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Appendix A

Technical Memorandum 1—Existing Watershed Conditions: Mill River Watershed-Based Plan

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MEMORANDUM

TO: Nicole Davis and Gwen Macdonald, Save the Sound

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DATE: April 9, 2018

RE: **Technical Memorandum 1 – Existing Watershed Conditions**
Mill River Watershed-Based Plan

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1. Introduction

Save the Sound, a program of Connecticut Fund for the Environment (CFE/Save the Sound), the Connecticut Department of Energy and Environmental Protection (CTDEEP), the watershed municipalities, and other key stakeholders are working together to address the water quality issues facing the Mill River and its tributaries by developing a watershed-based plan for the Mill River. Several of these waterbodies have impairments for recreation or aquatic life support due to elevated levels of bacteria and other pollutants. The watershed-based planning process brings together stakeholders from throughout the watershed to identify projects and practices that will satisfy United States Environmental Protection Agency (EPA) and CTDEEP requirements for watershed planning for the Mill River, and in doing so, improve water quality and restore conditions in the watershed. The watershed-based plan is funded in part by the CTDEEP through an EPA Clean Water Act Section 319 Nonpoint Source grant and utilizes the EPA's nine-element process.

An initial step in developing the watershed-based plan is to document water quality conditions and other watershed characteristics that are relevant to the water quality impairments in the watershed. This technical memorandum provides an overview of relevant watershed conditions based on a review of existing water quality data, mapping, and prior studies and planning efforts for the Mill River watershed.

2. Existing Plans and Studies

The Mill River has been the focus of numerous prior studies, planning efforts, and projects, which are documented by a large and diverse collection of existing reports, from formal water quality assessments, to University-sponsored research, to advocacy reports. Information from many of these documents, which are summarized in **Table 1** beginning with the most recent documents, has been incorporated into this technical memorandum.

Table 1. Existing Documentation Related to the Mill River

Document/Information Source	Author (Date)	Notes
Public Information Meeting Presentation: New Haven CSO Long Term Control Plan	City of New Haven and GNHWPCA (2017)	Public update on the Long Term Control Plan for CSOs in New Haven, as well as rainfall conditions modeling.
Greater New Haven Water Pollution Control Authority Consent Order WC5509 Annual Progress Report: July 1, 2016- June 30, 2017	GHNWPCA (2017)	Provides updated sewer system mapping, status of all CSOs, and metering data for CSOs during the reporting period.
2016 Connecticut Integrated Water Quality Report	CTDEEP (2016)	Identifies waterbody segments that are classified as impaired relative to aquatic life, recreation, or shellfish.
Lower Mill River Water Quality Monitoring Reports	RWA (2000-2016)	Weekly, warm season measurement data for salinity and dissolved oxygen at the plunge pool, spillway, and footbridge sites.
New Haven Vision 2025: Chapter VII: Environment	City of New Haven (2015)	Chapter of the New Haven comprehensive plan dealing with environmental issues. Addresses water quality in Long Island Sound, sewage, and stormwater issues.
Connecticut Watershed Response Plan for Impervious Cover: Core Document	CTDEEP (2015)	Provides background information on the effects of stormwater on water quality, identifies 12% as a critical impervious cover threshold.
Connecticut Watershed Response Plan for Impervious Cover: Appendix 6-9—Mill River (CT5302) Summary	CTDEEP (2015)	Provides specific information on impaired segments, extant impervious cover and target reduction
New Haven Vision 2025: Status of Sewer Separation Map	GHNWPCA (2015)	Indicates area where separation of sanitary and stormwater sewers has been completed, is under construction, or under design.
Urban River Permits Review and Advocacy Recommendations for the Quinnipiac, Mill, and West Rivers	Mushinsky, M. (2015)	Report produced in conjunction with the Mill River Watershed Association of South Central Connecticut and River Advocates of South Central Connecticut. Descriptions of the three rivers in the New Haven area, water quality pollutants, relevant permits affecting water quality, and advocacy recommendations.
Public Meeting Presentation	RWA (2015)	Update on the Lake Whitney management plan and monitoring efforts.
2014 Connecticut Integrated Water Quality Report	CTDEEP (2014)	Identifies waterbody segments that are classified as impaired relative to aquatic life, recreation, or shellfish.
WUCC Report to the Commissioner	Connecticut Department of Public Health (2014)	Details recommendations for proposed alteration of the boundaries of Connecticut Public Water Supply Management Areas.
Connecticut Statewide Total Maximum Daily Load (TMDL)for Bacteria-Impaired Waters: Core Document	CTDEEP (2012)	Provides documentation for the impaired waters listing status and need for a TMDL, water quality targets, and estimated percent reductions needed to attain water quality targets.
Connecticut Statewide TMDL for Bacteria-Impaired Waters: Appendix 57—Mill River Watershed Summary	CTDEEP (2012)	Provides specific information on impaired segments, potential bacteria sources, current management activities, and recommendations for impaired segments in the Mill River subregional basin.

