Shetucket River Watershed Summary

Shetucket River and Obwebetuck Brook

Watershed Description and Maps

The Shetucket River watershed covers an area of approximately 28,866 acres in the eastern-central portion of Connecticut (Figure 1). There are several municipalities located at least partially in the watershed, including the Towns of Windham, Lebanon, Franklin, Scotland, Sprague, Lisbon, and Norwich, CT.

The Shetucket River watershed includes two 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. Several of the segments in the watershed are currently unassessed as of the writing of this document. This does not suggest that there are no issues on these segments, but indicates a lack of current data to evaluate the segments as part of the assessment process. An excerpt of the Integrated Water Quality Report is included in Table 1 to show the status of the other waterbodies in the watershed (CT DEEP, 2010). Obwebetuck Brook is not shown in Table 1 because the impairment is based on sampling data from 2010; the segment will be included in the 2012 list.

The Shetucket River (CT3800-00_05) begins at the confluence of the Natchaug and Willimantic Rivers in Windham, flows southeast through Windham, and ends at its confluence with Cold Brook in Windham. This impaired segment is 12.22 miles long and is located in the Town of Windham. Obwebetuck Brook (CT3800-02_01) begins at the confluence of Jordan Brook and Obwebetuck Brook near Bush Hill Road in Windham, flows east, and ends at the confluence of Shetucket River south of Richmond Lane in Windham. Obwebetuck Brook's impaired segment is 0.55 miles long and is located in the Town of Windham.

The impaired segment of the Shetucket River has a water quality classification of B. Designated uses include habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Obwebetuck Brook has 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. Both segments are impaired due to elevated bacteria concentrations, affecting the

Impaired Segment Facts

Impaired Segments Name:
1. Shetucket River (CT3800-00_05)
2. Obwebetuck Brook (CT3800-02_01)

Municipalities: Windham

Impaired Segment Length:
CT3800-00_05 (4.99 miles),
CT3800-02_01 (0.55 miles)

Water Quality Classification:
CT3800-00_05**:** Class B
CT3800-02_01: Class A

Designated Use Impairment:
Recreation

Sub-regional Basin Name and Code: Shetucket River, 3800

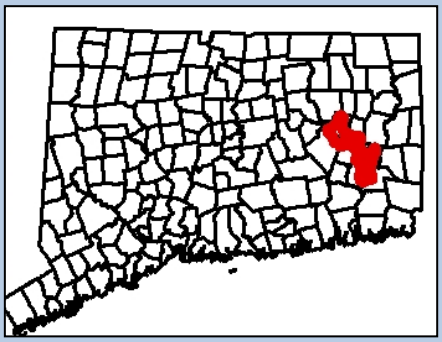
Regional Basin: Shetucket

Major Basin: Thames

Watershed Area (acres): 28,866

MS4 Applicable? No

Figure 1: Watershed location in Connecticut



designated use of recreation. As there are no designated beaches on these segments, 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
CT3800-00_01	Shetucket River-01	From end of estuary, at Route 2 crossing, US to Greenville dam, Norwich.	1.56	U	NOT	FULL
CT3800-00_02	Shetucket River-02	From Greenville Dam, Norwich, US through Greenville Dam impoundment, Taftville Pond, and Occum Pond to Sprague (Baltic) WPCF, Sprague.	6.09	U	U	FULL
CT3800-00_03	Shetucket River-03	From Sprague WPCF (near head of Occum Pond), US to confluence with Merrick Brook at Sprague/Scotland town line (DS of Scotland Dam).	4.7	FULL	FULL	FULL
CT3800-00_04	Shetucket River-04	From confluence with Merrick Brook (DS of Scotland Dam), US to confluence with Cold Brook just DS from Franklin Mushroom Farm STP (on unnamed tributary).	2.18	U	U	FULL
CT3800-00_05	Shetucket River-05	From confluence with Cold Brook (DS of Franklin Mushroom Farm STP from unnamed tributary), US to headwaters at confluence of Natchaug River and Willimantic River.	4.99	NOT	NOT	FULL

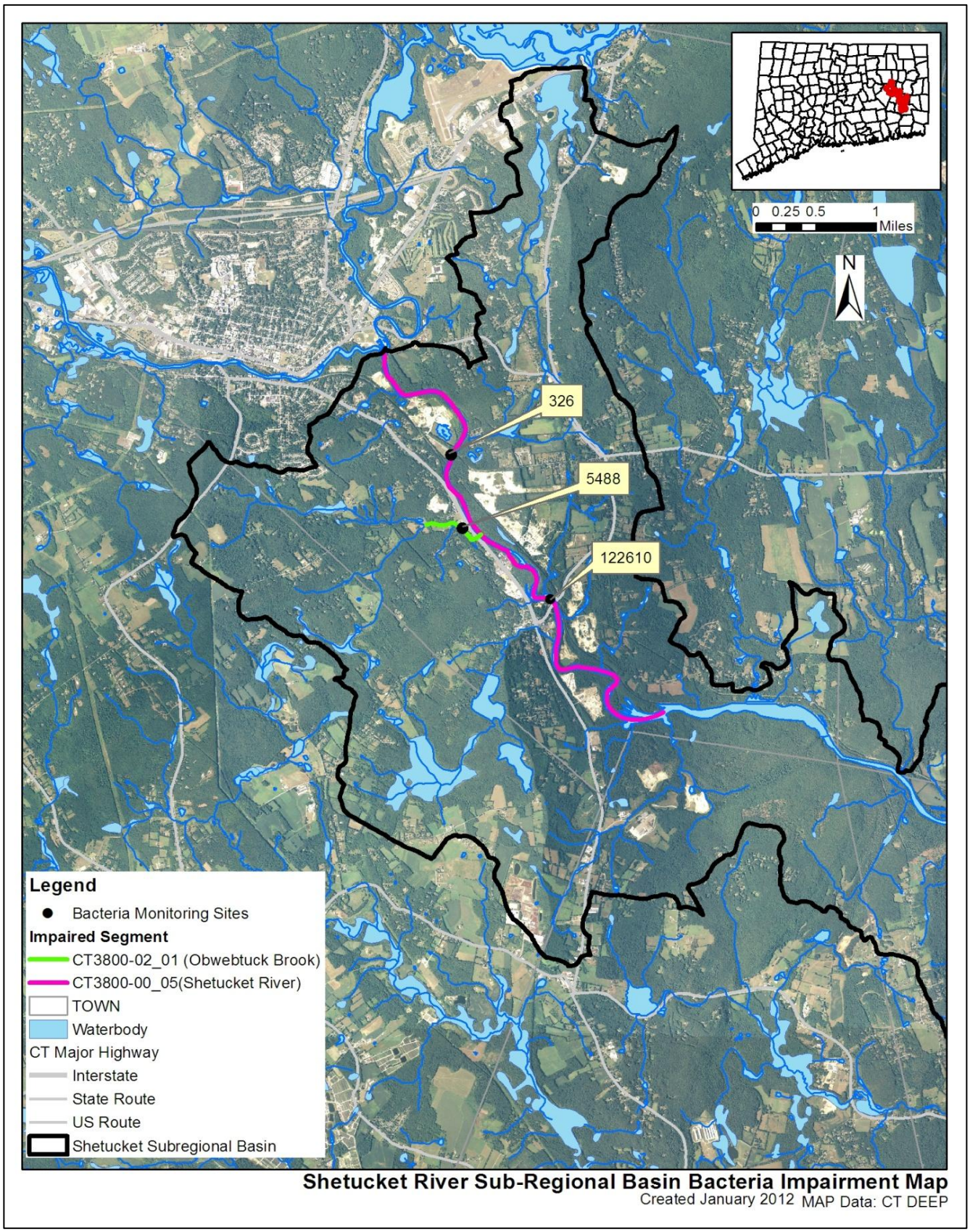
Shaded cells indicate impaired segment addressed in this TMDL

