Southwest Shoreline Watershed Summary

Indian River

Watershed Description and Maps

The Southwest Shoreline watershed covers an area of approximately 26,504 acres in the southwestern corner of Connecticut (Figure 1). There are two municipalities located in the watershed, including the City of Norwalk and the Town of Westport, CT.

The Southwest Shoreline 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. An excerpt of the Integrated Water Quality Report is included in Table 1 (CT DEEP, 2010).

Indian River (Segment 2) (CT7000-22_02) begins in Norwalk near the intersection of US Route 1 and Strawberry Hill Avenue, flows easterly through a heavily developed area, flows southerly through multiple residential neighborhoods, and crosses the town line into Westport. Indian River (Segment 1) (CT7000-22_01) continues south from Interstate 95 near Hiawatha Avenue, crosses the railroad tracks, and empties into the Saugatuck River at Burritt Cove just downstream of Route 136 (Figures 2 and 5). Portions of Indian River (Segment 2) flow through concrete channels and underground pipes.

Both impaired segments of the Indian River have a water quality classification of A. Designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. These segments are impaired due to elevated bacteria concentration, affecting the designated use of recreation. As there are no designated beaches in these segments of the Indian River, the specific recreation impairments are for non-designated swimming and other water contact related activities.

Impaired Segment Facts

Impaired Segments:
1. Indian River (Segment 1) (CT7000-22_01)
2. Indian River (Segment 2) (CT7000-22_02)

Municipalities: Norwalk and Westport

Impaired Segments and Lengths (miles): 7000-22_01 (0.53), 7000-22_02 (0.94)

Water Quality Classifications: Class A

Designated Use Impairments: Recreation

Sub-regional Basin Name and Code: Southwest Shoreline, 7000

Regional Basin: Saugatuck

Major Basin: Southwest Coastal

Watershed Area (acres): 26,504

MS4 Applicable? Yes

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

Figure 1: Watershed location in Connecticut

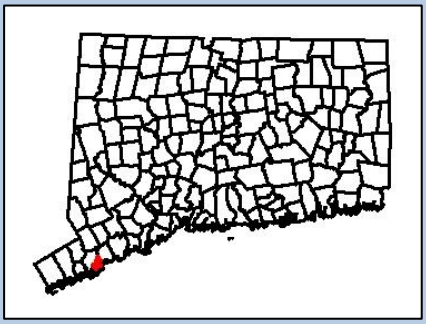


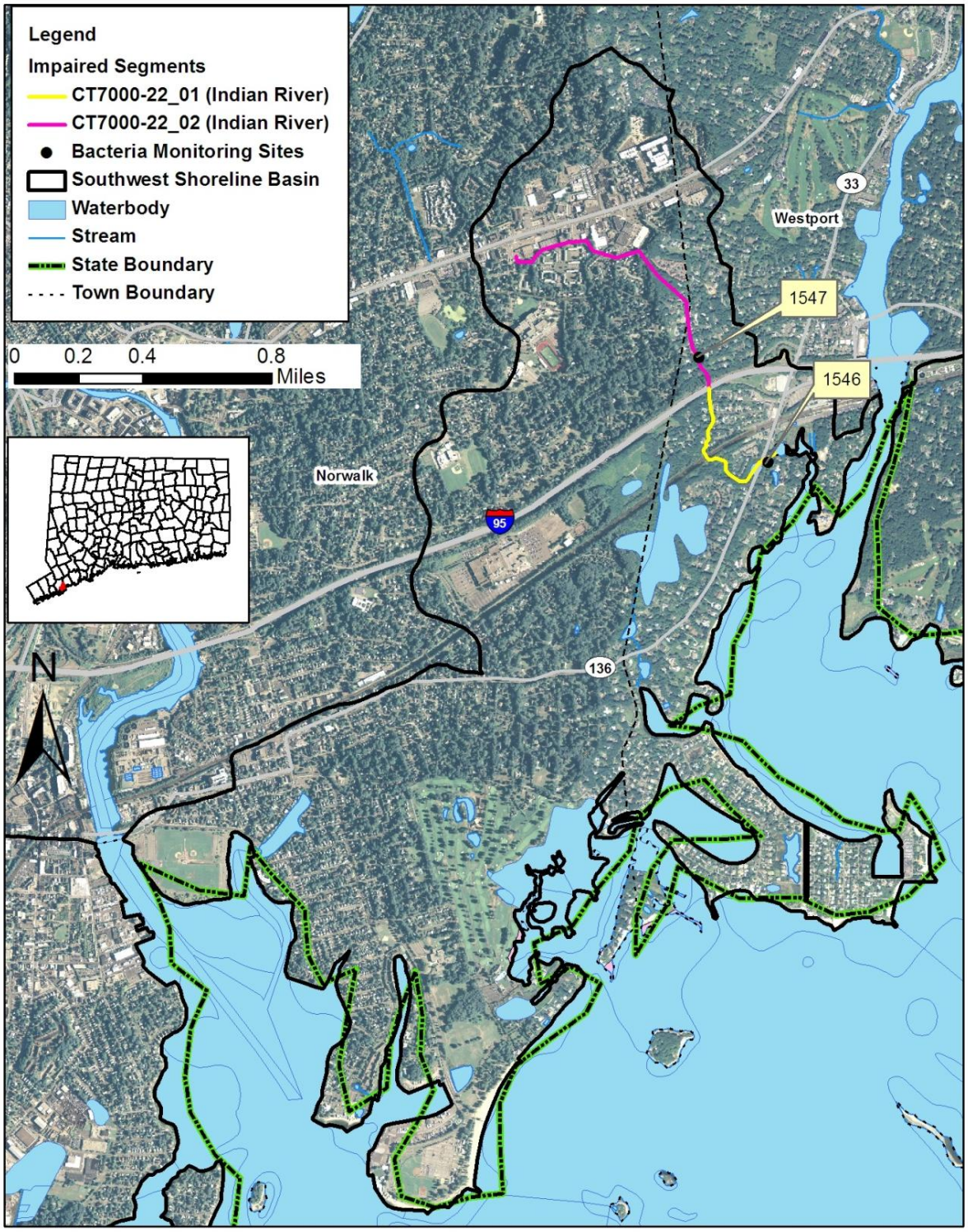
Table 1: Impaired segments and nearby waterbodies from the Connecticut 2010 Integrated Water Quality Report

Waterbody ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation	Fish Consumption
CT7000-22_01	Indian River (Westport)-01	From mouth at Saugatuck River (head of Burritt Cove, Saugatuck River Estuary, just DS of Saugatuck Avenue (Route 136) crossing), US to I95 crossing, Westport.	0.53	U	NOT	FULL
CT7000-22_02	Indian River (Westport)-02	From I95 crossing, Westport, US to headwaters (portions of river in concrete channels and pipes), Norwalk. (Segment made from site map, actual hydro must be mapped to confirm underground portions)	0.94	U	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 Southwest Shoreline watershed at the sub-regional level (the location and name of each sampling station is indicated on each segment)



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 Southwest Shoreline watershed consists of 82% urban area, 12% forest, 5% water, and 1% agriculture. The majority of the watershed is characterized as developed and includes a mix of residential, commercial, and industrial land uses. Small patches of forested area can be found throughout the watershed. Approximately 1% of the watershed is occupied by agricultural land uses. This area is concentrated along Interstate 95 in Norwalk near the border of Westport (Figure 4).