Table 1. Existing Documentation Related to the Mill River (continued)

Document/Information Source	Author (Date)	Notes
Drinking Water Assessment and Source Protection Program	Connecticut Department of Public Health (2012)	Statewide assessment results and source water areas for public drinking water supply systems. Potential contaminant sources impacting surface or groundwater are discussed.
Mill River Freshwater Tidal Marshes: 2011 Vegetation Monitoring	Sharp, P.; prepared for RWA (2012)	Summarizes vegetation monitoring efforts from 2000-2011.
Management Plan for Lake Whitney Water Treatment Plant: Revised April 2, 2012	RWA (2012)	Recommended performance standards and mitigation/monitoring measures for the operation of Lake Whitney as a public water supply.
2000-2011 Lower Mill River Invertebrate Monitoring Report	Water Resource Services; prepared for RWA (2012)	Summarizes macroinvertebrate data for the Lower Mill River.
A Biological Assessment of Upper Lake Whitney	AECOM; prepared for RWA (2010)	Summarizes biological assessments conducted from 2004 to 2009, including studies of plankton, aquatic macrophytes, benthic macroinvertebrates, fish, and water quality.
Effectiveness of Stormwater Treatment Systems Within a Highly Urbanized Watershed	Hudak, J.P., and M.E. Ellum (2003)	Report on a stormwater treatment system designed to treat a 20-acre watershed in the vicinity of Lake Whitney.
Summary of Upper Lake Whitney Management Study: January 23, 2002	Milone & MacBroom (2002)	Summarizes monitoring efforts by the RWA to collect baseline and continuing data on Lake Whitney in conjunction with the reestablishment of the lake as a public water supply.
Polycyclic Aromatic Hydrocarbons (PAHs) in the Sediments and Fish of the Mill River, New Haven, Connecticut, USA	White, J.C. and T. Triplett (2002)	Investigation of PAHs in the segment of the Mill River from Lake Whitney to the tidegates, where the most intense use for fishing and recreation occurs.
Baseline Description of the Lower Mill River Benthos	Mador, M., A. Saar, and M. Funaro (2001)	Baseline description of watershed contributions to the health of the river, local threats and potential future issues related to ecological health. Aquatic chemistry course project from Prof. Gabe Benoit's course at Yale School of Forestry.
Environmental Evaluation: Whitney Environmental Study Team Recommendations	Hudak, J.P., S.R. Kellert, J.T. Maughan, J.L. Rogers, and P.C. Sharp (1999)	Summary of recommendations from the Lake Whitney Water Treatment Plant Environmental Evaluation, including minimum spillway flow, minimum flow releases, dissolved oxygen, spring flood releases, and ongoing ecological monitoring.
The Lake Whitney Urban Runoff Project Final Report	Hudak, J.P. (1996)	Report on planning, construction, and monitoring of a stormwater treatment system designed to address runoff from an urban outfall pipe in the vicinity of Lake Whitney.
Lake Whitney Reservoir Urban Runoff Treatment Project Phase II	New Haven County Soil and Water Conservation District (1995)	A review of existing regulations relating to watershed protection and/or water quality.

Table 1. Existing Documentation Related to the Mill River (continued)

Document/Information Source	Author (Date)	Notes
Phosphorus Transport in the Mill River, New Haven County, Connecticut	Perkins, E.J. (1993)	Yale University study of processes affecting phosphorus transport in the Mill River.
Lake Whitney Stormwater Treatment Systems Map	RWA (n.d.)	Map showing locations of stormwater treatment systems in the vicinity of Lake Whitney.
Lake Whitney Project Mill River Subbasins	Unknown (n.d.)	Prioritization of subbasins for urban runoff, subwatershed descriptions, and historic outfall mapping.

3. Watershed Description

The Mill River watershed consists of two subregional basins: Mill River Subregional Basin (#5302) and Willow Brook Subregional Basin (#5301). Each subregional basin contains 7 local basins of varying size (**Figure 1**). The watershed covers an area of approximately 38 square miles (24,584 acres) in the municipalities of Bethany, Prospect, Cheshire, Hamden, North Haven, Wallingford, and New Haven, in New Haven County (**Figure 2**; **Table 2**). The upper watershed is generally rural or suburban in nature, with development intensity increasing at the southern end of the watershed and in the vicinity of the mouth of the river. Population density ranges from 262 people per square mile in Bethany to 6,992 people per square mile in New Haven. Cheshire and Hamden, which together make up 83% of the watershed area, have population densities of 885 and 1,884 people per square mile, respectively.

Table 2. Distribution of Municipalities in the Mill River Watershed

Municipality	Total Acreage of Municipality	Acreage in Watershed	% of Municipality in Watershed	% of Watershed	Population Density (people/sq.mi.)
Bethany	13,690	128	0.9	0.5	262
Cheshire	21,165	7,377	34.9	30.0	885
Hamden	21,278	13,117	61.6	53.4	1,884
New Haven	12,288	1,179	9.6	4.8	6,992
North Haven	13,510	835	6.2	3.4	1,149
Prospect	9,238	799	8.7	3.3	680
Wallingford	25,821	1,149	4.5	4.7	1,155
Watershed (total)	**116,990**	**24,585**	**N/A**	**100.0**	**1,723**

The main stem of the Mill River itself is approximately 12.6 miles long, winding from its northern headwaters in Cheshire, south to Long Island Sound, passing through an approximately 0.068 mi^2 estuary region of tidal influence, before ultimately flowing into New Haven Harbor. The largest tributary to the Mill River is Willow Brook, which drains an approximately 13 square-mile area before joining the Mill River in Hamden. Shepard Brook, Butterworth Brook, Jepp Brook, Eatons

Brook, and Brooksvale Stream are additional major tributaries. Numerous smaller streams complete the network of waterbodies draining through the Mill River to New Haven Harbor. Major surface waterbodies in the watershed include Lake Whitney, Turners Pond, and Jepp Pond. Other major landmarks in the watershed include Sleeping Giant State Park, East Rock Park, Naugatuck State Forest, and Quinnipiac University.

4. Water Quality

In compliance with section 305(b) of the Federal Clean Water Act, the state of Connecticut submits a water quality report to the EPA every two years. That report lists waterbody segments and denotes whether they have met water quality standards for certain designated uses, including aquatic life use support, recreation, and shellfish harvesting. Six river segments and one estuary segment within the Mill River Watershed were identified in the 2016 Integrated Water Quality Report (IWQR). Of these, four river segments and the estuary are impaired for at least one use category (**Figure 3**). Two additional segments within the watershed were included in the 2014 IWQR as fully supporting or not assessed but were not reported in the 2016 update.