FULL = Designated Use Fully Supported

NOT = Designated Use Not Supported

U = Unassessed

Figure 2: GIS map featuring general information of the Shetucket River 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 Shetucket River watershed consists of 57% forest, 24% urban area, 12% agriculture, and 7% water. The areas adjacent to the impaired segment of the Shetucket River in Windham are characterized by urban land use. There are several large agriculture operations near the Shetucket River's impaired segment in central Windham. Portions of the watershed surrounding the upstream area of Obwebetuck Brook's impaired segment are characterized by agricultural land use. While much of the watershed is dominated by forest, there are many areas where urban or agricultural land uses surround the impaired segment of the Shetucket River and Obwebetuck Brook's impaired segment.

Figure 3: Land use within the Shetucket River watershed

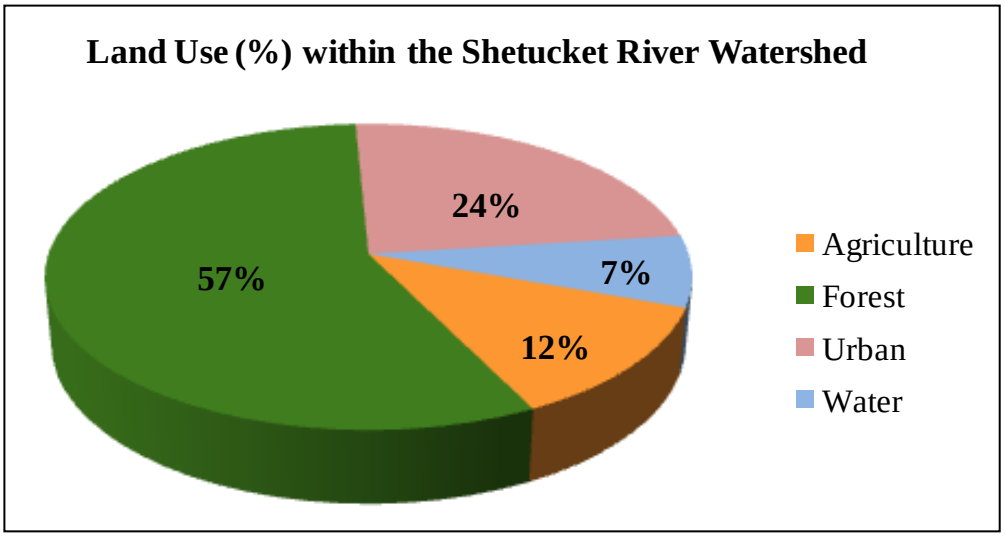
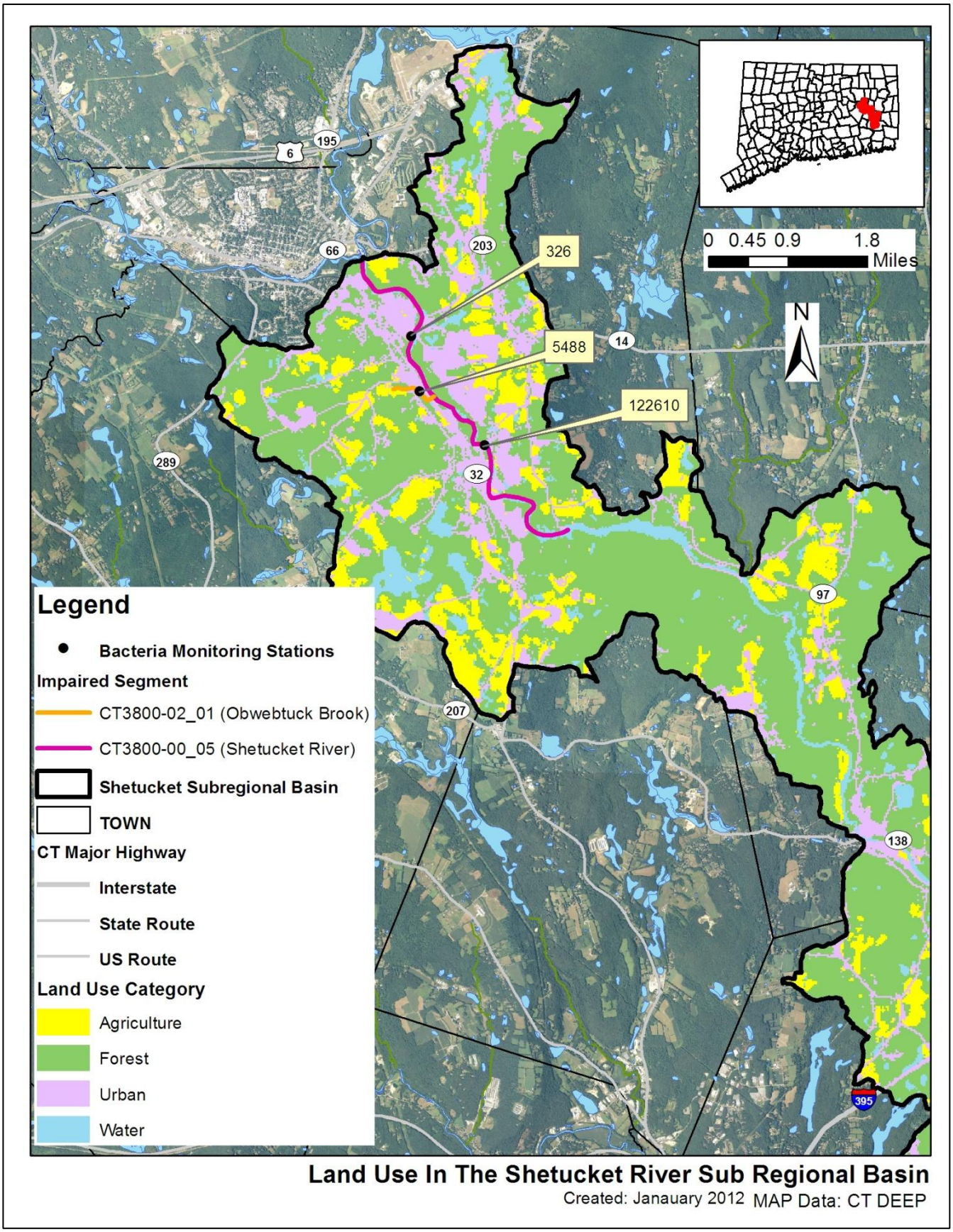


