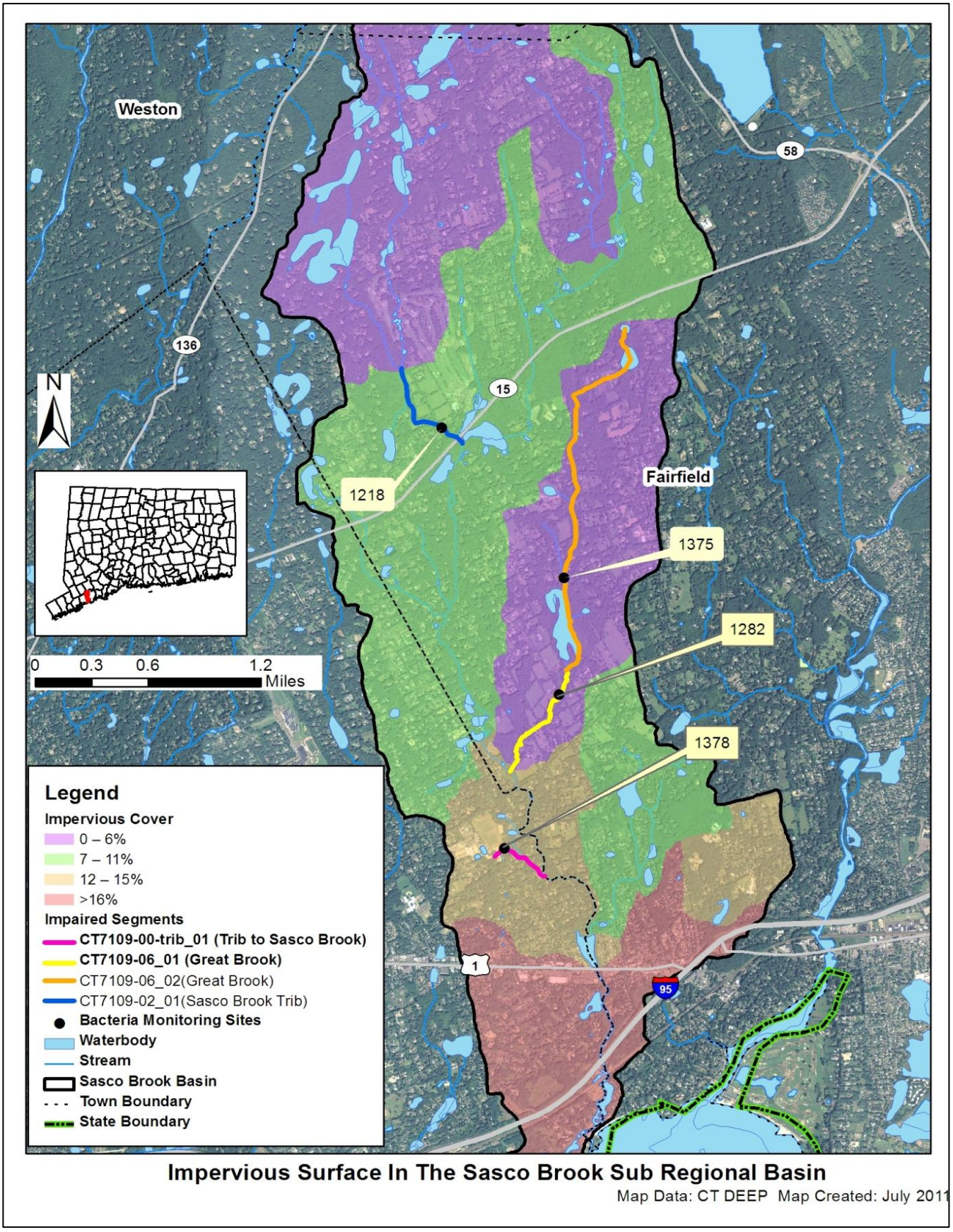


Figure 9: Impervious cover (%) for the Great Brook sub-regional watershed



Wildlife and Domestic Animal Waste

Wildlife and domestic animals within the Sasco Brook watershed represent another potential source of bacteria. Wildlife, including waterfowl, may be a significant bacteria source to surface waters. With the construction of roads and drainage systems, these wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface water. These physical land alterations can exacerbate the impact of natural sources on water quality (USEPA, 2001). As the majority of the watershed is residential development adjacent to the impaired segments, pet waste may be a more direct potential source of bacteria.

The Patterson Club golf course is located within the Sasco Brook watershed along the main stem of Sasco Brook immediately adjacent to Sasco Brook (Tributary 2). Geese and other waterfowl are known to congregate in open areas including recreational fields, agricultural crop fields, and golf courses. In addition to creating a nuisance, large numbers of geese can also create unsanitary conditions on the grassed areas and cause water quality problems due to bacterial contamination associated with their droppings. Large populations of geese can also lead to habitat destruction as a result of overgrazing on wetland and riparian plants.

Agricultural Activities

Agricultural operations are an important economic activity and landscape feature in many areas of the State. Runoff from agricultural fields may contain pollutants such as bacteria and nutrients (USEPA, 2011a). This runoff can include pollutants from farm practices such as storing manure, allowing livestock to wade in nearby waterbodies, applying fertilizer, and reducing the width of vegetated buffer along the shoreline. Agricultural land use makes up 6% of the Sasco Brook watershed. The upstream portion of the Sasco Brook (Tributary 1) is adjacent to the largest horse farm in the Sasco Brook watershed: Fairfield County Hunt Club, which was a major concern in the original 1999 TMDL assessment of Sasco Brook and its tributaries. Several other smaller horse farms are scattered throughout the watershed. A large agricultural area surrounds Great Brook (Segments 1 and 2), and the Sasco Brook Watershed Based Plan (2011) identified the lack of vegetated buffer from hayfields, row crops, and livestock areas as a potential source of bacteria to Great Brook.

Insufficient Septic Systems and Illicit Discharges

As shown in Figure 6, the majority of the watershed in Westport and Fairfield relies on onsite wastewater treatment systems, such as septic systems. Insufficient or failing septic systems can be significant sources of bacteria by allowing raw waste to reach surface waters. The Sasco Brook Watershed Based Plan (2011) identified failing septic systems as a potential issue in the watershed that should be addressed by municipal inspection and enforcement.