- **Sanford Brook:** Sanford Brook segment CT5301-02_01 ("Sanford Brook (Cheshire)-01") is 2.68 miles long and extends from its mouth at the confluence with Willow Brook downstream of South Brooksvale Road in Cheshire, upstream to the headwaters (just upstream of Candee Road) in Prospect. It is fully supporting of both aquatic life and recreation.

- **Willow Brook:** Willow Brook segment CT5301-00_01 ("Willow Brook (Hamden)-01") is 1.87 miles long and extends from its mouth at the confluence with the Mill River downstream of the Willow Street crossing in Hamden, upstream to the confluence with Brooksvale Stream in Cheshire, traveling along the railroad tracks. It is impaired for recreation and is not assessed for aquatic life. Willow Brook segment CT5302-00_02 ("Willow Brook (Hamden)-02") is 3.84 miles long and extends from its confluence with Brooksvale Stream to the headwaters near Timber Lane, in Cheshire. The segment was included in the 2014 IWQR as not assessed for aquatic life and having insufficient information for recreation; it was not included in the 2016 IWQR.

- **Shepard Brook:** Shepard Brook segment CT5302-06_01 ("Shepard Brook (Hamden)-01") is 1.78 miles long and extends from its mouth at the confluence with the Mill River just downstream of Route 15, includes Turners Pond, and continues upstream to the confluence with an unnamed tributary behind the business park off Sherman Avenue and Town Walk Drive. The segment is not assessed for aquatic life and is impaired for recreation.

- **Mill River:** Mill River segment CT5302-00_01 ("Mill River (Hamden)-01") is 0.41 miles long and extends from the footbridge crossing to the Lake Whitney outlet dam, in Hamden. The segment is tidally affected freshwater, and is fully supporting of both aquatic life and recreation uses. Mill River segment CT5302-00_02 ("Mill River(Hamden/Cheshire)-02") is 9.06 miles long and extends from the inlet to Lake Whitney on the east side of Route 15, just downstream of Connolly Parkway in Hamden, to the Cook Hill Road crossing in Cheshire. The segment is impaired for both recreation and aquatic life. Mill River segment

CT5302-00_03 ("Mill River (Cheshire)-03") is 3.09 miles long and extends from the Cook Hill Road crossing to the headwaters, just upstream of Williamsburg Drive. The segment is impaired for aquatic life; there is insufficient information to assess recreation impairments.

- **Lake Whitney:** The Lake Whitney segment CT5302-00-4-L3_01 ("Whitney, Lake (Hamden)") is reported in the 2014 IWQR but not included in the 2016 report. The Lake, which is an impoundment of the Mill River, covers 140.42 acres and was denoted in the 2014 IWQR as fully supporting for aquatic life and unassessed for recreation.

- **Inner-Mill River Estuary:** The estuary segment CT-C1_023-SB (identified in the IWQR as "LIS CB Inner-Mill River (mouth), New Haven/Hamden") covers 0.068 mi^2, extending northward from the mouth of the Mill River at its confluence with the Quinnipiac River in New Haven to the footbridge crossing just upstream of East Rock Road in Hamden. The estuary segment is impaired for recreation, aquatic life, and shellfish.

Further details of the impaired waterbody segments within the watershed, including causes of impairment, are included in **Table 3**.

Bacteria Impairments

CTDEEP completed a "Statewide Bacteria Total Maximum Daily Load" (TMDL) for 176 impaired waterbody segments based on the 2010 Impaired Waters List (CTDEEP, 2012). The TMDL sets target pollution levels and establishes a framework for restoring water quality of the impaired segments. Only two of the bacteria impaired segments listed above are included in the approved TMDL (Mill River-02 and Shepard Brook). This is because several of the waterbody segments in the Mill River watershed that are now classified as impaired were assessed more recently than 2010. However, like the segments listed in the TMDL, the Willow Brook segment (Willow Brook-01) is also

Table 3. Impaired Waterbody Segments in the Mill River Watershed

Impaired Segment	Impaired Designated Use	Cause	TMDL Status
CT-C1_023-SB LIS CB Inner-Mill River (mouth), New Haven/Hampden	Habitat for Marine Fish Aquatic Life Recreation Commercial Shellfish Harvesting	DO saturation Enterococcus Fecal coliform	Listed as category 5: TMDL required
CT5302-00_02 Mill River (Hamden/Cheshire)-02	Recreation Aquatic Life	*E. coli* Flow alterations	Included in Statewide Bacteria TMDL approved 2012
CT5302-00_03 Mill River (Cheshire)-03	Fish Habitat Aquatic Life	Unknown Flow alterations	Listed as category 5: TMDL required
CT5302-06_01 Shepard Brook (Hamden)-01	Recreation	*E. coli*	Included in Statewide Bacteria TMDL approved 2012
CT5301-00_01 Willow Brook (Hamden)-01	Recreation	*E. coli*	Listed as category 5: TMDL required; Proposed for action plan development in 2017

impaired for recreation due to *E. coli,* and the Inner-Mill River Estuary is impaired for recreation due to Enterococcus and fecal coliform. Based on the 2010 data included in the TMDL, the Mill River-02 segment requires a 77% reduction in geometric mean indicator bacteria (*E. coli*) levels and a 94% single sample *E. coli* reduction in order to meet the TMDL. For the Shepard Brook segment, the required percent reductions are 77% and 71%, respectively.