Figure 3: Land use within the Southwest Shoreline watershed

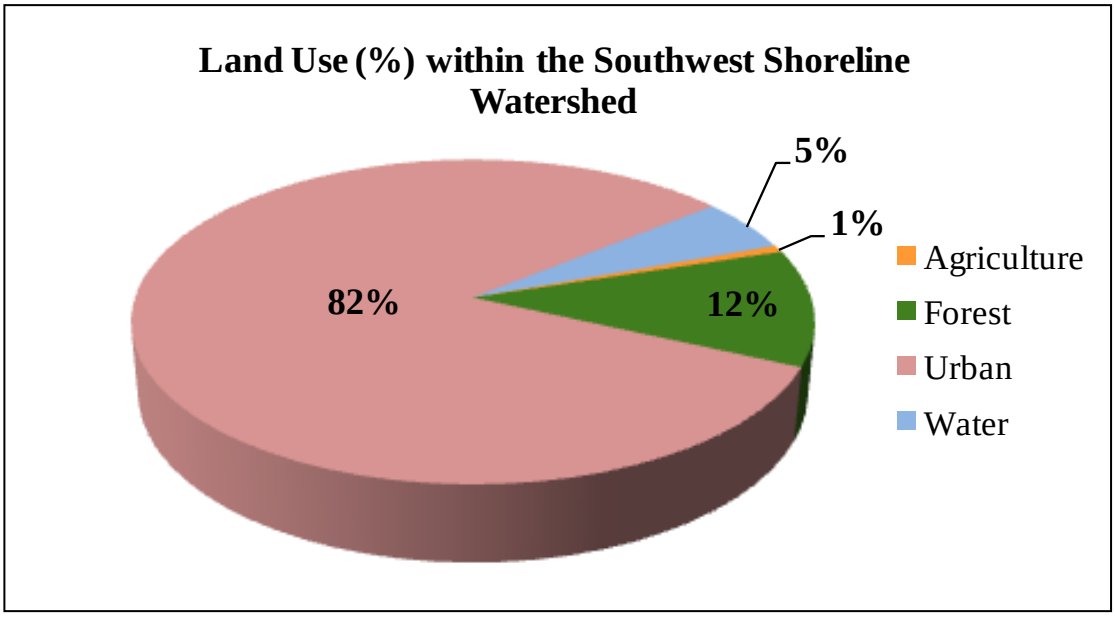
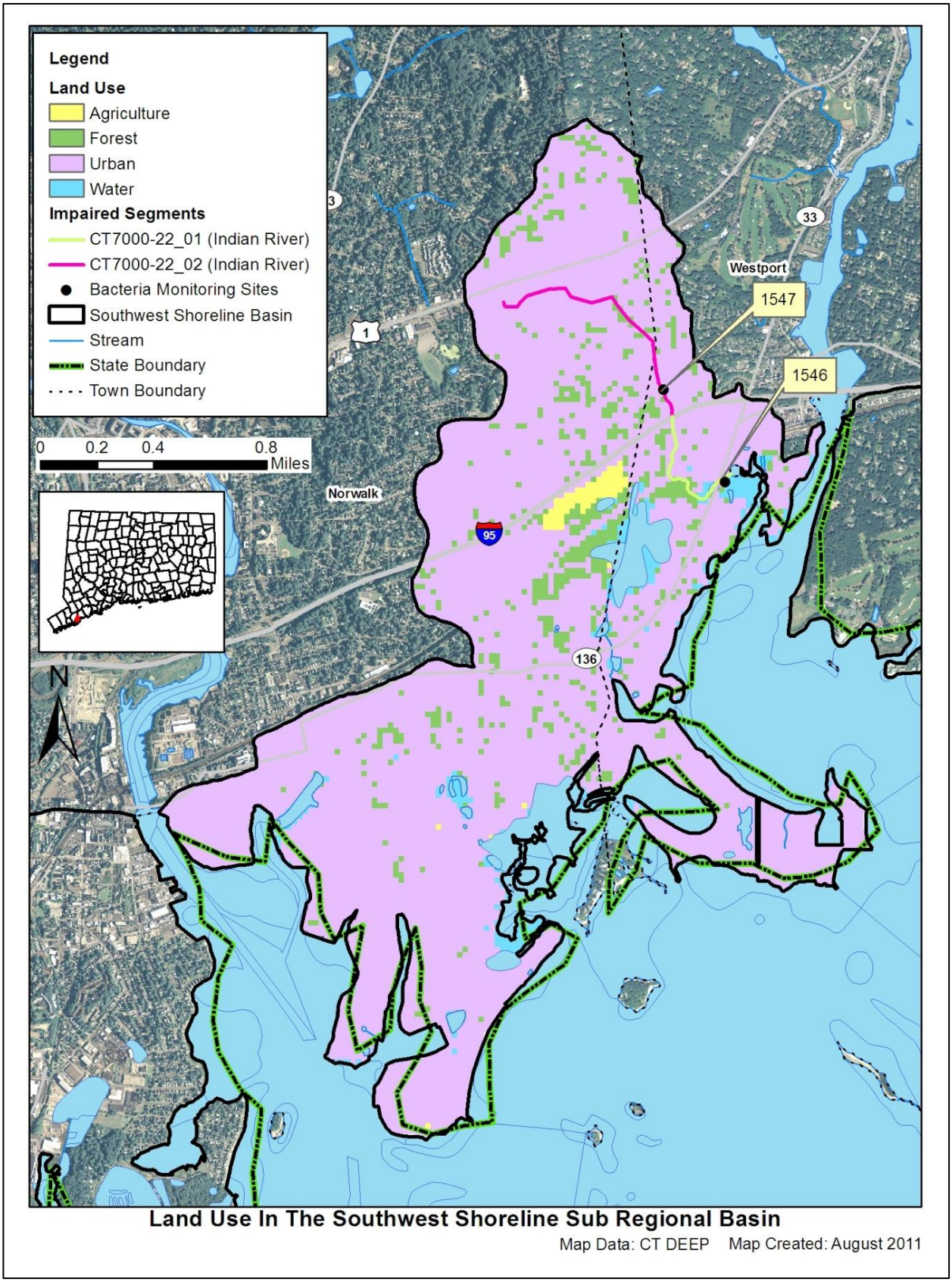


Figure 4: GIS map featuring land use for the Southwest Shoreline watershed at the sub-regional level



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 Southwest Shoreline Watershed (stations organized downstream to upstream)