In Connecticut, local health directors or health districts are responsible for keeping track of any reported insufficient or failing septic systems in a specific municipality. The Town of Westport is part of the Westport Weston Health District with a full-time health director (http://www.wwhd.org), and the Town of Fairfield has a full-time health director (http://www.fairfieldct.org/health.htm).

The area surrounding the Town of Fairfield and along US Route 1 downstream of the impaired segments of the Sasco Brook watershed is serviced by the municipal sewer system. In addition, there are likely many stormwater catch basins and pipes in the remaining part of town, since the entire watershed is designated an MS4 area. Sewer system leaks and illicit discharges to storm drains or pipes can contribute

bacteria to nearby surface waters. Illicit discharges and connections were addressed as a potential source in the Sasco Brook Watershed Based Plan (2011).

Additional Sources

As shown in Figure 6, there is a landfill along US Route 1 downstream of the impaired segments that may be a leachate source to nearby waterbodies and future downstream impairments. There may be other sources not listed here or identified in Figure 6 that contribute to the observed water quality impairment in the Sasco Brook watershed. Further monitoring and investigation will confirm the listed sources and discover additional ones. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement this TMDL.

Land Use/Landscape

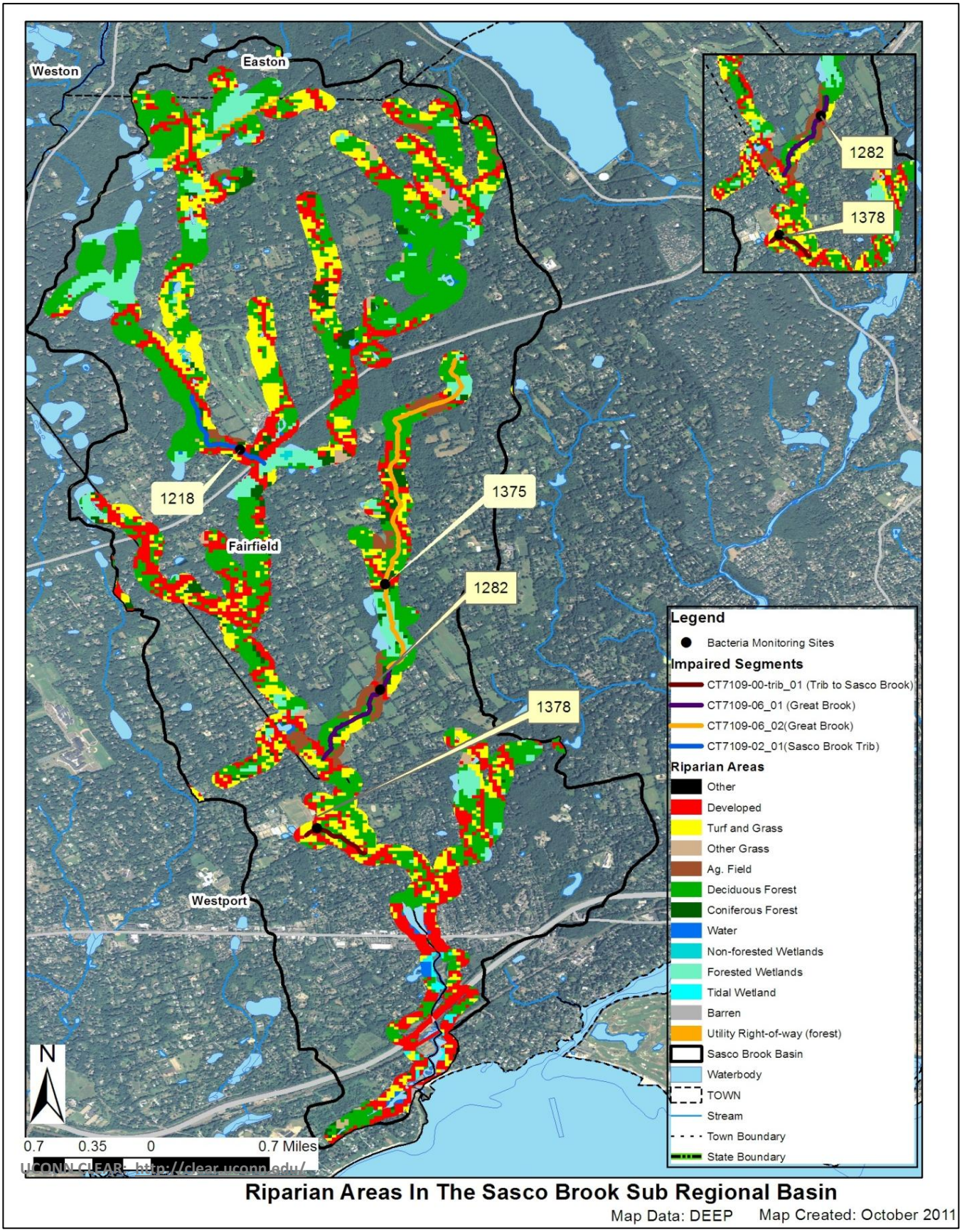
Riparian Buffer Zones

The riparian buffer zone is the area of land located immediately adjacent to streams, lakes, or other surface waters. The boundary of the riparian zone and the adjoining uplands is gradual and not always well-defined. However, riparian zones differ from uplands because of high levels of soil moisture, frequent flooding, and the unique assemblage of plant and animal communities found there. Through the interaction of their soils, hydrology, and vegetation, natural riparian areas influence water quality as contaminants are taken up into plant tissues, adsorbed onto soil particles, or modified by soil organisms. Any change to the natural riparian buffer zone can reduce the effectiveness of the natural buffer and has the potential to contribute to water quality impairment (USEPA, 2011b).

The CLEAR program at UCONN has created streamside buffer layers for the entire State of Connecticut (http://clear.uconn.edu/), which have been used in this TMDL. Analyzing this information can reveal potential sources and implementation opportunities at a localized level. The land use directly adjacent to a waterbody can have direct impacts on water quality from surface runoff sources.