Potential sources of indicator bacteria identified in the TMDL include point sources, such as permitted discharges from Municipal Separate Storm Sewer Systems (MS4s), combined sewer overflows (CSOs), and industrial and commercial facilities. Additional non-point sources include stormwater runoff, failing septic systems, agricultural activities, and wastes from wildlife and pets. Stormwater discharges to MS4s and illicit discharges are two of the primary targets identified in the Statewide Bacteria TMDL for pollution reduction of freshwater segments. The TMDL also recommends removal of CSOs in New Haven for bacteria reduction in the New Haven estuaries.

Water Quality Monitoring

CTDEEP routinely monitors ambient water quality, macroinvertebrate diversity, and fisheries at various locations within the watershed (**Table 4; Figure 3**). Many of these data are ultimately incorporated into the biannual IWQRs and TMDLs. Additional water quality and biological monitoring took place in the Lake Whitney portion of the watershed in conjunction with the planning and eventual opening of the new Lake Whitney Water Treatment Plant, which opened in April, 2005 (discussed in more detail below; **Table 5**). Other studies (some published, some unpublished) have been conducted in association with local organizations or academic institutions that focus on specific water quality issues, such as polycyclic aromatic hydrocarbons in Mill River sediments and fish (J.C. White, 2002), phosphorus transport, and aquatic chemistry.

Table 4. CTDEEP Water Quality Monitoring Stations

Ambient Water Quality Station ID	TMDL Station ID	Waterbody	Location
15271	5410	Mill River	At Whitney road exit at park and ride
14301	176	Mill River	Downstream of Dixwell Avenue
15013	923	Mill River	First pull-off downstream of Tuttle Road
14300	175	Mill River	Upstream of Tuttle Road
16413		Mill River	Adjacent to Route 22
16851		Mill River	400 m Downstream of Clark's Pond
17611	6180	Shepard Brook	Route 10
15986		Sanford Brook	Near Mountaincrest Drive
15855		Willow Brook	Willow Street

Impervious Cover Response Plan

The Mill River headwaters segment (CT5302-00_03) has been designated as impaired for aquatic life and fish habitat, but the cause of the impairment is unknown. This segment has been included in the *Connecticut Watershed Response Plan for Impervious Cover* (IC Response Plan) (CTDEEP, 2015), along with 15 other streams that are also impaired for aquatic life but have no known cause for the impairment. The IC Response Plan uses impervious cover as a surrogate for the suite of potential pollution sources carried by stormwater runoff, and sets a target of 11% impervious cover. The target is not a required reduction or a regulatory limit, but is meant to guide best

management practices (BMPs) and low impact development (LID) within the impaired drainage areas. The current impervious cover of the watershed area corresponding to the impaired segment is 15%; meeting the target would therefore require a 27% reduction in impervious cover (CTDEEP, 2015).

Table 5. South Central Connecticut Regional Water Authority (RWA) Monitoring Studies of Lake Whitney

Monitoring Type	Monitoring Dates/Frequency	Parameters	Main Findings
Dissolved Oxygen and Salinity	2000-present. Weekly, July to September at plunge pool, spillway, and footbridge	Dissolved oxygen Salinity	DO studies by the Authority have established a DO target level of 7 mg/L in the plunge pool when there is no flow over the spillway from Lake Whitney to the Mill River
Biological Assessment of Upper Lake Whitney	2005-2009 Annually, in June	Phytoplankton Zooplankton Aquatic macrophytes Benthic macroinvertebrates Fish Water quality	11-14 taxa of macroinvertebrates detected per year across study. Fish are dominated by planktivores (perch, shiners) and detritivores (carp), with some bass, etc. Only rooted plants exhibit more than temporary impact of drawdowns.
Benthic Biological Assessment of Lower Mill River	2000-2009 Two dates in summer (typically June and August)	Water temp Dissolved oxygen Specific conductivity Turbidity pH Flow Habitat characterization	Percentage of observations with "fairly significant" and "significant" organic pollution generally ranged from 75%-100%, though in 2009 it was only 25%.
Mill River Freshwater Tidal Marsh Vegetation Monitoring	2000-2011	Precipitation Soil Conditions Groundwater Salinity	Data indicate gradual changes are taking place primarily due to natural phenomena.
Lower Mill River Invertebrate Monitoring	2000-2011	Macroinvertebrates	Generally indicates intermediate stream community health.

5. Watershed Land Cover and Land Use

Land Cover

The distribution of land cover (physical land type) and land use (how people are making use of land) within the watershed plays an important role in shaping spatial patterns and sources of nonpoint source pollution and surface water quality. Impervious cover, in particular, is central to determining rates and volume of stormwater runoff, which is often a key contributing factor to water quality impairments.

The National Land Cover Database (NLCD) provides Landsat-based, 30-meter resolution land cover data for the entire nation. The most recent national data, which are presented here, are from 2011. The University of Connecticut Center for Land Use Education and Research (UConn CLEAR) provides a more recent dataset (2015), but the NLCD data are preferred as they disaggregate developed land into more precise categories based on density of development, and provide more detailed divisions for agricultural land and other habitat types (**Figure 4**).