Figure 4: GIS map featuring land use for the Shetucket River watershed at the sub-regional level



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 the impaired segments in the Shetucket River watershed (stations organized downstream to upstream)

Waterbody ID	Waterbody Name	Station	Station Description	Municipality	Latitude	Longitude
CT3800-00_05	Shetucket River	122610	at South Windham	Windham	--	--
CT3800-00_05	Shetucket River	326	Plains Road adjacent to USGS gauge	Windham	41.700189	-72.182278
CT3800-02_01	Obwebetuck Brook	5488	US of Rte 32	Windham	41.691110	-72.180560

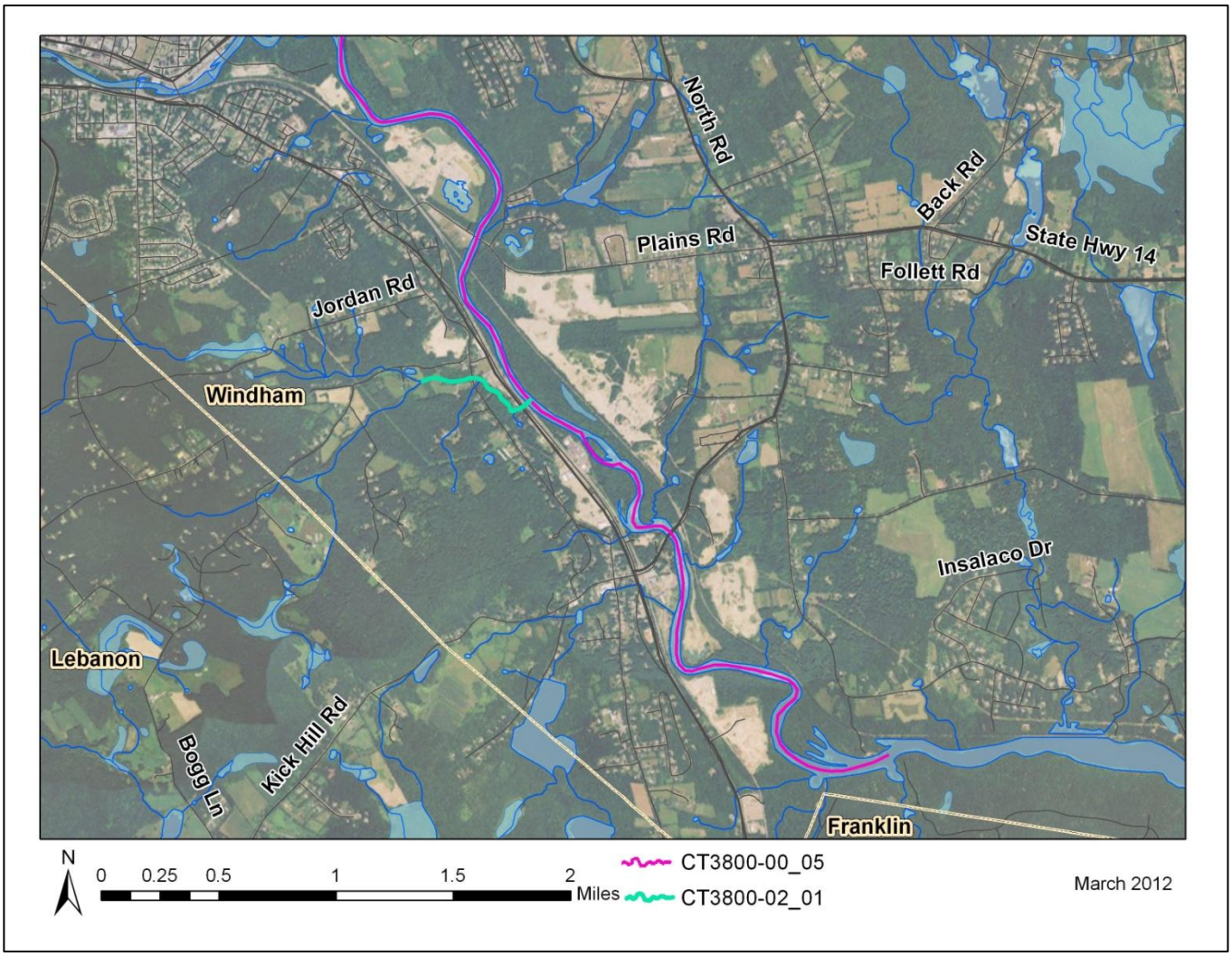
The Shetucket River (CT3800-00_05) is a Class B freshwater river (Figure 5). The applicable designated uses are habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. Obwebetuck Brook (CT3800-02_01) is a Class A freshwater stream (Figure 5). The applicable designated uses are potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. Water quality analyses were conducted using data from two sampling locations on the Shetucket River (Stations 122610 and 326), and from one sampling location on Obwebetuck Brook (Station 5488) (Table 2).

The water quality criteria for *E. coli*, along with bacteria sampling results from 1999-2000 and 2006-2009, are presented in Table 8 for the Shetucket River, and sampling results from 2010 are presented in Table 9 for Obwebetuck Brook. For the Shetucket River, single sample values for Station 122610 exceeded the WQS for *E. coli* once in 2008 and 2009. The annual geometric mean was calculated for Station 122610 and did not exceed the WQS for *E. coli* in any sampling year. Neither the geometric mean nor any single samples at Station 326 exceeded the WQS for *E. coli* in any sampling year. The annual geometric mean was calculated for Station 5488 on Obwebetuck Brook in 2010 and exceeded the WQS for *E. coli.* Single sample values exceeded the WQS for *E. coli* at Station 5488 three times in 2010.

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 8 and 9). For the Shetucket River, the geometric mean during wet and dry-weather did not exceed the WQS for *E. coli* at Station 122610 or Station 326. For Obwebetuck Brook, the geometric mean during both wet and dry-weather exceeded the WQS for *E. coli* at Station 5488. At Station 5488, the geometric mean during wet-weather was nearly three times greater than dry-weather.