The majority of the riparian zone for Sasco Brook (Tributaries 1 and 2) is characterized by developed land use with some turf/grass and deciduous forested areas (Figure 10). The riparian zone for Great Brook (Segment 1) is characterized by agricultural fields and deciduous forested areas with some developed and turf/grass areas. The majority of the riparian zone for Great Brook (Segment 2) is characterized by developed land use with some turf/grass, mixed forest, and agricultural areas. As previously noted, if not properly treated, runoff from developed areas may contain pollutants such as bacteria and nutrients.

Figure 10: Riparian buffer zone information for the Sasco Brook watershed



CURRENT MANAGEMENT ACTIVITIES

The Towns of Westport and Fairfield have developed and implemented programs to protect water quality from bacterial contamination. In 2011, the Sasco Brook Watershed Based Plan was completed (Sasco Brook Pollution Abatement Committee, 2011). This document outlines current actions in the watershed and recommends future actions necessary to maintain or improve water quality.

CT DEEP's Non-Point Source Pollution Program administers a Non-Point Source Grant Program with funding from EPA under Section 319 of the Clean Water Act (319 grant). A $25,000 319 grant was awarded to Coleytown Elementary School in Westport, CT to implement a program that reduces nitrogen application on lawns through education outreach and demonstration sites (http://www.depdata.ct.gov/maps/nps/npsmap.htm). Another $20,000 319 grant was awarded to the Town of Westport's Sasco Brook Pollution Abatement Committee to develop a watershed based plan that addresses non point source pollution within the Sasco Brook watershed. The Watershed Based Plan was finalized in February 2011 and is available for viewing at http://www.ct.gov/dep/lib/dep/water/watershed_management/wm_plans/sasco_brook_wbp_abridged.pdf.

As indicated previously, Westport and Fairfield are regulated under the MS4 program. The MS4 General Permit is required for any municipality with urbanized areas that initiates, creates, originates or maintains any discharge of stormwater from a storm sewer system to waters of the state. The MS4 permit requires towns to design a Stormwater Management Plan (SMP) to reduce the discharge of pollutants in stormwater to improve water quality. The plan must address the following 6 minimum measures:

1. Public Education and Outreach.
2. Public Involvement/Participation.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control.
5. Post-construction stormwater management in new development and redevelopment.
6. Pollution prevention/good housekeeping for municipal operations.

Each town is also required to submit an annual update outlining the steps they are taking to meet the six minimum measures. All updates that address bacterial contamination in the watershed are summarized in Tables 7 and 8.

Table 7: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Westport, CT (Permit #GSM000026)

Minimum Measure	Westport Annual Report (2009)
Public Outreach and Education	1) Utilized and updated Town website as method of public outreach on stormwater issues. 2) Updated bulletin board outside Public Works office with information on Phase 2 program.
Public Involvement and Participation	1) Continued to solicit volunteers to aid in community outreach campaign.

Table 7: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Westport, CT (Permit #GSM000026) (continued)

Minimum Measure	Westport Annual Report (2009)
Illicit Discharge Detection and Elimination	1) Mapped all outfalls 12" and larger.
Construction Site Stormwater Runoff Control	1) Included sediment and erosion control inspections and enforcement into job responsibilities of Conservation and Zoning enforcement officers.
Post Construction Stormwater Management	1) Actively incorporated post-construction runoff controls into permit requirements by considering water quality in the design of storm drainage systems. At least 1 inch of runoff must be retained from all impervious surfaces.
Pollution Prevention and Good Housekeeping	1) Performed annual cleaning of outfalls, plunge pools, and terminal catch basins. 2) Reduced winter sand use. 3) All Town roads swept in the spring through early summer. High traffic areas swept weekly.

Table 8: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Fairfield, CT (Permit #GSM000012)

Minimum Measure	Fairfield Annual Report (2010)
Public Outreach and Education	1) Sponsored school Environmental Fair to educate students on stormwater quality. 2) Published a month-long series of articles related to groundwater, recharge, and water quality/runoff. 3) Installed collection containers and reviewed current ordinances for pet waste management. 4) Conducted annual collection of household hazardous waste and provided educational brochures on proper handling and disposal.
Public Involvement and Participation	1) Involved Boy Scouts in stenciling 52 storm drains. Over 500 drains have been stenciled and Sasco Brook watershed stenciling is complete. 2) Currently developing a stormwater ordinance to satisfy Phase 2 requirements and MS4 regulations. 3) Conducted annual beach and riverfront clean-ups. 4) Created a volunteer watershed organization to help identify outfalls, find illicit discharge, organize clean-ups, and stencil storm drains. 5) Created a Stormwater Phase 2 Advisory Committee. 6) Provided opportunities for stormwater quality volunteers to supply recycled pet waste bags, help the Shellfish Commission determine illicit discharges, and organize clean-ups.

Table 8: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Fairfield, CT (Permit #GSM000012) (continued)

Minimum Measure	Fairfield Annual Report (2010)
Illicit Discharge Detection and Elimination	1) Currently developing a proposed illicit discharge ordinance. 2) Created brochures related to illicit discharges available in the Engineering office for public information. 3) Mapped 99% of all storm system outfalls with continued investigation of hidden or illegal connections. 4) Performed over 180 dry weather inspections for illicit discharges. All complaints or incidents recorded for review.
Construction Site Stormwater Runoff Control	1) Continued required inspection program, and conducted random inspections of construction sites to determine compliance.
Post Construction Stormwater Management	1) Developed and implemented post-construction BMP strategy for water quality improvement from impervious surfaces.
Pollution Prevention and Good Housekeeping	1) Developed a maintenance plan for cleaning catch basin sumps, swirl concentrators, and other drainage structures. 2) Increased sweeping in the Downtown and Town Hall Green areas.

RECOMMENDED NEXT STEPS

The Towns of Westport and Fairfield have developed and implemented programs to protect water quality from bacterial contamination. Future mitigative activities are necessary to ensure the long-term protection of Sasco Brook and its tributaries and have been prioritized below. Some of these actions are provided in more detail in the 2011 Sasco Brook Watershed Based Plan (Sasco Brook Pollution Abatement Committee, 2011).