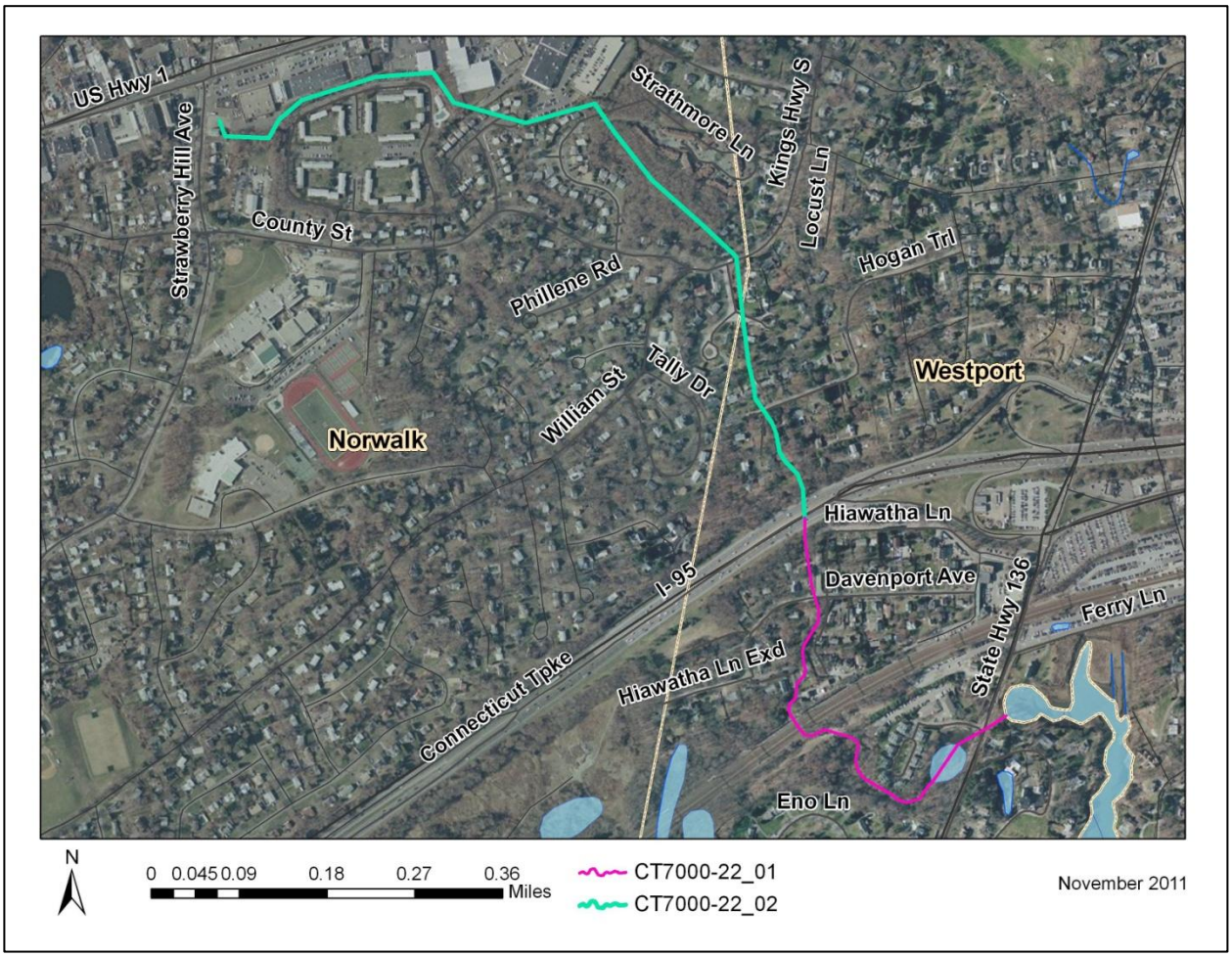
Waterbody ID	Waterbody Name	Station	Station Description	Municipality	Latitude	Longitude
CT7000-22_01	Indian River	1546	Confluence with Saugatuck estuary	Westport	41.116194	-73.375611
CT7000-22_02	Indian River	1547	Hogan Trail (midpoint)	Westport	41.120889	-73.379806

The two impaired segments of the Indian River (CT7000-22_01 and CT7000-22_02) are Class A freshwater rivers (Figure 5). Their applicable designated uses are potential drinking water supply, 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 from 2005-2008 (Stations 1546 and 1547) (Table 2). The water quality criteria for *E. coli*, along with bacteria sampling results from 2005-2008 are presented in Tables 10 and 11. The annual geometric mean value exceeded the WQS for *E. coli* during all sampling years at Station 1546 and from 2007-2008 at Station 1547. Single sample values for both stations exceeded the WQS for *E. coli* on multiple dates during the sampling period.

To aid in identifying possible bacteria sources, the geometric mean was also calculated for wet-weather and dry-weather sampling days for each sampling station on the Indian River (Tables 10 and 11). At Station 1546 on the Indian River (Segment 1), geometric means exceeded the WQS for *E. coli* during both wet and dry-weather with wet-weather higher than dry weather. At Station 1547 on the Indian River (Segment 2), the geometric mean exceeded the WQS for *E. coli* during wet-weather.

Due to the elevated bacteria measurements presented in Tables 10 and 11, these two impaired segments 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 Indian River (Segments 1 and 2)



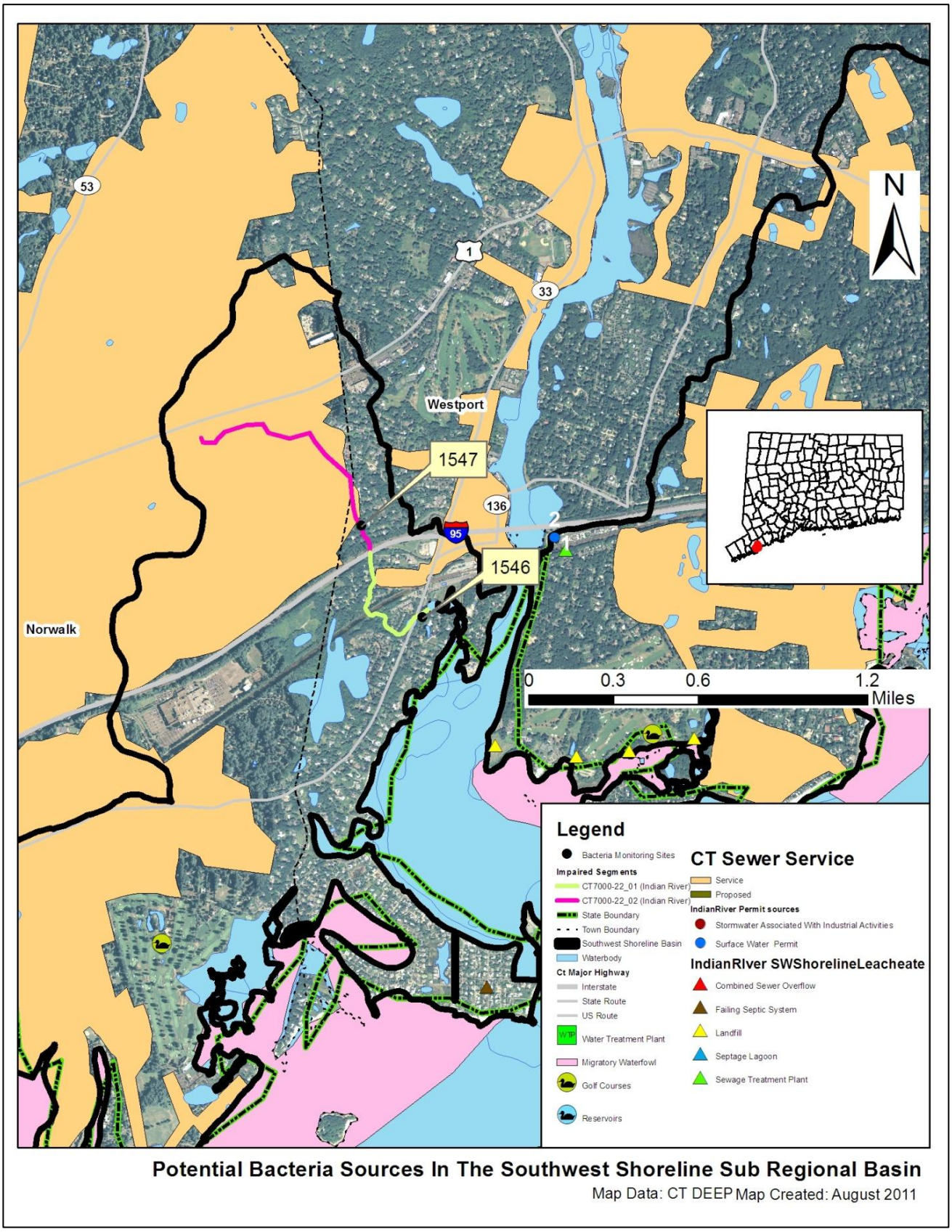
POTENTIAL BACTERIA SOURCES

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 Southwest Shoreline watershed

Impaired Segment	Permit Source	Illicit Discharge	CSO/SSO Issue	Failing Septic System	Agricultural Activity	Stormwater Runoff	Nuisance Wildlife/Pets	Other
Indian River CT7000-22_01	**x**	**x**		**x**	**x**	**x**	**x**	
Indian River CT7000-22_02	**x**	**x**		**x**		**x**	**x**	

Figure 6: Potential sources in the Southwest Shoreline 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. A list of active permits in the watershed is included in Table 5. Additional investigation and monitoring could reveal the presence of additional discharges in the watershed.