Due to the elevated bacteria measurements presented in Tables 8 and 9, the Shetucket River and Obwebetuck Brook 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 the Shetucket River



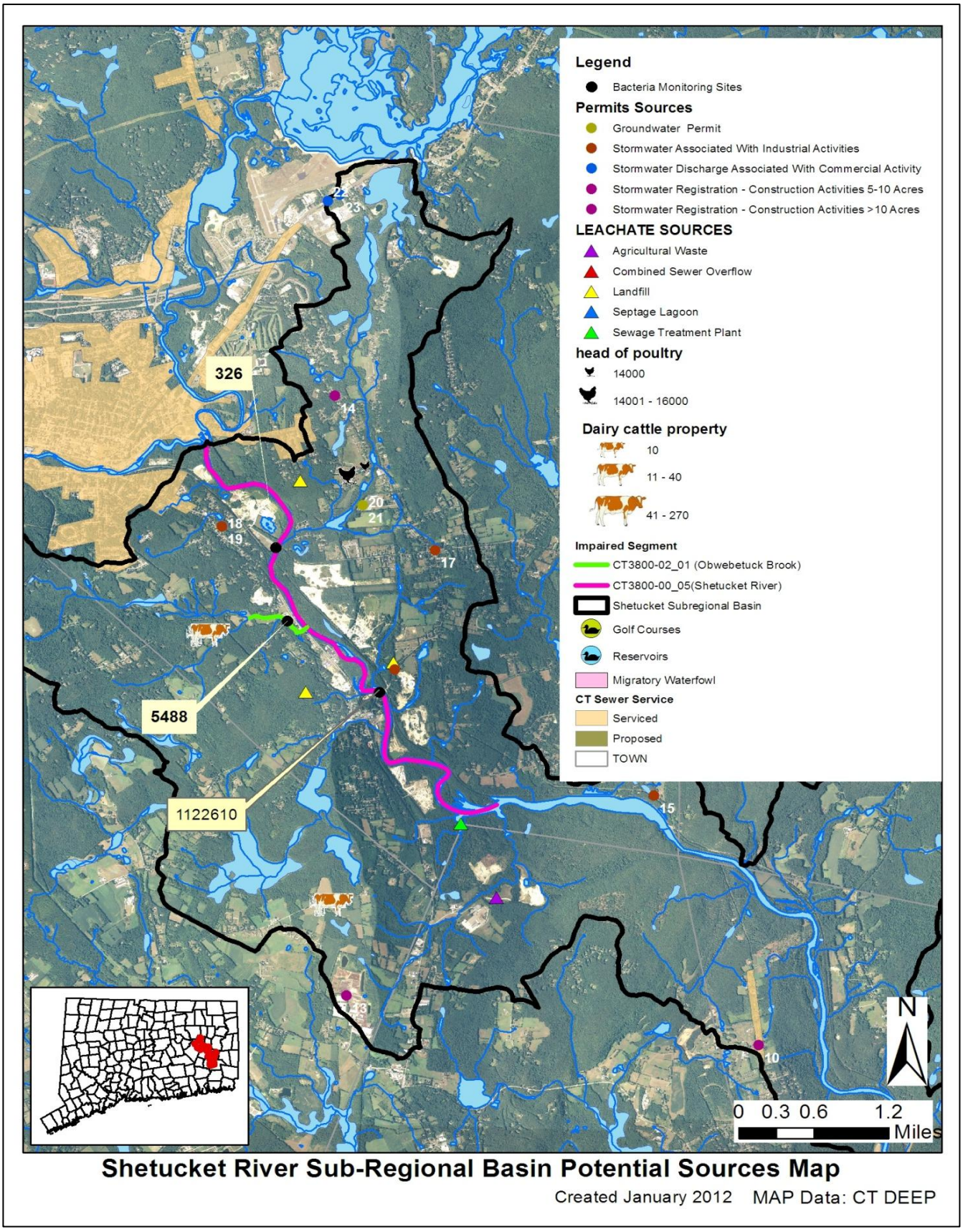
POTENTIAL BACTERIA SOURCES

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 watershed based on land use (Figures 3 and 4) and a collection of local information for the impaired waterbody is presented in Table 3 and Figure 6. 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 segments. Further monitoring and investigation will confirm listed sources and discover additional ones. Some segments in this watershed are currently listed as unassessed by CT DEEP procedures. This does not suggest that there are no potential issues on this segment, but indicates a lack of current data to evaluate the segment as part of the assessment process. 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 Shetucket River watershed

Impaired Segment	Permit Source	Illicit Discharge	CSO/SSO Issue	Failing Septic System	Agricultural Activity	Stormwater Runoff	Nuisance Wildlife/ Pets	Other
Shetucket River CT3800-00_05	**x**	**x**		**x**	**x**	**x**	**x**	
Obwebetuck Brook CT3800-02_01	**x**			**x**	**x**	**x**	**x**	

Figure 6: Potential sources in the Shetucket River watershed



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. A list of active permits in the watershed is included in Table 5. 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	1
GSI	Stormwater Associated with Industrial Activity	5
GSM	Part B Municipal Stormwater MS4	0
GSN	Stormwater Registration – Construction	1
LF	Groundwater Permit (Landfill)	0
UI	Underground Injection	2

Permitted Sources

As shown in Table 5, there are multiple permitted discharges in the Shetucket River watershed. Bacteria data from 2001-2002 from several of these industrial permitted facilities are included in Table 6. Though this data cannot be compared to a water quality standard as there is no recreation standard for fecal coliform bacteria, several samples were high from Rogers Corporation in Windham (GSI000854), exceeding 2,000 colonies/100 mL. This result indicates that permitted sources near the impaired segments (Figure 6) may be potential sources of bacterial contamination to the Shetucket River and Obwebetuck Brook. 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 Shetucket River watershed

Town	Client	Permit ID	Permit Type	Site Name/Address	Map #
Windham	Windham Materials	GSI001809	Stormwater Associated With Industrial Activities	Windham Materials, Llc	16
Windham	Windham Materials	GSI001739	Stormwater Associated With Industrial Activities	Windham Materials Llc	18
Windham	Windham Materials	GSI001810	Stormwater Associated With Industrial Activities	Windham Materials Llc	19
Windham	Home Depot U. S. A., Inc.	GSC000330	Stormwater Discharge Associated With Commercial Activity	Home Depot, The Store #6230	22
Windham	Skanska Usa Building Inc	GSN002106	Stormwater Registration - Construction Activities 5-10 Acres	Windham Cultural And Environmental Magnet School	14
Willimantic	United Abrasives, Inc.	GSI000695	Stormwater Associated With Industrial Activities	United Abrasives Inc	17
Windham	Health Care Assurance L.L.C	UI0000031	Groundwater Permit	Health Care Assurance Llc	20
Windham	Health Care Assurance L.L.C	UI0000031	Groundwater Permit	Douglas Manor Convalescent Home	21
Windham	Firstlight Hydro Generating Company, Ne Hydro Generating Co	GSI001943	Stormwater Associated With Industrial Activities	Scotland Station	15

Table 6: Industrial permits in the Shetucket River watershed and available fecal coliform data (colonies/100mL). The results cannot be compared to the water quality standard as there is no recreation standard for fecal coliform.