1) Identify areas along Sasco Brook and its tributaries to implement Best Management Practices (BMPs) to control stormwater runoff.

As noted previously, 53% of the Sasco Brook watershed is considered urban, and the Towns of Westport and Fairfield are MS4 communities regulated by the MS4 program. The majority of the watershed near Sasco Brook (Tributary 1) consists of small-lot residential development with an impervious cover greater than 12%. Although the land surrounding Great Brook (Segments 1 and 2) is largely agriculture, runoff from livestock areas and pastures may be a source of bacterial contamination. As such, stormwater runoff is most likely contributing bacteria to the waterbodies.

The Sasco Brook Watershed Based Plan (2011) made specific recommendations to reduce the impacts of stormwater runoff on water quality. The suggested BMPs within the watershed municipalities are listed in Table 9. The plan highlighted multiple areas to install structural BMPs, LID strategies, stormwater infiltration and filtration measures, public outreach and education initiatives, and informed land use planning. Specifically, the plan addressed the commercial parking areas along US Route 1 as candidates for future stormwater runoff mitigation opportunities.

Table 9: Recommended structural BMPs in Westport and Fairfield from the 2011 Sasco Brook Watershed Based Plan

Location	Town	Recommended BMPs
US Route 1 commercial parking areas	Westport	No specific recommendations
Small horse farms	Westport/Fairfield	Plant vegetated buffer and install swales
Patterson Club golf course	Fairfield	Plant vegetated buffer for waterfowl mitigation
Fairfield County Hunt Club	Fairfield	Replace storm drainage networks and install grass swale

To identify other areas that are contributing bacteria to the impaired segments, the municipalities should continue to conduct wet-weather sampling at stormwater outfalls that discharge directly to the impaired segments in the Sasco Brook watershed. Outfalls that have previously shown high bacteria concentrations should be prioritized for BMP installation. To treat stormwater runoff, the municipalities should identify areas along the impaired segment to install BMPs designed to encourage stormwater to infiltrate into the ground before entering the waterbodies. These BMPs would disconnect impervious areas and reduce pollutant loads to the river. More detailed information and BMP recommendations can be found in the core TMDL document.

2) Ensure there are sufficient buffers on agricultural lands along Sasco Brook and its tributaries.

Agricultural land use represents 6% of the Sasco Brook watershed, and horse farms addressed in the Sasco Brook Watershed Based Plan (2011) may be a potential bacterial source in the watershed (Figure 4). The Sasco Brook Pollution Abatement Committee has already taken great efforts to improve the largest horse farm in the Sasco Brook watershed adjacent to Sasco Brook (Tributary 1). The Fairfield County Hunt Club utilized $500,000 to buffer streams, improve collection and discharge infrastructure, install roof drains, catch basins, and a septic system for the horse stalls, and construct a horse washing station. Similar efforts for a reduction of stormwater runoff pollution have been implemented on several smaller horse farms throughout the Sasco Brook watershed. The Sasco Brook Watershed Based Plan (2011) recommended a second phase of improvements to the Fairfield County Hunt Club, including replacement of their underground storm drainage network and installation of grass swales in proximity of affected waterbodies. Future efforts should also focus on establishing vegetated buffers and swales around smaller horse farms in the watershed.

Agricultural producers should continue to work with the CT Department of Agriculture and the U.S. Department of Agriculture Natural Resources Conservation Service to develop conservation plans for their farming activities within the watershed. These plans should focus on ensuring that there are sufficient stream buffers, that fencing exists to restrict access to livestock and horses from streams and wetlands, and that animal waste handling, disposal, and other appropriate BMPs are in place.

3) Evaluate municipal education and outreach programs regarding animal waste.

As most of the Sasco Brook watershed is developed by residential neighborhoods or open spaces, any education and outreach program should highlight the importance of managing waste from horses, dogs, and other pets and not feeding waterfowl and wildlife. The municipalities and residents can take measures to minimize waterfowl-related impacts such as allowing tall, coarse vegetation to grow in the riparian areas of Sasco Brook and its tributaries that are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. In addition, any educational program should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in the Sasco Brook watershed and can harm human health and the environment. Animal wastes should be disposed of away from any waterbody or storm drain system. BMPs effective at reducing the impact of animal waste on water quality include installing signage, providing pet waste receptacles in high-use areas, enacting ordinances requiring the clean-up of pet waste, and targeting educational and outreach programs in problem areas. The Sasco Brook Watershed Based Plan (2011) recommended establishing a vegetated buffer at Patterson Club golf course to mitigate waterfowl impact.

4) Develop a system to monitor septic systems.

Most residents in the Sasco Brook watershed rely on septic systems. If not already in place, Westport and Fairfield should establish programs to ensure that existing septic systems are properly operated and maintained, and create an inventory of existing septic systems through mandatory inspections. Inspections help encourage proper maintenance and identify failed and sub-standard systems. Policies that govern the eventual replacement of sub-standard systems within a reasonable timeframe can be adopted. The municipalities should also develop a program to assist citizens with the replacement and repair of older and failing systems. The Sasco Brook Watershed Based Plan (2011) identified septic system seepage along Woodhill Road in Westport, CT as a source of bacteria, which was rectified by the extension of sanitary sewer connections along the road.

5) Implement a program to evaluate the sanitary sewer system.

Residents in the lower portion of the Sasco Brook watershed and the area surrounding the Town of Fairfield rely on a municipal sewer system. Although this area is downstream of the impaired segments, it is still important for the municipalities to develop a program that evaluates its sanitary sewer and reduces leaks and overflows to protect the water quality of downstream portions of Sasco Brook and its tributaries. This program should include periodic inspections of the sewer line. The Sasco Brook Watershed Based Plan (2011) identified illegal wastewater and washwater discharges to the stormwater drainage system as a potential source of bacteria. The Towns of Westport and Fairfield have worked to separate stormwater and sewer drainage connections.

6) Continue monitoring of permitted sources.