Table 4: General categories list of other permitted discharges

Permit Code	Permit Description Type	Number in watershed
CT	Surface Water Discharges	2
GPL	Discharge of Swimming Pool Wastewater	0
GSC	Stormwater Discharge Associated with Commercial Activity	0
GSI	Stormwater Associated with Industrial Activity	16
GSM	Part B Municipal Stormwater MS4	3
GSN	Stormwater Registration – Construction	0
LF	Groundwater Permit (Landfill)	0
UI	Underground Injection	1

Permitted Sources

As shown in Table 5, there are multiple permitted discharges in the Southwest Shoreline watershed. Bacteria data from 2001-2007 for several industrial permitted facilities are included in Table 6. Although this data cannot be compared to a water quality standard as there is no recreation standard for fecal coliform in Connecticut, multiple samples were high, exceeding 2,000 colonies/100 mL, at Beiersdorf (GSI000784) and FedEx (GSI000972). 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 Southwest Shoreline watershed

Town	Client	Permit ID	Permit Type	Site Name/Address	Map #
Norwalk	City Of Norwalk	GSM000024	Part B Municipal Stormwater MS4	Norwalk, City Of	N/A
Westport	TOWN OF WESTPORT (Permittee)	GSI001716	Stormwater Associated With Industrial Activities	WESTPORT WPCF	1
Westport	TOWN OF WESTPORT (Permittee)	CT0100684	Surface Water Permit	WESTPORT WPCF	2
Westport	Town Of Westport	200902793	Part B Municipal Stormwater MS4	Westport, Town Of	N/A
Westport	Town Of Westport	GSM000026	Part B Municipal Stormwater MS4	Westport, Town Of	N/A
Westport	CT DOT	GSI000081	Stormwater Associated With Industrial Activities	Westport Maintenance Facility	ND
Westport	Town Of Westport	GSI001207	Stormwater Associated With Industrial Activities	Parsell Public Works Center	ND
Westport	Town Of Westport	GSI001716	Stormwater Associated With Industrial Activities	Westport WPCF	ND
Westport	Town Of Westport	GSI002142	Stormwater Associated With Industrial Activities	Westport Transfer Station	ND

ND = Not Displayed on the map

Table 6: Industrial permits in the Southwest Coastal 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.

Location	Permit Number	Receiving Water	Sample Location	Sample Date	Result
Town of Westport DPW	GSI001207	Unknown	CB NE001	10/15/01	150
Town of Westport-DPW	GSI001207	Unknown	CB NE001	11/05/02	5

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)

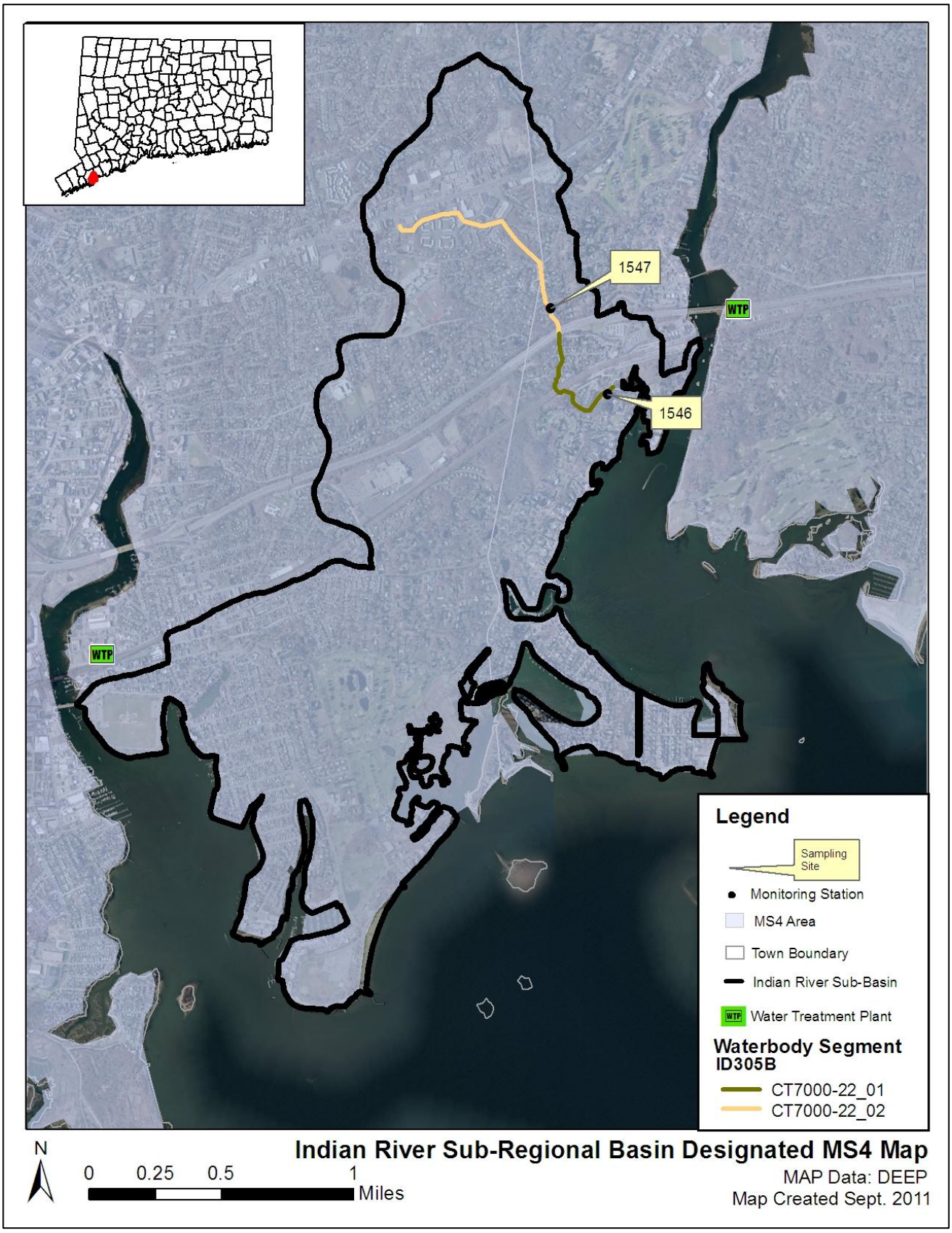
While it is possible that CT DEEP will be expanding the reach of the MS4 program to include UC municipalities in the near future they are not currently under the permit. However, the GIS layers used to create the MS4 maps in this Statewide TMDL did include both UA and UC blocks. This factor creates some 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 in the Southwest Shoreline watershed are located within the Town of Westport and the City of Norwalk. Both municipalities have designated urban areas, 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 as well as to 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).