Table 6. Distribution of Land Cover Types by Acres and Percent (NLCD 2011)

Acres				Percent		
Willow Brook Subregional Basin	**Mill River Subregional Basin**	**Entire Watershed**	**Land Cover**	**Willow Brook Subregional Basin**	**Mill River Subregional Basin**	**Entire Watershed**
23	277	300	**Open Water**	0.3	1.7	1.2
1,166	3,314	4,480	**Developed, Open Space**	14.1	20.4	18.3
1,008	2,946	3,954	**Developed, Low Density**	12.2	18.1	16.1
318	2,194	2,512	**Developed, Medium Density**	3.8	13.5	10.2
41	641	683	**Developed, High Density**	0.5	3.9	2.8
3.3	7.8	11	**Barren**	0.0	0.0	0.0
4,775	5,495	10,270	**Deciduous Forest**	57.7	33.8	41.9
81	300	381	**Coniferous Forest**	1.0	1.8	1.6
45	130	176	**Mixed Forest**	0.5	0.8	0.7
118	122	240	**Shrub/Scrub**	1.4	0.7	1.0
45	213	258	**Herbaceous**	0.5	1.3	1.1
153	175	328	**Pasture/Hay**	1.9	1.1	1.3
5.3	0.0	5	**Cropland**	0.1	0.0	0.0
481	431	912	**Woody Wetland**	5.8	2.6	3.7
7	19	26	**Emergent Herbaceous Wetland**	0.1	0.1	0.1
8,271	16,265	24,536	**Total**	100.0	100.0	100.0

Based on NLCD data, approximately 47% of the watershed falls into one of the four developed land categories (**Table 6**), while 41.9% is deciduous forest land. At 55.9% developed land and 33.8% forest, the Mill River subregional basin is substantially more developed than the Willow Brook subregional basin, which has 30.6% developed land and 57.7% deciduous forest cover. This is consistent with the trend noted above, that highly developed areas are concentrated to a large degree at the southern end of the watershed, while the northern portion of the watershed is generally less developed. This pattern is even more pronounced for land cover in the riparian zone (**Figure 5**). Vegetated riparian buffers can slow stormwater runoff, and trap sediment and other pollutants. On the other hand, riparian lands that are developed and lack a dense stand of vegetation may be especially vulnerable to water quality issues.

Land Use

Whereas land cover categorizes the physical landscape, land use refers to the way that humans are utilizing the land and focuses on five primary categories (commercial/mixed use, industrial,

institutional, residential, open space) in addition to an 'other' category. Land use data were obtained from both the South Central Regional Council of Governments (SCRCOG) and the Naugatuck Valley Council of Governments (NVCOG). SCRCOG last updated their land use data in 2016; NVCOG last revised their data in 2017.

Residential use dominates land use across the entire watershed, comprising slightly more than half of all land use in both subregional basins (**Table 7; Figure 6**). Open space is the next largest category in both watersheds, but makes up nearly 1/3 of land use in the Willow Brook subregional basin compared with only 18% in the Mill River subregional basin. Commercial, industrial, and institutional uses make up a small proportion of land use in both subregional basins, but are more concentrated in the Mill River subregional basin, and tend to cluster at the southern-most end of the watershed, in New Haven.

Table 7. Distribution of Land Use Types by Acres and Percent (NVCOG 2017, SCRCOG 2016)

Acres				Percent		
Mill River Subregional Basin	**Willow Brook Subregional Basin**	**Entire Watershed**	**Land Use**	**Mill River Subregional Basin**	**Willow Brook Subregional Basin**	**Entire Watershed**
810	160	971	**Commercial & Mixed Use**	5.1	1.9	4.0
416	25	442	**Industrial**	2.6	0.3	1.8
1,101	303	1,405	**Institutional**	6.9	3.7	5.8
2,938	2,640	5,578	**Open Space**	18.5	32.1	23.1
1,289	694	1,984	**Other**	8.1	8.4	8.2
9,367	4,413	13,781	**Residential**	58.8	53.6	57.0
15,923	8,237	24,160	**Total**	100.0	100.0	100.0

Historic Land Use

In general, commercial/industrial land use in the watershed is a potential source of bacteria and other pollutants. As indicated in the TMDL, there are approximately 11 permitted commercial and industrial facilities in the Mill River watershed. Historic industrial land uses continue to affect the Mill River watershed through legacy contamination. One such historic site is English Station, a closed power plant located on Ball Island, near the mouth of the Mill River. Occupying nearly 9 acres, the site is known to be widely contaminated with polychlorinated biphenyls (PCBs) and other hazardous contaminants. Excavation on the site in 1997 resulted in a documented release of PCBs into the Mill River (CTDEEP, 2016) and a 2005 report noted that PCBs were present in concentrations thirty times the industrial direct exposure criteria (CTDEEP, 2016). Early stages of remediation for English Station are currently underway.

There are also known petroleum, metal, and PCB impacts to the river in the vicinity of 470 James Street due to legacy contamination from the former trolley garage (later a state bus garage), related underground storage tanks and fueling system releases. Erosion of polluted urban fill at the site has impacted sediment and water quality in the Mill River. Conceptual planning for remediation and restoration of the site is in progress.

Impervious Cover

Impervious cover (IC) refers to any surface which prevents natural infiltration of stormwater into the soil, most notably buildings and pavement. As stormwater travels across impervious surfaces, rather than sinking into the ground, it picks up pollutants (e.g. oils, sediment) from the surface and transports these materials as part of the stormwater discharge. If not treated before the stormwater drains into a waterbody, these pollutants can become a major contributor to waterbody impairments. Extensive research has documented the effects of urbanization on stream and watershed health, including studies by CTDEEP that have documented a negative relationship between upstream impervious cover and aquatic life in adjacent waters, with predictable detrimental impacts to aquatic life when impervious cover exceeds 12% (CTDEEP, 2015).