Town	Location	Permit Number	Receiving Water	Sample Location	Sample Date	Result
Windham	Rogers Corp	GSI000854	Shetucket River	ECD SW-03	09/26/02	>2000
Windham	Schilberg Integrated Metals	GSI000936	Shetucket River		12/18/01	100

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)

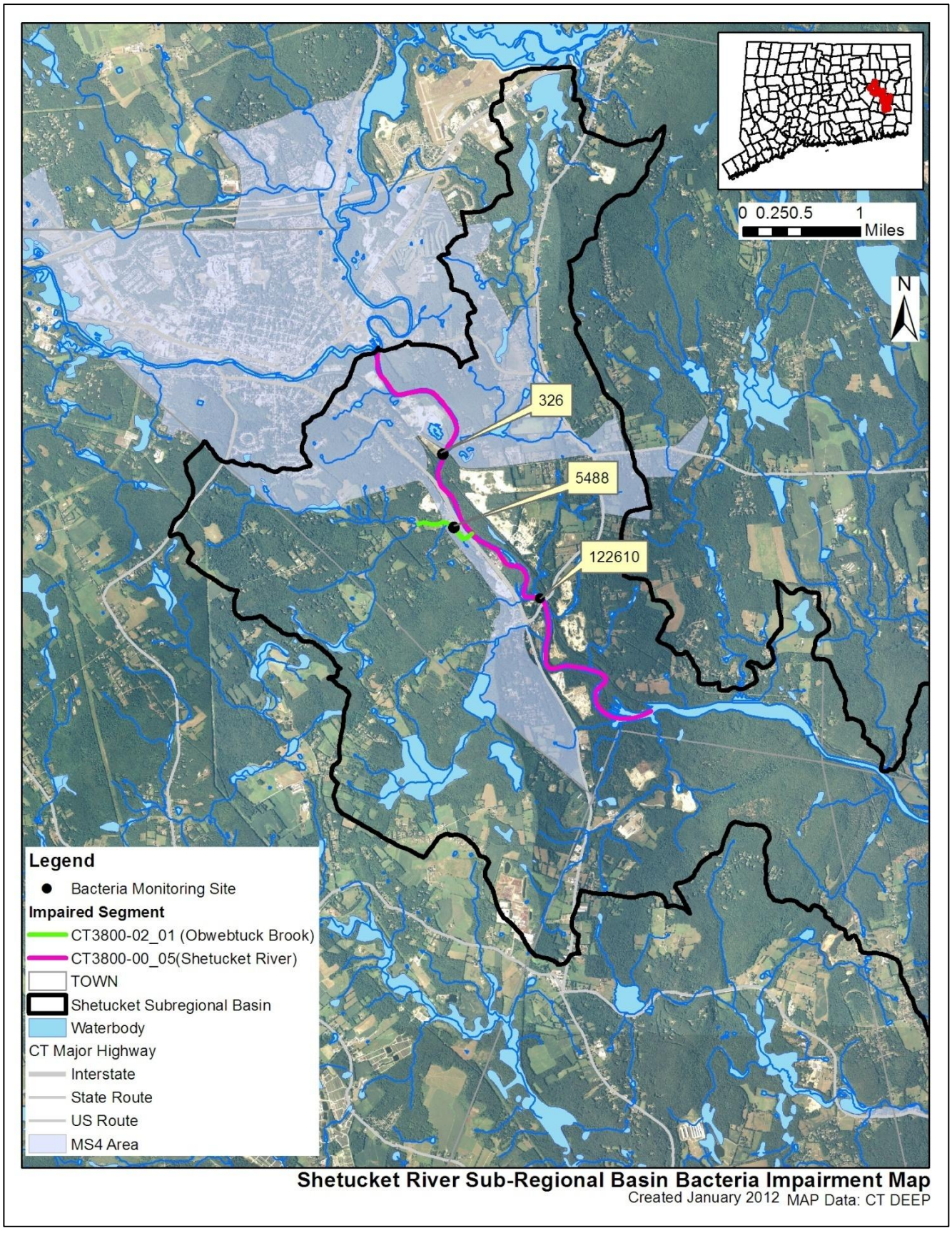
While it is possible that CT DEEP will be expanding the reach of the MS4 program to include UC municipalities in the near future they are not currently under the permit. However, the GIS layers used to create the MS4 maps in this Statewide TMDL did include both UA and UC blocks. This factor creates some 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 Shetucket River and Obwebetuck Brook are located in the town of Windham. As Windham (Willimantic region) is in an Urban Cluster Block (described above), the town is not an MS4 area and is not required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 permit) issued by the CT DEEP (Figure 7). 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).

Figure 7: MS4 areas of the Shetucket River 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 Shetucket River watershed are described below.

Stormwater Runoff from Developed Areas

The majority of the Shetucket River and Obwebetuck Brook watersheds is developed. Approximately 24% of the land use in the watershed is considered urban, and much of that area is concentrated around the impaired segments in the Town of Windham (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).

Approximately 77% of the Shetucket River watershed is characterized by 0-6% impervious cover, 13% is characterized by 7-11% impervious cover, 2% is characterized by 12-15%, and 8% is characterized by >16% impervious cover (Figure 8). Figure 8 pertains to the entire Shetucket River watershed, while Figure 9 displays only the watershed in the area of the impaired segment of the Shetucket River and Obwebetuck Brook. There are many areas in the more urbanized portions of Windham, particularly South Windham, where impervious surfaces are in proximity to the Shetucket River and Obwebetuck Brook. Route 32 (Windham Road) runs parallel to the impaired segment of the Shetucket River for much of its course and Bush Hill Road runs parallel to portions of the impaired segment of Obwebetuck Brook. The proximity of impervious surfaces to the Shetucket River and Obwebetuck Brook indicate that stormwater runoff from developed areas are a potential source of bacterial contamination.