Figure 7: MS4 areas of the Southwest Shoreline watershed



Publicly Owned Treatment Works

As shown in Figure 7, there are two publicly owned treatment works (POTWs), or wastewater treatment plants, near the Southwest Shoreline watershed, one of which is located in Westport near the impaired segments. The Westport Water Pollution Control Facility (WPCF) (CT0100684) discharges directly to the Saugatuck River as it empties into Long Island Sound, and the plant did not exceed its permit limits on any date sampled (Table 7).

Table 7: Wastewater Treatment Plant fecal coliform (colonies/100 mL) data discharging near the Southwest Shoreline watershed

Town	Permitee	Permit Number	Receiving Water	Date	30-Day Geometric Mean	7-Day Geometric Mean
Westport	Westport WPCF	CT0100684	Indian River	01/31/2009	2	3
Westport	Westport WPCF	CT0100684	Indian River	02/28/2009	1	3
Westport	Westport WPCF	CT0100684	Indian River	03/31/2009	3	4
Westport	Westport WPCF	CT0100684	Indian River	04/30/2009	3	6
Westport	Westport WPCF	CT0100684	Indian River	05/31/2009	3	7
Westport	Westport WPCF	CT0100684	Indian River	06/30/2009	2	4
Westport	Westport WPCF	CT0100684	Indian River	07/31/2009	3	10
Westport	Westport WPCF	CT0100684	Indian River	08/31/2009	6	26
Westport	Westport WPCF	CT0100684	Indian River	09/30/2009	10	35
Westport	Westport WPCF	CT0100684	Indian River	10/31/2009	4	15
Westport	Westport WPCF	CT0100684	Indian River	11/30/2009	3	6
Westport	Westport WPCF	CT0100684	Indian River	12/31/2009	2	4
Westport	Westport WPCF	CT0100684	Indian River	01/31/2010	3	11
Westport	Westport WPCF	CT0100684	Indian River	02/28/2010	4	27
Westport	Westport WPCF	CT0100684	Indian River	03/31/2010	1	3
Westport	Westport WPCF	CT0100684	Indian River	04/30/2010	1	4
Westport	Westport WPCF	CT0100684	Indian River	05/31/2010	4	22
Westport	Westport WPCF	CT0100684	Indian River	06/30/2010	3	15
Westport	Westport WPCF	CT0100684	Indian River	07/31/2010	4	13
Westport	Westport WPCF	CT0100684	Indian River	08/31/2010	3	17
Westport	Westport WPCF	CT0100684	Indian River	09/30/2010	6	37
Westport	Westport WPCF	CT0100684	Indian River	10/31/2010	6	30
Westport	Westport WPCF	CT0100684	Indian River	11/30/2010	3	25
Westport	Westport WPCF	CT0100684	Indian River	12/31/2010	4	7
Westport	Westport WPCF	CT0100684	Indian River	01/31/2011	4	25
Westport	Westport WPCF	CT0100684	Indian River	02/28/2011	2	31
Westport	Westport WPCF	CT0100684	Indian River	03/31/2011	4	8
Westport	Westport WPCF	CT0100684	Indian River	04/30/2011	2	4

Table 7: Wastewater Treatment Plant fecal coliform (colonies/100 mL) data discharging near the Southwest Shoreline watershed (continued)

Town	Permitee	Permit Number	Receiving Water	Date	30-Day Geometric Mean	7-Day Geometric Mean
Westport	Westport WPCF	CT0100684	Indian River	05/31/2011	2	5
Westport	Westport WPCF	CT0100684	Indian River	06/30/2011	2	5
Westport	Westport WPCF	CT0100684	Indian River	07/31/2011	3	15
Westport	Westport WPCF	CT0100684	Indian River	08/31/2011	5	13
Westport	Westport WPCF	CT0100684	Indian River	09/30/2011	4	10
30-Day Geometric Mean Permit Limit = 200 colonies/100 mL **7-Day Geometric Mean Permit Limit = 400 colonies/100 mL**						

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 Southwest Shoreline watershed are described below.

Stormwater Runoff from Developed Areas

Approximately 82% of the watershed is considered urban (Figure 4). 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).

The majority of the Southwest Shoreline watershed has more than 16% impervious surfaces (Figure 8), particularly near the impaired segments (Figure 9). Although Figure 9 shows that the entire watershed has more than 16% impervious surfaces, the portion shown in the map represents a smaller section of the larger coastal watershed whose range of impervious surfaces in shown in Figure 8.

High geometric means for *E. coli* during wet-weather may indicate that stormwater runoff is a source of bacteria to nearby waterbodies. As shown in Tables 10 and 11, the geometric mean during wet-weather at Stations 1546 and 1547 on both segments of the Indian River exceeded the WQS for *E. coli.* As these segments are located in developed portions of the watershed, it is likely that stormwater runoff is a source of bacteria to the Indian River (Figures 4 and 9).