In 2017, UConn CLEAR analyzed 2012 aerial imagery to estimate the amount of total impervious cover in each local basin (**Figure 7; Table 8**). As a whole, the Mill River watershed has 17.2% impervious cover. At 10.2%, total impervious cover in the Willow Brook subregional basin is below the 12% threshold; the Mill River subregional basin, however, has total impervious cover of 20.8%. At the local basin scale, 6 of the 14 local basins across the entire watershed exceed the 12% threshold. The highest impervious cover in the watershed is found in the local basin that contains the main stem of the Mill River, where overall IC was 27.3%. This high percentage of IC is driven by particularly dense development in New Haven and in areas adjacent to the main stem. The local basin that contains Shepard Brook is similarly affected, with 21.2% impervious cover. Unsurprisingly, local basins that are predominantly rural and/or are less-developed tend to have impervious cover below 10%.

Table 8. Distribution of Impervious Cover by Acres and Percent (UConn CLEAR 2012)

Acres				Percent		
Willow Brook Subregional Basin	**Mill River Subregional Basin**	**Entire Watershed**	**Impervious Surface Type**	**Willow Brook Subregional Basin**	**Mill River Subregional Basin**	**Entire Watershed**
239	975	1,214	**Building**	2.9	6.0	4.9
365	1,523	1,889	**Other***	4.4	9.4	7.7
245	890	1,135	**Road**	2.9	5.5	4.6
849	**3,389**	**4,238**	**Total**	**10.2**	**20.8**	**17.2**

*Includes parking lots, sidewalks, driveways, patios, swimming pools, and decks.

Open Space

Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious cover, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as farmland preservation, community preservation, and passive recreation. Open space is also important as habitat for native and migratory species and protection of public water supply. Open space includes preserved natural areas as well as lightly developed parks, playgrounds, and cemeteries.

An initial assessment of active and passive open space areas in the Mill River watershed was identified based on GIS information provided by NVCOG (data updated in 2017) in addition to data

compiled and published by CTDEEP in 2015, including federal land, state-owned property, and other municipal and privately-owned open space. **Figure 8** shows open space land in the Mill River watershed and identifies major open space parcels. The largest open space land includes:

- Sleeping Giant State Park (1,615 acres)
- Regional Water Authority land (1,087 acres)
- Naugatuck State Forest (746 acres)
- Farmington Canal Heritage Trail (18.1 miles of linear trail)
- East Rock Park (425 acres)
- DeDominicis Property (200 acres)
- Puchalski Property (103 acres)
- Roaring Brook (87 acres)
- Hamden Fish and Game Protection Association (85.6 acres)
- Bens Homestead (63.4 acres)
- Brooksvale Farm Preserve (48 acres)

6. Physical Characteristics of the Watershed

Geology and Soils

Typical of coastal watersheds in Connecticut, the topography of the Mill River watershed is quite variable, encompassing flat plains along the coast and estuaries, with a mixture of rolling hills and steep slopes to the north. The surficial geology of the watershed has been shaped by glaciation and is a major factor shaping topography, soils, and drainage characteristics within the watershed. The Mill River runs along the historic path of a glacial meltwater stream; surficial geology along its channel is thus characterized by sand and gravel deposits.

To the east and west of the Mill River, the landscape rises and is characterized by thick glacial till (unsorted glacial deposits). On the east side of the watershed, Sleeping Giant State Park encompasses Mt. Carmel, a large drumlin with a maximum elevation of approximately 730 feet. The western slope of Mt. Carmel drains to the Mill River, while the eastern slope drains toward the Quinnipiac River. Mt. Sanford sits on the western edge of the Mill River watershed, within the Willow Brook subregional basin. At approximately 880 feet, Mt. Sanford is the highest point in the watershed; its northern and eastern slopes drain toward Willow Brook and eventually flow into the Mill River, while the southwestern slope drains toward the West River. A ridge runs northward from Mt. Sanford, forming much of the western edge of the watershed.

The City of New Haven is located on a plain at the southernmost tip of the watershed, where the Mill River meets the Quinnipiac River, New Haven Harbor, and then Long Island Sound. Much of the shoreline in this area has been reclaimed from the Sound and consists of artificial fill. The rest is glacial outwash consisting of sands and gravels over fine silts and clays.

The Natural Resources Conservation Service (NRCS) classifies soils into Hydrologic Soil Groups (HSG) that characterize a soil's runoff versus infiltration potential after prolonged wetting (**Figure 9**). Group A soils are the most well drained, meaning that they have low runoff potential and high infiltration potential. At the other extreme, Group D soils are the most poorly drained. Water movement through Group D soils is restricted, causing them to have high runoff potential and low

infiltration potential. Group D soils are frequently either high in clay content or shallow soils over an impermeable layer (such as shallow bedrock or a dense glacial till) or a shallow water table. Group B and C soils complete the continuum between these extremes. Group B soils have moderately low runoff potential and unimpeded water transmission through the soil, while group C soils have moderately high runoff potential and are somewhat restrictive of water movement.

Within the Mill River watershed, areas of poor infiltration potential characterized by Group D soils include Mt. Carmel, Mt. Sanford, the ridge that runs along the northwestern edge of the watershed, and significant portions of New Haven. Approximately 46% of the watershed is characterized as either Group C or Group D soils, indicating moderately high to high runoff potential, and relatively limited infiltration potential. 52% of the watershed as a whole consists of areas with Group A & B soils, which have greater infiltration potential and are generally more conducive to infiltration-based Low Impact development (LID) and green stormwater infrastructure practices. The Willow Brook subregional basin has a greater percentage of Group A & B soils than does the Mill River subregional basin (59% as compared to 48%, respectively), and is thus expected to have somewhat better infiltration potential than the Mill River subregional basin(**Table 9**). Additionally, some of the areas of Group A & B soils in the Mill River subregional basin coincide with areas of dense development, which makes these areas potential targets for urban stormwater retrofits.