Figure 8: Range of impervious cover (%) in the Shetucket River watershed

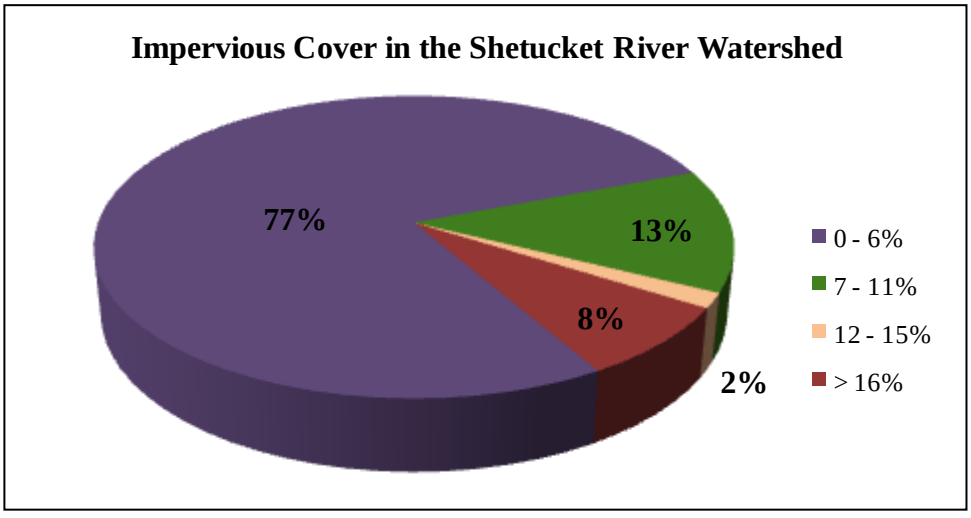
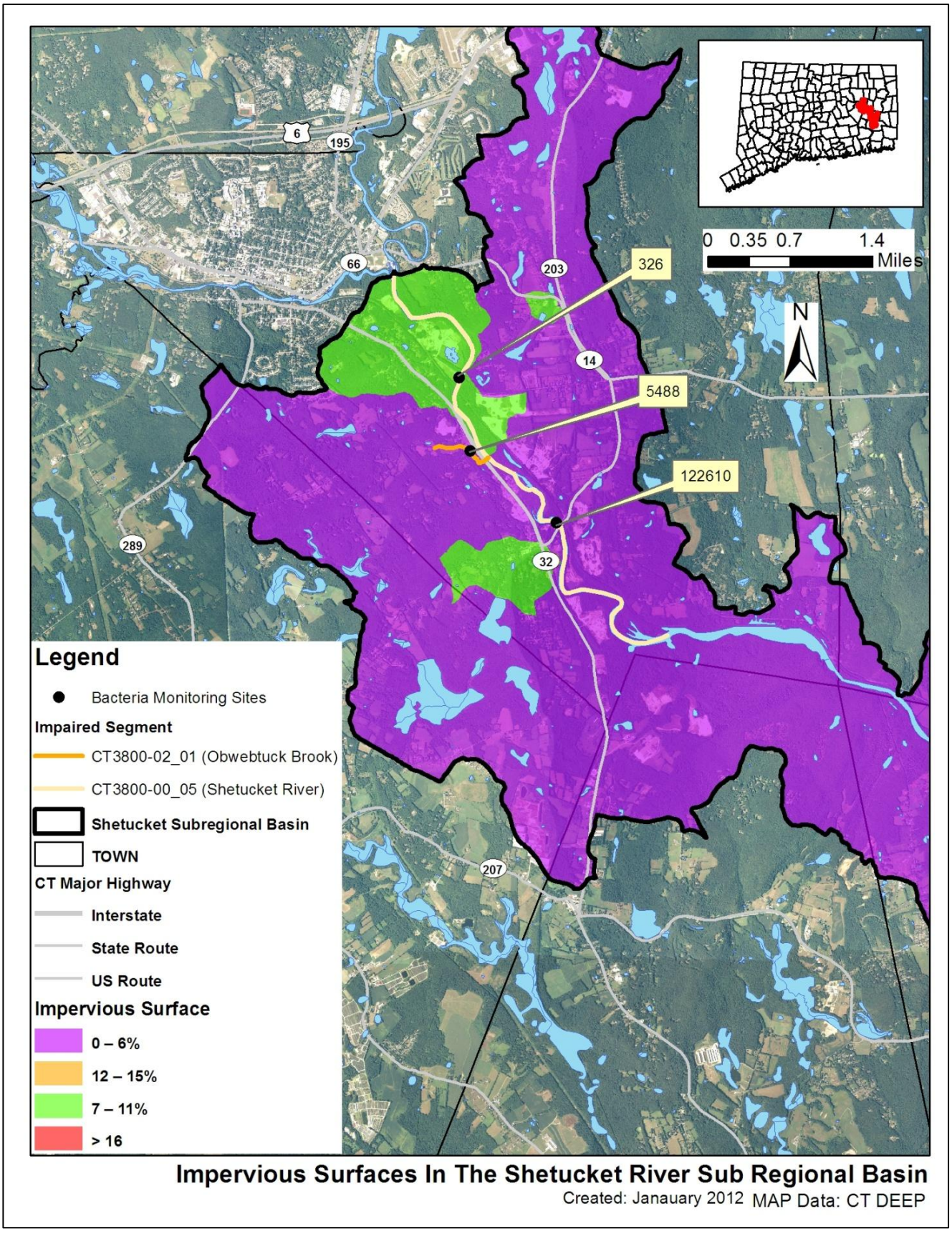


Figure 9: Impervious cover (%) for the Shetucket River sub-regional watershed



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 12% of the Shetucket River watershed. There are multiple operations near the Shetucket River's impaired segment in Windham and several agricultural operations near the impaired segment of Obwebetuck Brook in Lebanon and Windham.

As shown in Figure 6, there are several poultry farms located along a tributary to the Shetucket River in northern Windham. There are also multiple agricultural fields located near the impaired segment of the Shetucket River and tributaries to the river in central Windham off Windham Center Road. A cattle farm is also located near Obwebetuck Brook's impaired segment off Bush Hill Road near the Lebanon-Windham town line. These agricultural areas are potentially carrying pollutants, including bacteria, into the Shetucket River and Obwebetuck Brook.

Insufficient Septic Systems and Illicit Discharges

As shown in Figure 6, very few residents within the Shetucket River watershed have access to a sanitary sewer. Residents living near the Shetucket River and Obwebetuck Brook must rely on onsite wastewater treatment systems, such as septic systems to treat their waste. Insufficient or failing septic systems can be significant sources of bacteria by allowing raw waste to reach surface waters. 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 Windham is part of the regional North Central District Health District (http://www.ncdhd.org/).

As shown in Figure 6, several small portions of the Shetucket River's impaired segment in downtown Windham are serviced by sanitary sewer. It also appears that there are sewer pipes crossing tributaries to the impaired segment of the Shetucket River. Sewer system leaks and other illicit discharges that are located within the watershed of the impaired segment of the Shetucket River may be contributing bacteria to the waterbody.