Although there is currently no data on permitted sources within the Sasco Brook watershed, it may be a potential source that the towns should investigate further. Further monitoring will provide information essential to better locate, understand, and reduce pollution sources. If any current monitoring is not done with appropriate bacterial indicator based on the receiving water, then a recommended change during the next permit reissuance is to include the appropriate indicator species. If facility monitoring indicates elevated bacteria, then implementation of permit required, and voluntary measures to identify and reduce sources of bacterial contamination at the facility are an additional recommendation. Regular monitoring should be established for all permitted sources to ensure compliance with permit requirements and to determine if current requirements are adequate or if additional measures are necessary for water quality protection.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within four months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established by the TMDL. For discharges to impaired waterbodies, the municipality must assess and modify the six minimum measures of its plan, if necessary, to meet TMDL standards. Particular focus should be placed on the following plan components: public education, illicit discharge detection and elimination, stormwater structures cleaning, and the repair, upgrade, or retrofit of storm sewer structures. The goal of these modifications is to establish a program that improves water quality consistent with TMDL requirements. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of DEEP for review and approval.

Table 10 details the appropriate bacteria criteria for use as waste load allocations established by this TMDL for use as water quality targets by permittees as permits are renewed and updated, within the Sasco River watershed.

For any municipality subject to an MS4 permit and affected by a TMDL, the permit requires a modification of the SMP to include BMPs that address the included impairment. In the case of bacteria related impairments municipal BMPs could include: implementation or improvement to existing nuisance wildlife programs, septic system monitoring programs, any additional measures that can be added to the required illicit discharge detection and elimination (IDDE) programs, and increased street sweeping above basic permit requirements. Any non-MS4 municipalities can implement these same types of initiatives in effort to reduce bacteria source loading to impaired waterways.

Any facilities that discharge non-MS4 regulated stormwater should update their Pollution Prevention Plan to reflect BMPs that can reduce bacteria loading to the receiving waterway. These BMPs could include

nuisance wildlife control programs and any installations that increase surface infiltration to reduce overall stormwater volumes. Facilities that are regulated under the Commercial Activities Stormwater Permit should report any updates to their SMP in their summary documentation submitted to DEEP.

Table 10 Bacteria (e.coli) TMDLs, WLAs, and LAs for Recreational Use

		Instantaneous *E. coli* (#/100mL)						Geometric Mean *E. coli* (#/100mL)	
Class	**Bacteria Source**	**WLA[6]**			**LA[6]**			**WLA[6]**	**LA[6]**
	Recreational Use	1	2	3	1	2	3	**All**	**All**
A	Non-Stormwater NPDES	0	0	0				0	
	CSOs	0	0	0				0	
	SSOs	0	0	0				0	
	Illicit sewer connection	0	0	0				0	
	Leaking sewer lines	0	0	0				0	
	Stormwater (MS4s)	235[7]	410[7]	576[7]				126[7]	
	Stormwater (non-MS4)				235[7]	410[7]	576[7]		126[7]
	Wildlife direct discharge				235[7]	410[7]	576[7]		126[7]
	Human or domestic animal direct discharge[5]				235	410	576		126

(1) **Designated Swimming.** Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protections and the Department of Public Health. May 1989. Revised April 2003 and updated December 2008.

(2) **Non-Designated Swimming.** Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

(3) **All Other Recreational Uses.**

(4) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23. (Class B surface waters located north of Interstate Highway I-95 and downstream of a sewage treatment plant providing seasonal disinfection May 1 through October 1, as authorized by the Commissioner.)

(5) Human direct discharge = swimmers

(6) Unless otherwise required by statute or regulation, compliance with this TMDL will be based on ambient concentrations and not end-of-pipe bacteria concentrations

(7) Replace numeric value with “natural levels” if only source is naturally occurring wildlife. Natural is defined as the biological, chemical and physical conditions and communities that occur within the environment which are unaffected or minimally affected by human influences (CT DEEP 2011a). Sections 2.2.2 and 6.2.7 of this Core Document deal with BMPs and delineating type of wildlife inputs.

BACTERIA DATA AND PERCENT REDUCTIONS TO MEET THE TMDL

Table 11: Sasco Brook Bacteria Data

Waterbody ID: CT7109-00-trib_01

Characteristics: Freshwater, Class A, Potential Drinking Water Supplies, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, Navigation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **85%**

Single Sample: **99%**

Data: 2004-2005 from Earthplace volunteer monitoring efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from Station 1378 on Sasco Brook (Tributary 1) with annual geometric mean calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1378	Bulkley Avenue crossing[1]	1/8/2004	40	dry	
1378	Bulkley Avenue crossing[1]	2/12/2004	84	dry	
1378	Bulkley Avenue crossing[1]	3/11/2004	20	dry	
1378	Bulkley Avenue crossing[1]	4/8/2004	40	dry	
1378	Bulkley Avenue crossing[1]	5/3/2004	260000[a]	wet	
1378	Bulkley Avenue crossing[1]	5/17/2004	1700	wet	
1378	Bulkley Avenue crossing[1]	6/14/2004	1800	dry	
1378	Bulkley Avenue crossing[1]	6/21/2004	580	dry	
1378	Bulkley Avenue crossing[1]	6/24/2004	32000*	dry	
1378	Bulkley Avenue crossing[1]	7/1/2004	1360	dry	844*
1378	Bulkley Avenue crossing[1]	7/12/2004	880	dry	
1378	Bulkley Avenue crossing[1]	7/26/2004	13300	wet	
1378	Bulkley Avenue crossing[1]	8/9/2004	15000	dry	
1378	Bulkley Avenue crossing[1]	8/23/2004	1700	wet	
1378	Bulkley Avenue crossing[1]	9/2/2004	1100	dry	
1378	Bulkley Avenue crossing[1]	9/21/2004	3000	wet	
1378	Bulkley Avenue crossing[1]	10/21/2004	520	dry	
1378	Bulkley Avenue crossing[1]	11/4/2004	28	wet	
1378	Bulkley Avenue crossing[1]	12/16/2004	52	dry	