Figure 8: Range of impervious cover (%) in the Southwest Shoreline watershed

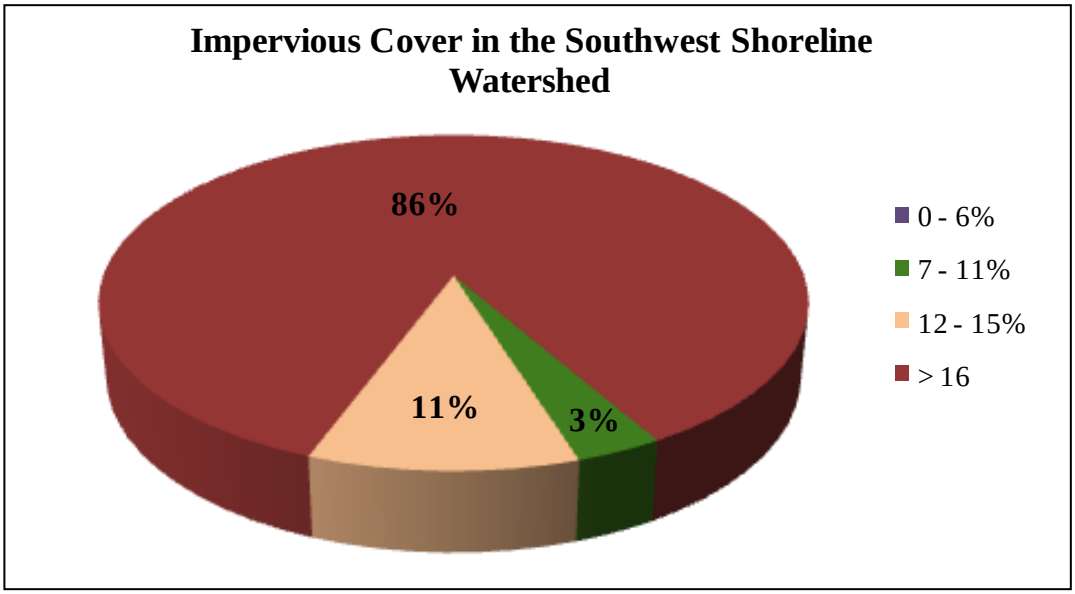
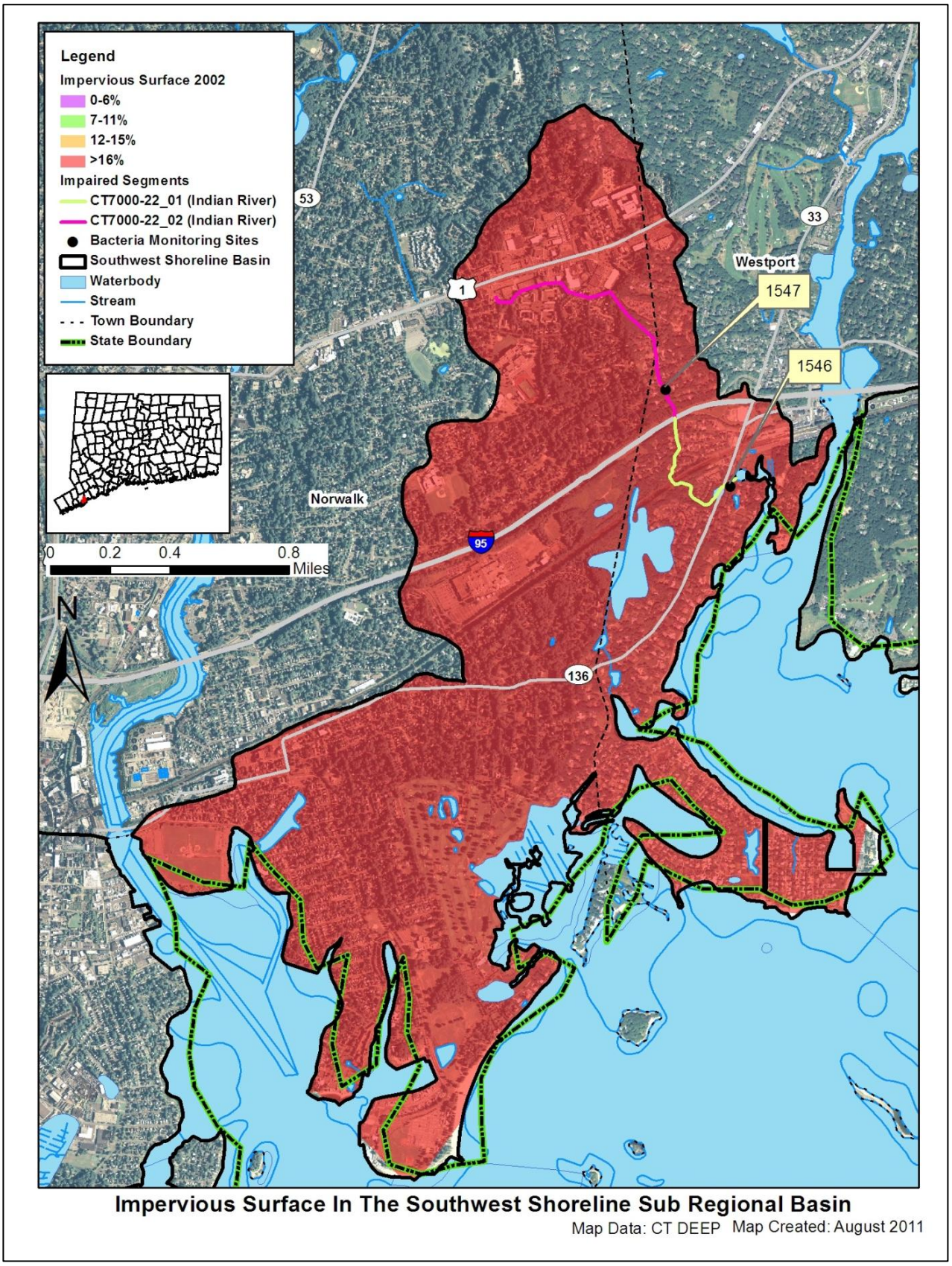


Figure 9: Impervious cover (%) for the Southwest Shoreline sub-regional watershed



Illicit Discharges and Insufficient Septic Systems

As shown in Figure 6, the majority of the Southwest Shoreline watershed, including the area surrounding the Indian River (Segment 2) and a small section near the Indian River (Segment 1), relies on the municipal sanitary sewer system. Sewer system leaks and other illicit discharges can contribute bacteria to nearby surface waters.

A portion of the watershed, particularly near the Indian River (Segment 1), also relies on onsite wastewater treatment systems, such as septic systems. Properly managed septic systems and leach fields have the ability to effectively remove bacteria from waste. If systems are not maintained, waste will not be adequately treated and may result in bacteria reaching nearby surface and ground water. 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 City of Norwalk has a full-time health director (http://www.norwalkct.org/index.aspx?nid=676). Westport does not have a specific health director and is part of the Westport-Weston health district (http://www.wwhd.org/).

High geometric mean values for *E. coli* during dry-weather may indicate that sources such as insufficient septic systems and illicit discharges are contributing bacteria to nearby surface waters. As shown in Table 10, the geometric mean during dry-weather at Station 1546 on the Indian River (Segment 1) exceeds the WQS for *E. coli*. As this portion of the watershed relies on both the sanitary sewer system and septic systems for waste disposal, illicit discharges and insufficient septic systems may be a source of bacteria to this impaired segment of the Indian River.

Wildlife and Domestic Animal Waste

Wildlife and domestic animals within the Southwest Shoreline watershed represent another potential source of bacteria to the impaired waterbodies. Elevated bacteria levels that are due solely to a natural population of wildlife are not subject to the WQS. However, any exacerbation of wildlife population sizes or residency times influenced by human activities are subject to the CT WQS and TMDL provisions.

With the construction of roads and drainage systems, wildlife wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface waterbody. As such these physical land alterations can exacerbate the impact of natural sources on water quality (USEPA, 2001). Although only 12% of the Southwest Shoreline watershed is undeveloped, wildlife waste from these forested or wetland areas are a potential source of bacteria in the watershed. In particular, there is a large wetland near the Norwalk-Westport border just north of Route 136 near Heron Road, east of Norden Systems Heliport, and west of the Indian River (Segment 1). As much of the surrounding area is developed, waterfowl and wildlife may congregate in this undeveloped area. Large numbers of wildlife can cause water quality problems due to bacterial contamination associated with their droppings and can also lead to habitat destruction as a result of overgrazing on wetland and riparian plants.

Much of the residential development in the watershed is located near the Indian River. Waste from domestic animals such as dogs, may also be contributing to bacteria concentrations in these impaired segments in the Southwest Shoreline 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). Though agricultural land use makes up only 1% of the Southwest Shoreline watershed, there are agricultural fields located near Interstate 95 near the Indian River (Segment 1) (Figure 4). Agricultural runoff from these farms and others in the area is a potential source of bacteria to the Indian River (Segment 1).

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 Southwest Shoreline 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