Wildlife and Domestic Animal Waste

Wildlife and domestic animals within the Shetucket River watershed represent a potential source of bacteria. 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).

Open spaces located along the impaired segments may provide an area for waterfowl to congregate. Geese and other waterfowl are known to congregate in open areas including recreational fields, golf courses, and agricultural crop fields. There is a large recreational field adjacent to the Shetucket River's impaired segment off of Plains Road in Windham. There are also multiple agricultural crop fields in proximity to the impaired segments. 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.

Residential development also surrounds portions of the Shetucket River and Obwebetuck Brook (Figure 5). When not properly disposed, waste from domestic animals such as dogs can enter surface waters directly or through stormwater infrastructure. Therefore, domestic animal waste may be contributing to bacteria concentrations in the impaired segments of the Shetucket River watershed.

Additional Sources

There may be other sources not listed here or identified in Figure 6 that contribute to the observed water quality impairment in the Shetucket River and Obwebetuck Brook. 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

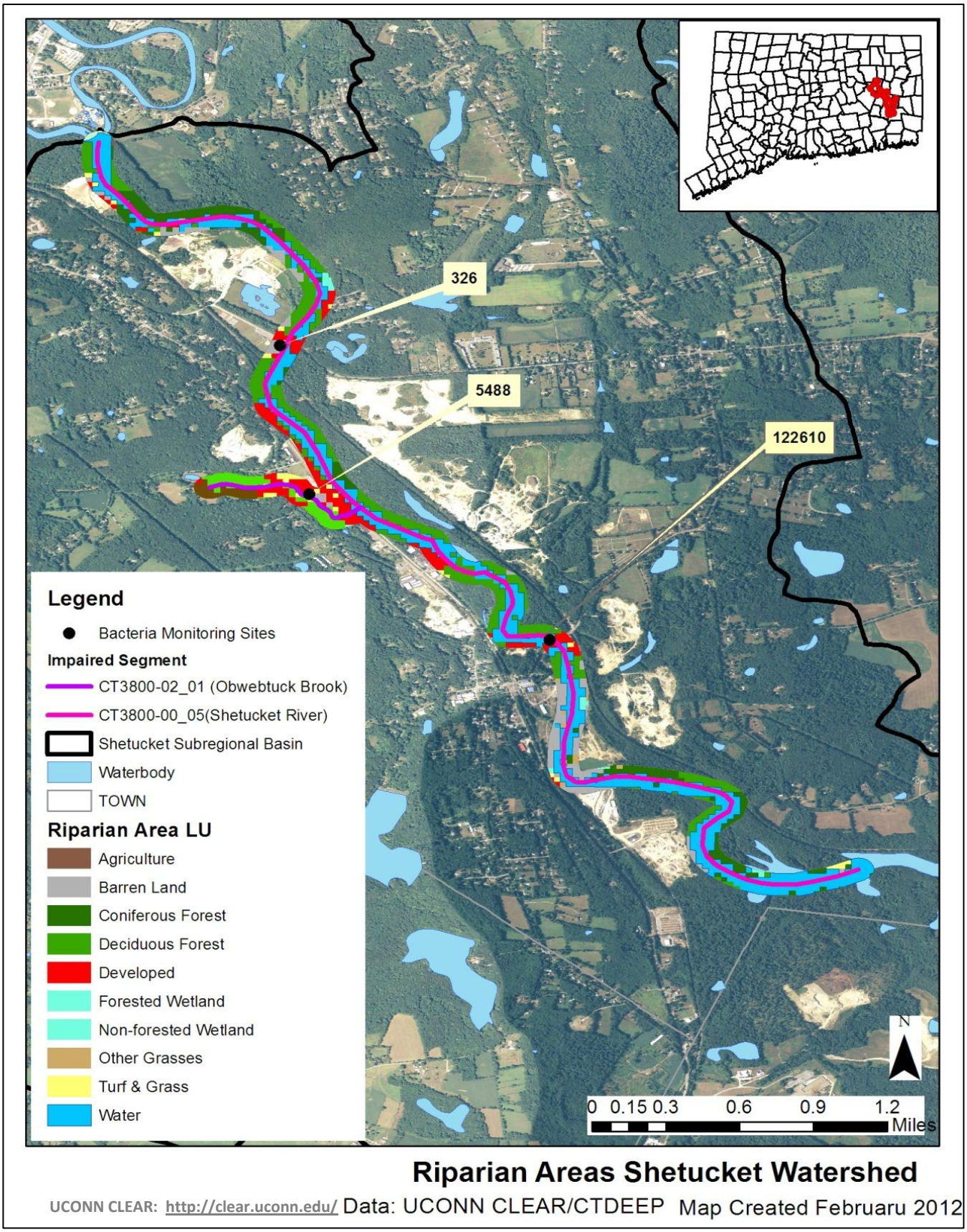
Riparian Buffer Zones

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 riparian zone of the Shetucket River and Obwebetuck Brook is mostly forested (Figure 10). However, there are multiple areas, such as near Station 122610 and Station 326 on the Shetucket River, where most of the riparian zone is characterized by development. Also, there is a fair amount of developed land within the riparian zone near Station 5488 on Obwebetuck Brook. The riparian zone of Obwebetuck Brook also contains agricultural lands near the upstream portion of the impaired segment. As previously mentioned, developed and agricultural areas can be sources of bacterial contamination.

Figure 10: Riparian buffer zone information for the Shetucket River watershed



RECOMMENDED NEXT STEPS

Future mitigative activities are necessary to ensure the long-term protection of the Shetucket River and Obwebetuck Brook and have been prioritized below.

1) Identify areas along the Shetucket River to implement Best Management Practices (BMPs) to control stormwater runoff.

Since urban development is concentrated around the Shetucket River and Obwebetuck Brook, stormwater runoff may be contributing bacteria to these waterbodies. To identify specific areas that are contributing bacteria, Windham should conduct wet-weather sampling at stormwater outfalls that discharge directly to the Shetucket River and Obwebetuck Brook. To treat stormwater runoff, the town should also identify areas along the more developed sections of the Shetucket River and Obwebetuck Brook, to install BMPs that encourage stormwater to infiltrate into the ground before entering these waterbodies. These BMPs would disconnect impervious areas and reduce pollutant loads to the Shetucket River's impaired segments. More detailed information and BMP recommendations can be found in the core TMDL document.

2) Ensure there are sufficient buffers on agricultural lands along the Shetucket River and its tributaries.

If not already in place, agricultural producers should 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 livestock and horse access to streams and wetlands, and that animal waste handling, disposal, and other appropriate Best Management Practices (BMPs) are in place. Particular attention should be paid to the agricultural operations near the Shetucket River, Obwebetuck Brook, and their tributaries.