Table 9. Distribution of Hydrologic Soil Groups

HSG	Mill River Subregional Basin (Acres)	Willow Brook Subregional Basin (Acre)	Grand Total (Acres)	% of Watershed
A	1,859	1,054	2,913	11.9
B	6,030	3,849	9,878	40.2
C	3,638	1,412	5,051	20.5
D	4,413	1,940	6,353	25.8
Water	346	44	390	1.6
Total	**16,286**	**8,299**	**24,585**	**100.0**

Wetlands

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and plant and animal communities living in the soil and on its surface. Wetlands can vary widely in type and characteristics, but are an important feature of a watershed, providing water quality benefits by removing pollutants and mitigating flooding. The extent and distribution of wetlands in the Mill River watershed are shown in **Figure 10.** Wetlands make up approximately 12% of the watershed overall. 7.4% of the Mill River subregional basin consists of poorly drained and very poorly drained soils, with an additional 3.1% alluvial and floodplain soils. The Willow Brook subregional basin has a somewhat higher percentage of poorly drained and very poorly drained soils (11.5%) and 2.7% alluvial and floodplain soils.

Endangered, Threatened, and Special Concern Species

CTDEEP maintains information on the location and status of endangered, threatened, and other species of special concern throughout the state through the CTDEEP Natural Diversity Database (NDDB). Approximate locations of state and federal listed species and significant natural communities are depicted in **Figure 10**. Activities in these areas are potentially subject to review by CTDEEP. The CTDEEP Wildlife Division may provide recommendations for avoiding impacts to listed species. .

7. Water Infrastructure

Dams

There are approximately 22 dams within the watershed, including 5 on the Mill River, and 1 on Shepard Brook (**Figure 11**). Most of the dams are located in the northern part of the watershed, in Hamden, with a few each in Cheshire and Wallingford. None are located on Willow Brook. The largest and most notable dam is the Lake Whitney Dam, which was established in 1860 for drinking water, fire-fighting, and hydropower. Flows over the dam average 55 million gallons per day (mgd) (RWA, 2018), with high flows during wet months typically ranging from 100 to 300 mgd. Smaller dams may provide recreational opportunities, habitat, or other amenities, but are likely also hindering fish passage through the watershed and may alter hydrologic characteristics in ways that affect water quality.

At least two of the smaller dams along the Mill River have been partially or fully breached at some point in their history. The Axle Shop Pond Dam was reported as partially breached, and Clarke's Pond Dam was reportedly rebuilt in the mid-1980s to repair a breach.

Water Supply

The Mill River watershed feeds Lake Whitney, which is part of the South Central Connecticut Regional Water Authority (RWA) public water supply system. Lake Whitney was established as the water supply for the City of New Haven in 1862. The original filtration plant, built in 1906, operated until 1991 and was demolished in 2002. A new Lake Whitney Water Treatment Plant was opened in 2005, reestablishing Lake Whitney as an active water supply. In 2000, prior to the plant's opening, the RWA commissioned a series of ongoing studies to collect baseline data and monitor changes due to lake withdrawals (**Table 4**). Operating standards were established with the intent of balancing ecological, aesthetic, and water supply interests. As part of those standards, it was established that a pre-emptive maintenance approach focused on watershed management techniques designed to control sediment loading should take priority over dredging, and periods of no flow should be minimized so as to limit disturbance to river ecology (Milone & MacBroom, Inc., 2002). The Lake Whitney Water Treatment Plant pumps approximately 3-15 mgd for the RWA under normal conditions, which supplies 45 mgd to an overall service population (i.e., both within the watershed and beyond) of approximately 430,000 people. Current operating guidelines, which were developed in part based on the recommendations of environmental monitoring studies (see **Table 5**), dictate that when lake levels are lower than 0.2 feet above the spillway, withdrawals are limited to 5 mgd except under extreme circumstances.

Groundwater serves as the primary water supply source for a significant portion of the northern half of the watershed. There are four Aquifer Protection Areas (APAs) (also referred to as "wellhead

protection areas") located within the watershed (**Figure 10**). APAs are designated around active well fields in sand and gravel aquifers that serve more than 1,000 people to protect major public water supply wells.

Wastewater

Approximately half of the watershed area is served by sanitary sewers and half by on-site wastewater treatment systems, also referred to as septic systems (**Figure 12**). Most of these septic systems are located in the upper half of the Mill River watershed in Cheshire and the northern portion of Hamden. Failing or older, sub-standard septic systems can impact surface water and groundwater quality and can be a source of bacteria to the Mill River and other surface waterbodies. Local health directors and health districts regulate the installation of subsurface sewage disposal systems and are responsible for site inspections, plan review, the issuing of permits and inspections of all new, repair and replacement systems. The Towns of Cheshire and Prospect are part of the Chesprocott Health District, located in Cheshire, and the City of North Haven and Towns of Hamden, and Bethany are part of the Quinnipiac Valley Health District, located in North Haven. The City of New Haven and Town of Wallingford each have independent, local health departments.

Combined Sewer Overflows (CSOs) impact water quality in the lower Mill River (**Figure 12**). CSOs are designated outfalls where combined sewers (carrying both sanitary wastes and stormwater) overflow when precipitation overwhelms the combined sewer system's capacity; such overflows result in discharge of untreated sanitary wastes into receiving waters. The City of New Haven has combined sanitary and storm sewer systems that discharge untreated sewage into New Haven Harbor during periods of heavy rain. The City of New Haven has been working to address CSOs since the early 1980s, and has worked in cooperation with the Greater New Haven Water Pollution Control Authority (GNHWPCA) since regionalization in the mid-2000s. The GNHWPCA's actions are guided in large part by CTDEEP consent order WC5509, last amended in 2015. As part of the consent order, GNHWPCA has developed a Long Term Control Plan (LTCP) which impacts both the Mill River watershed and neighboring Quinnipiac River and West River watersheds. The LTCP includes closure of some CSOs, modifications to others to ensure sewer separation, installation of additional storage, and CSO flow monitoring.