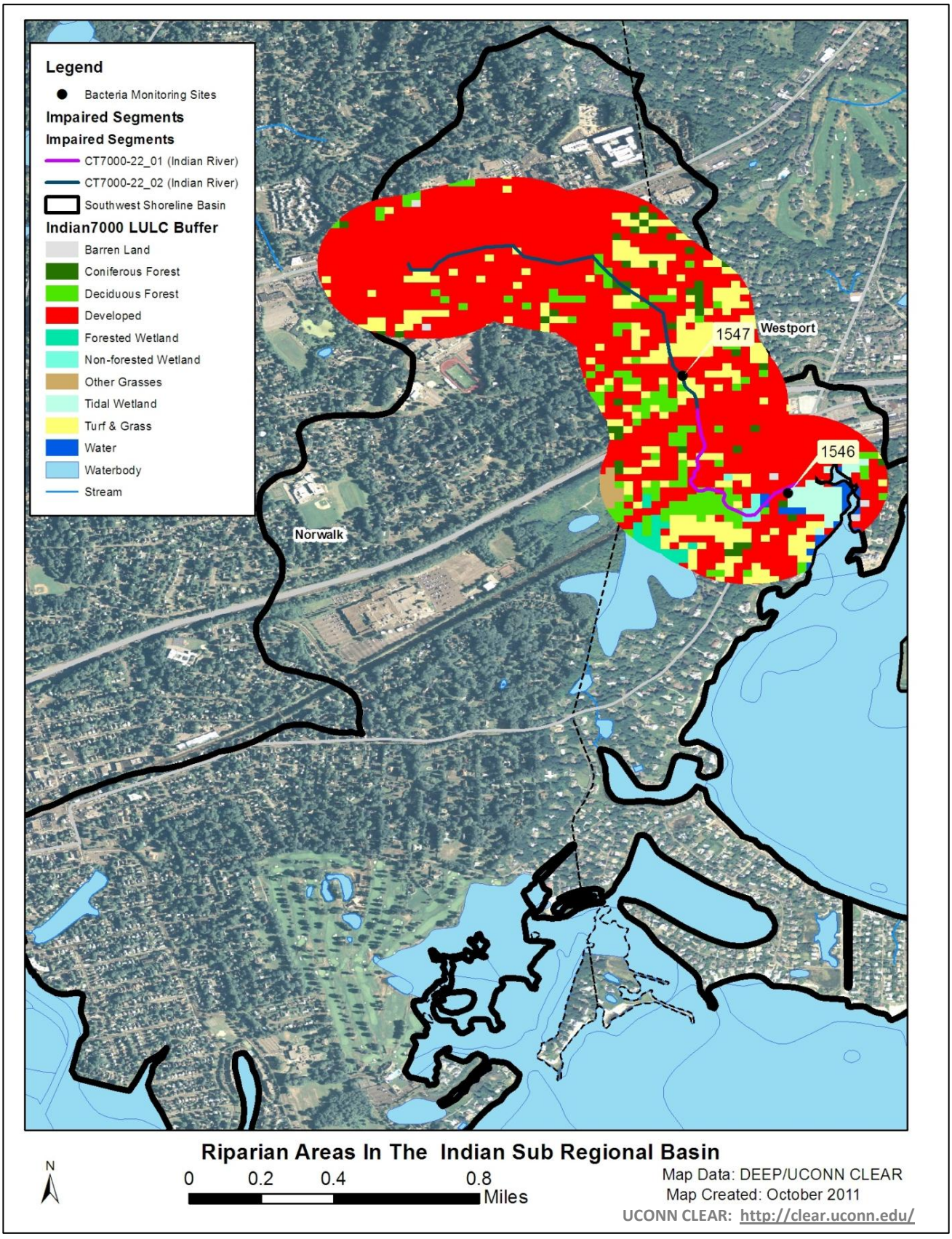
Riparian Buffer Zones

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 riparian zones for the impaired segments of the Indian River are characterized by urban areas (Figure 10). Developed areas within the riparian zone likely contribute pollutants such as bacteria to the waterbody since the natural riparian buffer is not available to treat runoff.

Figure 10: Riparian buffer zone information for the Indian River



CURRENT MANAGEMENT ACTIVITIES

The City of Norwalk and the Town of Westport have developed and implemented programs to protect water quality from bacterial contamination. As indicated previously, Norwalk and Westport 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 the new development and redevelopment.
6. Pollution prevention/good housekeeping for municipal operations.

Each municipality 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 8 and 9.

In addition to the municipal requirements of the MS4 permits, local volunteer groups have also been working to protect the water quality of the Indian River from bacterial contamination. In 2009, Harbor Watch, the water quality testing program run out of Earthplace, The Nature Discovery Center in Westport, organized a river clean-up of the upper and lower portions of the Indian River, including the two impaired segments. Dozens of volunteers removed trash and other debris from the river over a two-day clean-up effort (http://www.earthplace.org/environment/water_quality_news.html).

Table 8: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Norwalk, CT (Permit # GSM000024)

Minimum Measure	Norwalk Annual Report (2007)
Public Outreach and Education	1) Norwalk River Watershed Initiative and the Maritime Aquarium continue to distribute stormwater brochures. 2) Stormwater management information has been added to the City website. 3) Will provide additional stormwater information through a local access channel.
Public Involvement and Participation	1) Sponsored annual DPW Open House for public participation. 2) Providing public education through grant on installation of catch basin filters. 3) Monthly Water Quality Committee meetings open to the public.
Illicit Discharge Detection and Elimination	1) The City has mapped all outfalls greater than 12" on the Norwalk and Silvermine Rivers (75% of outfalls). 2) Developing program to detect and eliminate illicit discharges. 3) Developing illicit discharge ordinance.

Table 8: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Norwalk, CT (Permit # GSM000024) (continued)

Minimum Measure	Norwalk Annual Report (2007)
Construction Site Stormwater Runoff Control	1) Will review its zoning and subdivision regulations pertaining to erosion and sedimentation control and stormwater control measures for all construction activities.
Post Construction Stormwater Management	1) Updated Storm Drainage Manual. 2) Will implement new training program for inspection procedures to ensure conformance to required stormwater management practices.
Pollution Prevention and Good Housekeeping	1) Developed a training program on pollution prevention measures for Public Works and other municipal operations. 2) Continued street sweeping program. 3) Purchased two new vactor trucks. 4) Spent $250,000 to clean catch basins, stormwater pipes and other stormwater structures in the City.

Table 9: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Westport, CT (Permit # GSM000026)

Minimum Measure	Westport Annual Report Update (2010)
Public Outreach and Education	1) Utilizes the town website to post information about the Phase II program. 2) Educational information about the Phase II program is posted on a bulletin board outside the Public Works office.
Public Involvement and Participation	No updates
Illicit Discharge Detection and Elimination	1) Mapped all outfalls 12” and larger.
Construction Site Stormwater Runoff Control	1) Conservation and Zoning enforcement officers have incorporated sediment and erosion control inspections and enforcement into their job responsibilities.
Post Construction Stormwater management	1) Insists all development and redevelopment projects consider water quality in their design.
Pollution Prevention and Good Housekeeping	1) All town-owned streets were swept at least once in 2009. 2) All town-owned catch basins were inspected and cleaned if needed.

RECOMMENDED NEXT STEPS

Norwalk and Westport have developed and implemented programs to protect water quality from bacterial contamination. Future mitigative activities are necessary to ensure the long-term protection of the Indian River and have been prioritized below.

1) Identify areas in the Southwest Shoreline watershed to implement Best Management Practices (BMPs) to control stormwater runoff.

As noted previously, 82% of the Southwest Shoreline watershed is considered urban and the municipalities within the watershed are MS4 communities regulated by the MS4 program. The entire watershed surrounding the impaired segments has an impervious cover greater than 16%, and the impaired segments of the Indian River are located heavily urbanized areas. As such, stormwater runoff is likely contributing bacteria to both segments of Indian River.

To identify specific areas that are contributing bacteria to the impaired segments, Norwalk and Westport should conduct wet-weather sampling at stormwater outfalls that discharge directly to the impaired segments of Indian River. To treat stormwater runoff, Norwalk and Westport should identify areas along the river 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) Continue monitoring of permitted sources.

Previous discharge sampling from permitted sources has shown elevated level 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 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 Southwest Shoreline 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.

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

Most of the Southwest Shoreline watershed relies on a municipal sewer system (Figure 6), including residents near the Indian River (Segment 2). The Towns of Norwalk and Westport have already mapped all outfalls greater than 12" diameter, and Norwalk is developing an illicit discharge detection and elimination program. It is important for Norwalk and Westport to continue to develop and expand their programs to evaluate the sanitary sewer system and reduce leaks and overflows. This program should include periodic inspections of the sewer line.

4) Develop a system to monitor septic systems.

Some residents of the Southwest Shoreline watershed rely on septic systems, including those residents near the Indian River (Segment 1). If not already in place, all municipalities within the watershed 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. Municipalities can also develop programs to assist citizens with the replacement and repair of older and failing systems.