Single sample *E. coli* (colonies/100 mL) data from Station 1378 on Sasco Brook (Tributary 1) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1378	Bulkley Avenue crossing[1]	1/20/2005	8	dry**	615
1378	Bulkley Avenue crossing[1]	2/10/2005	7500	dry	
1378	Bulkley Avenue crossing[1]	3/10/2005	44	dry**	
1378	Bulkley Avenue crossing[1]	4/7/2005	20	dry	
1378	Bulkley Avenue crossing[1]	5/11/2005	40	dry	
1378	Bulkley Avenue crossing[1]	7/13/2005	27000	wet	
1378	Bulkley Avenue crossing[1]	7/15/2005	400	dry	
1378	Bulkley Avenue crossing[1]	7/25/2005	860	dry	
1378	Bulkley Avenue crossing[1]	7/27/2005	4000	dry	
1378	Bulkley Avenue crossing[1]	8/10/2005	19500	dry**	
1378	Bulkley Avenue crossing[1]	8/24/2005	6500	dry**	
1378	Bulkley Avenue crossing[1]	9/7/2005	520	dry**	
1378	Bulkley Avenue crossing[1]	9/21/2005	5800	dry**	
1378	Bulkley Avenue crossing[1]	10/20/2005	292	dry	
1378	Bulkley Avenue crossing[1]	11/10/2005	1720	wet	
1378	Bulkley Avenue crossing[1]	12/8/2005	28	dry	

Shaded cells indicate an exceedance of water quality criteria

[a] Not included in the geometric mean calculation as value may be an incorrect entry.

[†]Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

[1]adjacent to Fairfield County Hunt Club

Wet and dry weather geometric mean values for Station 1378 on Sasco Brook (Tributary 1)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1378	Bulkley Avenue adjacent to Fairfield County Hunt Club	2004-2005	8	27	731	3749	450

Shaded cells indicate an exceedance of water quality criteria
Weather condition determined from rain gages at Stamford 5 N station in Stamford, CT and at Hartford Bradley International Airport

Table 12: Sasco Brook Bacteria Data

Waterbody ID: CT7109-02_01

Characteristics: Freshwater, Class A, Potential Drinking Water Supplies, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, Navigation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **14%**

Single Sample: **92%**

Data: 1999-2005, 2011 from Earthplace volunteer monitoring efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from Station 1218 on Sasco Brook (Tributary 2) with annual geometric mean calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1218	Merwins Lane	6/21/1999	300	wet	102
1218	Merwins Lane	7/6/1999	98	dry	
1218	Merwins Lane	7/19/1999	190	wet	
1218	Merwins Lane	8/2/1999	230	dry	
1218	Merwins Lane	8/16/1999	2000	wet	
1218	Merwins Lane	8/30/1999	140	dry	
1218	Merwins Lane	9/14/1999	72	dry	
1218	Merwins Lane	9/27/1999	41	dry	
1218	Merwins Lane	10/12/1999	74	dry	
1218	Merwins Lane	10/25/1999	10	dry	
1218	Merwins Lane	11/8/1999	10	dry	
1218	Merwins Lane	11/22/1999	10	dry	
1218	Merwins Lane	12/7/1999	160	wet	
1218	Merwins Lane	12/20/1999	1000	wet	

Single sample *E. coli* (colonies/100 mL) data from Station 1218 on Sasco Brook (Tributary 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1218	Merwins Lane	1/3/2000	86	dry	
1218	Merwins Lane	1/20/2000	10	wet	
1218	Merwins Lane	1/31/2000	85	wet	
1218	Merwins Lane	2/23/2000	20	dry	
1218	Merwins Lane	3/13/2000	86	wet	
1218	Merwins Lane	3/27/2000	20	dry	
1218	Merwins Lane	4/10/2000	10	wet	
1218	Merwins Lane	4/24/2000	96	dry	
1218	Merwins Lane	5/8/2000	41	wet	
1218	Merwins Lane	5/22/2000	63	dry	
1218	Merwins Lane	6/7/2000	4900	wet	
1218	Merwins Lane	6/20/2000	240	dry	
1218	Merwins Lane	7/5/2000	140	wet	
1218	Merwins Lane	7/12/2000	52	dry	77
1218	Merwins Lane	7/19/2000	350	dry	
1218	Merwins Lane	8/9/2000	300	dry	
1218	Merwins Lane	9/6/2000	74	dry	
1218	Merwins Lane	9/20/2000	1800	wet	
1218	Merwins Lane	10/6/2000	10	wet	
1218	Merwins Lane	10/19/2000	52	wet	
1218	Merwins Lane	11/2/2000	20	dry	
1218	Merwins Lane	11/15/2000	41	wet	
1218	Merwins Lane	11/29/2000	190	dry	
1218	Merwins Lane	11/30/2000	160	wet	
1218	Merwins Lane	12/13/2000	41	dry	
1218	Merwins Lane	12/21/2000	20	dry	
1218	Merwins Lane	12/27/2000	120	dry	

Single sample *E. coli* (colonies/100 mL) data from Station 1218 on Sasco Brook (Tributary 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1218	Merwins Lane	1/10/2001	31	dry	70
1218	Merwins Lane	1/18/2001	70	dry	
1218	Merwins Lane	1/24/2001	63	dry	
1218	Merwins Lane	2/7/2001	31	wet	
1218	Merwins Lane	2/15/2001	190	dry	
1218	Merwins Lane	2/22/2001	63	dry	
1218	Merwins Lane	3/7/2001	41	wet	
1218	Merwins Lane	3/8/2001	33	dry	
1218	Merwins Lane	3/21/2001	10	wet	
1218	Merwins Lane	4/4/2001	41	dry	
1218	Merwins Lane	4/5/2001	200	dry	
1218	Merwins Lane	4/18/2001	97	wet	
1218	Merwins Lane	5/1/2001	38	dry	
1218	Merwins Lane	5/2/2001	10	dry	
1218	Merwins Lane	5/16/2001	20	dry	
1218	Merwins Lane	5/30/2001	86	wet	
1218	Merwins Lane	6/13/2001	590	wet	
1218	Merwins Lane	6/14/2001	210	dry	
1218	Merwins Lane	6/28/2001	102[†]	dry	
1218	Merwins Lane	7/11/2001	1600	wet	
1218	Merwins Lane	7/12/2001	144	wet	
1218	Merwins Lane	7/25/2001	52	dry	
1218	Merwins Lane	7/26/2001	**5400* (92%)**	wet	
1218	Merwins Lane	8/8/2001	170	dry	
1218	Merwins Lane	8/9/2001	60	dry	
1218	Merwins Lane	8/22/2001	340	wet	
1218	Merwins Lane	8/30/2001	340	dry	
1218	Merwins Lane	9/5/2001	310	dry	
1218	Merwins Lane	9/6/2001	20	dry	
1218	Merwins Lane	9/17/2001	95	dry	
1218	Merwins Lane	9/19/2001	31	dry	
1218	Merwins Lane	10/3/2001	130	dry**	
1218	Merwins Lane	10/11/2001	10	dry	
1218	Merwins Lane	10/17/2001	74	wet	