3) Develop a system to monitor septic systems.

Nearly all residents within the Shetucket River watershed rely on septic systems. If not already in place, Windham should establish a program to ensure that existing septic systems are properly operated and maintained. For instance, communities can 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 the sub-standard systems within a reasonable timeframe could also be adopted. Towns can also develop programs to assist citizens with the replacement and repair of older and failing systems.

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

Any education and outreach programs within Windham should highlight the importance of not feeding waterfowl and wildlife, and managing waste from dogs and other pets. Municipalities and residents can take measures to minimize waterfowl-related impacts such as allowing tall, coarse vegetation to grow in the riparian areas of the impaired segments of the Shetucket River 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 Shetucket River 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-uses areas, enacting ordinances requiring the clean-up of pet waste, and targeting educational and outreach programs in problem areas.

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

A small portion of the watershed near the Shetucket River's impaired segment in Windham has access to a municipal sewer system (Figure 6). Since the sanitary sewer is near the impaired segment and crosses a tributary to the impaired segment, ensuring there are no leaks or overflows from the sanitary sewer in this area should be made a priority. It is important for Windham to develop a program to evaluate its sanitary sewer and reduce leaks and overflows, especially in the areas around the Shetucket River's impaired segment. This program should include periodic inspections of the sewer line.

6) Continue monitoring permitted sources.

As Figure 6 displays, there are multiple permitted discharges within the Shetucket River watershed, particularly near the impaired segments. Previous sampling of permitted discharges in the watershed has shown elevated levels of fecal coliform bacteria, an indicator of bacterial pollution (Table 6). 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 7 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 Shetucket 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 7. 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
B[4]	Non-Stormwater NPDES	235	410	576				126	
	CSOs	235	410	576				126	
	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 8: Shetucket River Bacteria Data

Waterbody ID: CT3800-00_05

Characteristics: Freshwater, Class B, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, 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: **NA**

Single Sample: **83%**

Data: 1999-2000 and 2006-2009 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Shetucket River with annual geometric means calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
122610	Shetucket River at South Windham	5/17/2005	18	dry	64
122610	Shetucket River at South Windham	6/21/2005	62	dry**	
122610	Shetucket River at South Windham	7/28/2005	240	wet	
122610	Shetucket River at South Windham	8/25/2005	29	dry	
122610	Shetucket River at South Windham	9/15/2005	85	dry	
122610	Shetucket River at South Windham	11/16/2005	100	dry	
122610	Shetucket River at South Windham	1/9/2006	75	dry	45
122610	Shetucket River at South Windham	3/23/2006	17	dry	
122610	Shetucket River at South Windham	5/11/2006	18	wet	
122610	Shetucket River at South Windham	6/6/2006	320	wet	
122610	Shetucket River at South Windham	7/11/2006	49	dry	
122610	Shetucket River at South Windham	8/1/2006	60	dry	
122610	Shetucket River at South Windham	9/7/2006	40	dry	
122610	Shetucket River at South Windham	11/15/2006	20	wet	

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Shetucket River Segment 1 with annual geometric means calculated (continued)

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
122610	Shetucket River at South Windham	1/17/2007	110	dry	47
122610	Shetucket River at South Windham	3/14/2007	31	dry	
122610	Shetucket River at South Windham	5/15/2007	25	dry	
122610	Shetucket River at South Windham	6/11/2007	53	wet	
122610	Shetucket River at South Windham	7/11/2007	37	dry	
122610	Shetucket River at South Windham	8/27/2007	31	dry	
122610	Shetucket River at South Windham	9/25/2007	27	dry	
122610	Shetucket River at South Windham	11/7/2007	160	wet	
122610	Shetucket River at South Windham	1/15/2008	68	wet	113*
122610	Shetucket River at South Windham	3/5/2008	240	wet	
122610	Shetucket River at South Windham	5/6/2008	25	dry**	
122610	Shetucket River at South Windham	6/11/2008	88	dry**	
122610	Shetucket River at South Windham	7/8/2008	43	dry**	
122610	Shetucket River at South Windham	8/20/2008	55	dry**	
122610	Shetucket River at South Windham	9/8/2008	**2400* (83%)**	wet**	
122610	Shetucket River at South Windham	11/13/2008	130	dry	
122610	Shetucket River at South Windham	1/12/2009	34	wet	85
122610	Shetucket River at South Windham	3/17/2009	52	dry	
122610	Shetucket River at South Windham	5/18/2009	58	dry**	
122610	Shetucket River at South Windham	6/15/2009	460	wet**	
122610	Shetucket River at South Windham	7/23/2009	96	wet	
326	Plains Road adjacent to USGS gauge	10/28/1999	140	dry	NA
326	Plains Road adjacent to USGS gauge	3/1/2000	63	dry	75
326	Plains Road adjacent to USGS gauge	5/17/2000	81†	dry	
326	Plains Road adjacent to USGS gauge	8/22/2000	81†	dry	

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 all monitoring stations on Shetucket River

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
122610	Shetucket River at South Windham	2005-2009	12	23	65	124	46
326	Plains Road adjacent to USGS gauge	1999-2000	0	4	87	NA	87

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Norwich Public Utility Plant in Norwich, CT and at Hartford Bradley International Airport

Table 9: Obwebetuck Brook Bacteria Data

Waterbody ID: CT3800-02_01

Characteristics: Freshwater, Class A, Potential Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, 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: **39%**

Single Sample: **82%**

Data: 1998 and 2000 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Shetucket River Obwebetuck Brook with annual geometric means calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
5488	Upstream of Route 32 crossing	6/16/2010	120	dry	
5488	Upstream of Route 32 crossing	6/22/2010	20	dry	
5488	Upstream of Route 32 crossing	6/30/2010	75†	wet	
5488	Upstream of Route 32 crossing	7/8/2010	350	dry	
5488	Upstream of Route 32 crossing	7/14/2010	**2300*(82%)**	wet	
5488	Upstream of Route 32 crossing	7/21/2010	460	wet	**207* (39%)**
5488	Upstream of Route 32 crossing	7/28/2010	111†	dry	
5488	Upstream of Route 32 crossing	8/4/2010	120	dry**	
5488	Upstream of Route 32 crossing	8/11/2010	96†	dry**	
5488	Upstream of Route 32 crossing	8/19/2010	315†	dry**	
5488	Upstream of Route 32 crossing	9/13/2010	1100	dry**	

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 all monitoring stations on Obwebetuck Brook

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
5488	Upstream of Route 32 crossing	2010	3	8	207	430	157

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Norwich Public Utility Plant in Norwich, CT and at Hartford Bradley International Airport

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