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

Any education and outreach program in the watershed should highlight the importance of not feeding waterfowl and wildlife and managing waste from horses, dogs, and other pets. The towns 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 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 Southwest Shoreline 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.

6) Ensure there are sufficient buffers on agricultural lands in the Southwest Shoreline watershed.

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.

BACTERIA DATA AND PERCENT REDUCTIONS TO MEET THE TMDL

Table 11: Indian River (Segment 1) Bacteria Data

Waterbody ID: CT7000-22_01

Characteristics: Freshwater, Class A, Potential Public Drinking Water Supply, 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: **67%**

Single Sample: **96%**

Data: 2005-2008 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* data (colonies/100 mL) from Station 1546 on the Indian River (Segment 1) with annual geometric means calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1546	Confluence with Saugatuck estuary	5/5/2005	3	dry	153
1546	Confluence with Saugatuck estuary	5/19/2005	100	dry	
1546	Confluence with Saugatuck estuary	6/2/2005	36	dry	
1546	Confluence with Saugatuck estuary	6/16/2005	1230	dry	
1546	Confluence with Saugatuck estuary	7/7/2005	1520	wet	
1546	Confluence with Saugatuck estuary	7/21/2005	640	dry	
1546	Confluence with Saugatuck estuary	5/4/2006	20	wet**	164
1546	Confluence with Saugatuck estuary	5/18/2006	240	dry**	
1546	Confluence with Saugatuck estuary	6/8/2006	1440	wet**	
1546	Confluence with Saugatuck estuary	6/22/2006	560	dry**	
1546	Confluence with Saugatuck estuary	7/6/2006	**9300* (96%)**	wet**	
1546	Confluence with Saugatuck estuary	7/20/2006	800	dry**	
1546	Confluence with Saugatuck estuary	8/10/2006	<1	dry**	
1546	Confluence with Saugatuck estuary	8/24/2006	70	dry**	
1546	Confluence with Saugatuck estuary	9/7/2006	56	dry**	
1546	Confluence with Saugatuck estuary	9/21/2006	124	dry**	

Single sample *E. coli* data (colonies/100 mL) from Station 1546 on the Indian River (Segment 1) with annual geometric means calculated (continued)

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1546	Confluence with Saugatuck estuary	5/10/2007	8	dry**	285
1546	Confluence with Saugatuck estuary	5/31/2007	130	wet**	
1546	Confluence with Saugatuck estuary	6/14/2007	600	dry	
1546	Confluence with Saugatuck estuary	6/28/2007	2100	wet	
1546	Confluence with Saugatuck estuary	7/12/2007	60	wet	
1546	Confluence with Saugatuck estuary	7/26/2007	252	dry	
1546	Confluence with Saugatuck estuary	8/9/2007	2400	wet	
1546	Confluence with Saugatuck estuary	8/23/2007	320	dry	
1546	Confluence with Saugatuck estuary	9/13/2007	1260	dry**	
1546	Confluence with Saugatuck estuary	9/27/2007	184	dry**	
1546	Confluence with Saugatuck estuary	5/8/2008	820	dry**	**385* (67%)**
1546	Confluence with Saugatuck estuary	5/22/2008	288	dry**	
1546	Confluence with Saugatuck estuary	6/12/2008	440	dry**	
1546	Confluence with Saugatuck estuary	6/26/2008	900	dry**	
1546	Confluence with Saugatuck estuary	7/10/2008	240	dry**	
1546	Confluence with Saugatuck estuary	7/31/2008	280	wet**	
1546	Confluence with Saugatuck estuary	8/14/2008	224	dry	
1546	Confluence with Saugatuck estuary	8/28/2008	168	dry	
1546	Confluence with Saugatuck estuary	9/11/2008	340	dry**	
1546	Confluence with Saugatuck estuary	9/25/2008	900	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 *E. coli* geometric mean values (colonies/100 mL) for Station 1546 on the Indian River (Segment 1)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1546	Confluence with Saugatuck estuary	2005-2008	9	27	225	548	167

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: Indian River (Segment 2) Bacteria Data

Waterbody ID: CT700-22_02

Characteristics: Freshwater, Class A, Potential Public Drinking Water Supply, 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: **34%**

Single Sample: **92%**

Data: 2005 - 2008 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* data (colonies/100 mL) from Station 1547 on the Indian River (Segment 2) with annual geometric means calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1547	Hogan Trail (midpoint)	5/5/2005	6	dry	109
1547	Hogan Trail (midpoint)	5/19/2005	56	dry	
1547	Hogan Trail (midpoint)	6/2/2005	40	dry	
1547	Hogan Trail (midpoint)	6/16/2005	710	dry	
1547	Hogan Trail (midpoint)	7/7/2005	660	wet	
1547	Hogan Trail (midpoint)	7/21/2005	260	dry	
1547	Hogan Trail (midpoint)	5/4/2006	150	wet**	124
1547	Hogan Trail (midpoint)	5/18/2006	44	dry**	
1547	Hogan Trail (midpoint)	6/8/2006	300	wet**	
1547	Hogan Trail (midpoint)	6/22/2006	172	dry**	
1547	Hogan Trail (midpoint)	7/6/2006	**2900* (92%)**	wet**	
1547	Hogan Trail (midpoint)	7/20/2006	**2900* (92%)**	dry**	
1547	Hogan Trail (midpoint)	8/10/2006	<1	dry**	
1547	Hogan Trail (midpoint)	8/24/2006	120	dry**	
1547	Hogan Trail (midpoint)	9/7/2006	52	dry**	
1547	Hogan Trail (midpoint)	9/21/2006	48	dry**	

Single sample *E. coli* data (colonies/100 mL) from Station 1547 on the Indian River (Segment 2) with annual geometric means calculated (continued)

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1547	Hogan Trail (midpoint)	5/10/2007	32	dry**	**191* (34%)**
1547	Hogan Trail (midpoint)	5/31/2007	24	wet**	
1547	Hogan Trail (midpoint)	6/14/2007	140	dry	
1547	Hogan Trail (midpoint)	6/28/2007	2500	wet	
1547	Hogan Trail (midpoint)	7/12/2007	660	wet	
1547	Hogan Trail (midpoint)	7/26/2007	104	dry	
1547	Hogan Trail (midpoint)	8/9/2007	580	wet	
1547	Hogan Trail (midpoint)	8/23/2007	140	dry	
1547	Hogan Trail (midpoint)	9/13/2007	280	dry**	
1547	Hogan Trail (midpoint)	9/27/2007	156	dry**	
1547	Hogan Trail (midpoint)	5/8/2008	120	dry**	**191* (34%)**
1547	Hogan Trail (midpoint)	5/22/2008	80	dry**	
1547	Hogan Trail (midpoint)	6/12/2008	116	dry**	
1547	Hogan Trail (midpoint)	6/26/2008	420	dry**	
1547	Hogan Trail (midpoint)	7/10/2008	1020	dry**	
1547	Hogan Trail (midpoint)	7/31/2008	520	wet**	
1547	Hogan Trail (midpoint)	8/14/2008	100	dry	
1547	Hogan Trail (midpoint)	8/28/2008	240	dry	
1547	Hogan Trail (midpoint)	9/11/2008	132	dry**	
1547	Hogan Trail (midpoint)	9/25/2008	84	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 *E. coli* geometric mean values (colonies/100 mL) for Station 1547 on the Indian River (Segment 2)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1547	Hogan Trail (midpoint)	2005-2008	9	27	145	466	98

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

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