Single sample *E. coli* (colonies/100 mL) data from Station 1218 on Sasco Brook (Tributary 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1218	Merwins Lane	10/31/2001	10	dry	70
1218	Merwins Lane	11/14/2001	10	dry	
1218	Merwins Lane	11/29/2001	10	wet	
1218	Merwins Lane	12/12/2001	20	dry	
1218	Merwins Lane	1/10/2002	120	dry	50
1218	Merwins Lane	1/23/2002	51	dry	
1218	Merwins Lane	2/6/2002	31	dry	
1218	Merwins Lane	2/20/2002	10	dry	
1218	Merwins Lane	3/6/2002	10	dry	
1218	Merwins Lane	3/20/2002	73	wet	
1218	Merwins Lane	4/3/2002	31	wet	
1218	Merwins Lane	4/17/2002	20	dry	
1218	Merwins Lane	5/1/2002	220	wet	
1218	Merwins Lane	5/15/2002	640	wet	
1218	Merwins Lane	6/11/2002	96	dry	
1218	Merwins Lane	6/25/2002	82	dry	
1218	Merwins Lane	7/16/2002	26	dry	
1218	Merwins Lane	7/30/2002	88	dry	
1218	Merwins Lane	8/13/2002	24	dry	
1218	Merwins Lane	8/27/2002	50	dry	
1218	Merwins Lane	9/10/2002	78	dry	
1218	Merwins Lane	9/24/2002	32	dry	
1218	Merwins Lane	10/24/2002	18	dry	
1218	Merwins Lane	11/14/2002	70	wet	
1218	Merwins Lane	12/19/2002	48	dry	

Single sample *E. coli* (colonies/100 mL) data from Station 1218 on Sasco Brook (Tributary 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1218	Merwins Lane	1/16/2003	20	dry	65
1218	Merwins Lane	2/20/2003	2	dry	
1218	Merwins Lane	3/20/2003	10	wet**	
1218	Merwins Lane	4/17/2003	22	dry	
1218	Merwins Lane	5/29/2003	156	wet	
1218	Merwins Lane	6/9/2003	130	dry	
1218	Merwins Lane	6/23/2003	510	wet	
1218	Merwins Lane	7/7/2003	920	wet	
1218	Merwins Lane	7/21/2003	60	dry	
1218	Merwins Lane	8/2/2003	440	wet	
1218	Merwins Lane	8/23/2003	104	dry	
1218	Merwins Lane	9/10/2003	16	dry	
1218	Merwins Lane	9/29/2003	144	wet	
1218	Merwins Lane	10/22/2003	6	dry	
1218	Merwins Lane	11/5/2003	68	wet	
1218	Merwins Lane	12/11/2003	480	wet	
1218	Merwins Lane	1/8/2004	12	dry	61
1218	Merwins Lane	2/12/2004	30	dry	
1218	Merwins Lane	3/11/2004	10	dry	
1218	Merwins Lane	4/8/2004	4	dry	
1218	Merwins Lane	5/3/2004	72	wet	
1218	Merwins Lane	5/17/2004	120	wet	
1218	Merwins Lane	6/14/2004	80	dry	
1218	Merwins Lane	7/1/2004	52	dry	
1218	Merwins Lane	7/12/2004	156	dry	
1218	Merwins Lane	7/26/2004	300	wet	
1218	Merwins Lane	8/9/2004	68	dry	
1218	Merwins Lane	8/23/2004	640	wet	
1218	Merwins Lane	9/2/2004	24	dry	
1218	Merwins Lane	9/21/2004	400	wet	

Single sample *E. coli* (colonies/100 mL) data from Station 1218 on Sasco Brook (Tributary 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1218	Merwins Lane	1/20/2005	10	dry**	42
1218	Merwins Lane	2/10/2005	50	dry	
1218	Merwins Lane	3/10/2005	12	dry**	
1218	Merwins Lane	4/7/2005	20	dry	
1218	Merwins Lane	5/11/2005	21	dry	
1218	Merwins Lane	7/13/2005	216	wet	
1218	Merwins Lane	7/27/2005	72	dry	
1218	Merwins Lane	8/10/2005	24	dry**	
1218	Merwins Lane	8/24/2005	24	dry**	
1218	Merwins Lane	9/7/2005	64	dry**	
1218	Merwins Lane	9/21/2005	40	dry**	
1218	Merwins Lane	10/20/2005	72	dry	
1218	Merwins Lane	11/10/2005	140	wet	
1218	Merwins Lane	12/8/2005	82	dry	
1218	Merwins Lane	5/19/2011	740	wet**	**146* (14%)**
1218	Merwins Lane	5/20/2011	124	wet**	
1218	Merwins Lane	5/23/2011	64	wet**	
1218	Merwins Lane	5/24/2011	320	dry**	
1218	Merwins Lane	5/25/2011	72	dry**	
1218	Merwins Lane	5/27/2011	120	dry**	
1218	Merwins Lane	5/31/2011	560	wet**	
1218	Merwins Lane	6/1/2011	152	dry**	
1218	Merwins Lane	6/3/2011	72	dry**	
1218	Merwins Lane	6/6/2011	108	dry**	
1218	Merwins Lane	6/7/2011	84	dry**	
1218	Merwins Lane	6/8/2011	56	dry**	
1218	Merwins Lane	6/10/2011	270	wet**	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather geometric mean values for Station 1218 on Sasco Brook (Tributary 2)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1218	Merwins Lane	1999-2011	54	103	70	156	46

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Stamford 5 N Station in Fairfield, CT.

Table 13: Sasco Brook Bacteria Data

Waterbody ID: CT7109-06_01

Characteristics: Freshwater, Class A, Potential Drinking Water Supplies, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, Navigation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **61%**

Single Sample: **89%**

Data: 2004-2005 from Earthplace volunteer monitoring efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from Station 1282 on Great Brook (Segment 1) with annual geometric mean calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1282	Morehouse Lane	1/8/2004	200	dry	166
1282	Morehouse Lane	2/12/2004	38	dry	
1282	Morehouse Lane	3/11/2004	8	dry	
1282	Morehouse Lane	4/8/2004	12	dry	
1282	Morehouse Lane	5/3/2004	212	wet	
1282	Morehouse Lane	5/17/2004	360	wet	
1282	Morehouse Lane	6/14/2004	560	dry	
1282	Morehouse Lane	7/1/2004	380	dry	
1282	Morehouse Lane	7/12/2004	360	dry	
1282	Morehouse Lane	7/26/2004	680	wet	
1282	Morehouse Lane	8/9/2004	780	dry	
1282	Morehouse Lane	8/23/2004	660	wet	
1282	Morehouse Lane	9/2/2004	220	dry	
1282	Morehouse Lane	9/21/2004	880	wet	
1282	Morehouse Lane	10/21/2004	84	dry	
1282	Morehouse Lane	11/4/2004	24	wet	
1282	Morehouse Lane	12/16/2004	98	dry	

Single sample *E. coli* (colonies/100 mL) data from Station 1282 on Great Brook (Segment 1) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1282	Morehouse Lane	1/20/2005	22	dry**	325*
1282	Morehouse Lane	2/10/2005	108	dry	
1282	Morehouse Lane	3/10/2005	58	dry**	
1282	Morehouse Lane	4/7/2005	126	dry	
1282	Morehouse Lane	5/11/2005	40	dry	
1282	Morehouse Lane	7/13/2005	440	wet	
1282	Morehouse Lane	7/27/2005	1720	dry	
1282	Morehouse Lane	8/10/2005	800	dry**	
1282	Morehouse Lane	8/24/2005	1420	dry**	
1282	Morehouse Lane	9/7/2005	480	dry**	
1282	Morehouse Lane	9/21/2005	1220	dry**	
1282	Morehouse Lane	10/20/2005	184	dry	
1282	Morehouse Lane	11/10/2005	3600*	wet	
1282	Morehouse Lane	12/8/2005	620	dry	

Shaded cells indicate an exceedance of water quality criteria

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather geometric mean values for Station 1282 on Great Brook (Segment 1)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1282	Morehouse Lane	2004-2005	8	23	225	429	180

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Stamford 5 N station in Stamford, CT and at Hartford Bradley International Airport

Table 14: Sasco Brook Bacteria Data

Waterbody ID: CT7109-06_02

Characteristics: Freshwater, Class A, Potential Drinking Water Supplies, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, Navigation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **53%**

Single Sample: **94%**

Data: 2000-2003, 2011 from Earthplace volunteer monitoring efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from Station 1375 on Great Brook (Segment 2) with annual geometric mean calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1375	Merwin's Lane at Fair Oak Drive intersection	11/30/2000	106	wet	65
1375	Merwin's Lane at Fair Oak Drive intersection	12/21/2000	40	dry	

Single sample *E. coli* (colonies/100 mL) data from Station 1375 on Great Brook (Segment 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1375	Merwin's Lane at Fair Oak Drive intersection	1/18/2001	94	dry	167
1375	Merwin's Lane at Fair Oak Drive intersection	2/15/2001	111	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	3/8/2001	64	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	4/5/2001	10	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	5/1/2001	110	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	5/17/2001	170	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	6/14/2001	56	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	6/28/2001	580	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	7/12/2001	224	wet	
1375	Merwin's Lane at Fair Oak Drive intersection	7/26/2001	**6600* (94%)**	wet	
1375	Merwin's Lane at Fair Oak Drive intersection	8/9/2001	180	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	8/30/2001	160	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	9/6/2001	120	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	9/17/2001	345	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	10/11/2001	300	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	6/11/2002	24	dry	164
1375	Merwin's Lane at Fair Oak Drive intersection	6/25/2002	264	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	7/16/2002	228	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	7/30/2002	380	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	8/13/2002	240	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	8/27/2002	300	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	9/10/2002	156	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	9/24/2002	320	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	10/24/2002	200	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	11/14/2002	68	wet	
1375	Merwin's Lane at Fair Oak Drive intersection	12/19/2002	88	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	1/16/2003	98	dry	24
1375	Merwin's Lane at Fair Oak Drive intersection	2/20/2003	1	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	3/20/2003	44	wet**	
1375	Merwin's Lane at Fair Oak Drive intersection	4/17/2003	18	dry	
1375	Merwin's Lane at Fair Oak Drive intersection	5/29/2003	100	wet	

Single sample *E. coli* (colonies/100 mL) data from Station 1375 on Great Brook (Segment 2) with annual geometric mean calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1375	Merwin's Lane at Fair Oak Drive intersection	5/19/2011	720	wet**	**267* (53%)**
1375	Merwin's Lane at Fair Oak Drive intersection	5/20/2011	144	wet**	
1375	Merwin's Lane at Fair Oak Drive intersection	5/23/2011	140	wet**	
1375	Merwin's Lane at Fair Oak Drive intersection	5/25/2011	176	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	5/27/2011	260	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	5/31/2011	380	wet**	
1375	Merwin's Lane at Fair Oak Drive intersection	6/1/2011	196	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	6/3/2011	64	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	6/6/2011	192	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	6/7/2011	268	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	6/8/2011	196	dry**	
1375	Merwin's Lane at Fair Oak Drive intersection	6/10/2011	4200	wet**	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather geometric mean values for Station 1375 on Great Brook (Segment 2)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1375	Merwin's Lane at Fair Oak Drive intersection	2000-2003, 2011	10	33	151	317	121

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Stamford 5 N Station in Fairfield, CT.

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