Of the 13 remaining CSOs maintained by GNHWPCA that discharge directly to receiving waters, three discharge to the Mill River:

- **CSO #009 at Grand Avenue and James Street**: The weir was raised in 2015. The reported reduction in CSO discharge volume based on the modeled 2-year design storm in 2016 compared to 1997 is 0.1 million gallons. The LTCP calls for a final status of inactive.

- **CSO #011 at Humphrey Street and I-91**: 2017 update status indicates that sewer separation design is complete. A CSO Storage Tank is proposed as a capital improvement in the LTCP. Three additional active regulators (#010(A), #014, and #026) contribute discharges to the CSO #011 outfall.

- **CSO #012 on Mitchell Drive east of Nicoll Street**: The weir was raised in 2013.The reported reduction in CSO discharge volume based on the modeled 2-year design storm in 2016

compared to 1997 is 0.8 million gallons. A capacity improvement project is planned and design of that project is underway. The LTCP calls for closure of the CSO. One additional active regulator (#028) contributes discharges to the CSO #012 outfall.

Three additional CSOs that previously discharged to the Mill River were closed in 2014.

In 2017, CSO discharges resulted in 4.86 million gallons of CSO flow into the Mill River from a combined 43 overflow events (another 10.64 million gallons discharged directly to the New Haven Harbor). One CSO in particular (CSO #011) contributed the majority (81%) of the discharge volume, at 3.916 million gallons over 13 events. This made it one of the top four CSO overflows in Greater New Haven in terms of volume of discharge during the 2017 reporting period (May 2016 to April 2017). The remaining 19% of CSO discharges to the Mill River came from CSO 009 (0.855 million gallons) and CSO 012 (0.087 million gallons). CSO discharge volume to the Mill River during the 2017 reporting period was more than double that of the 2016 reporting period (2.22 million gallons). CSO discharge volume for the 2015 reporting period was 6.27 million gallons. Differences from one reporting period to the next reflect both differences in annual precipitation and changes due to CSO closures/modifications.

Stormwater

Urban stormwater runoff generated in developed areas from buildings, pavement, and other compacted or impervious surfaces is a significant source of pollutants to the Mill River and its tributaries. Impervious surfaces prevent infiltration of rainfall and runoff into the ground. Stormwater generated from impervious surfaces typically contains increased pollutants from the atmosphere, vehicles, industry, lawns, construction sites, humans and animals. Without treatment, these pollutants are conveyed from the impervious surfaces to storm drainage systems and eventually to the receiving waterbodies during storms. Impervious surfaces and traditional piped storm drainage systems increase the volume, peak flow rates, and velocity of stormwater runoff to receiving waters. This can contribute to channel erosion, sedimentation, and reduced stream baseflow during dry periods. The amount of impervious cover in the Mill River watershed and the implications for water quality and overall stream health is discussed in Section 5 of this technical memorandum.

In recognition of the impacts of stormwater runoff on water quality, CTDEEP regulates stormwater discharges from municipalities, commercial and industrial sites, and construction sites. As of the 2012 TMDL, permitted stormwater discharges within the Mill River subregional basin included: 1 commercial permittee, 10 industrial permittees, and 2 construction permittees. All of the municipalities within the watershed are regulated under the CTDEEP General Permit for the Discharge of Small Municipal Separate Storm Sewer Systems (MS4 Permit), and therefore are required to implement stormwater management programs centered around 6 minimum control measures, including public education and involvement, illicit discharges, land use regulatory controls for construction and post-construction runoff, impervious cover reduction, and good housekeeping and pollution prevention. The MS4 Permit, in particular, requires increasingly stringent approaches to limit stormwater pollution over the next five years, largely through addressing impervious area and illicit discharges to the stormwater system and encouraging green infrastructure and low impact development. The MS4 permit also requires all municipalities to create updated and detailed stormwater infrastructure mapping, which will help to facilitate

identification and tracking of illicit discharges, storm system maintenance, and stormwater retrofits.

Green infrastructure solutions are also a key objective of the GNHWPCA strategic plan (GNHWPCA, 2017). GNHWPCA requires the use of green infrastructure stormwater management practices (e.g., infiltrators and drywells, rain water storage tanks, bioswales and tree wells, water features) for development projects within combined sewer areas in accordance with the GNHWPCA Permitting and Design Criteria Manual. GNHWPCA and the City of New Haven, working with CFE/Save the Sound and other groups, are also installing bioswales at numerous locations throughout the City within the public right-of-way to reduce runoff to the combined sewer system and reduce pollutant loads to surface waters. The City of New Haven has also adopted regulatory requirements to reduce stormwater runoff from development projects contributing to the City's combined sewer system.

Flood Zones

Flood hazard areas within the Mill River watershed are shown in **Figure 13.** Flood zones are defined by the Federal Emergency Management Agency (FEMA) as the area below the high water level that occurs during a flood of a specified recurrence interval (e.g., the "100-year flood" is defined as having a probability of occurring once in 100 years, or a 1% chance of occurring in any single year). Similarly, the "500-year flood" has a 0.2% chance of occurring in a given year. FEMA also defines a 'floodway' as the stream channel and adjacent areas that carry the majority of the flood flow at a significant velocity, whereas 'floodplain' also includes the flood fringe or areas that are flooded without a strong current.

The region, including the Mill River watershed, has suffered flood damage in inland and coastal areas from Tropical Storm Irene (2011) and Hurricane Sandy (2012). Historic flood events that have impacted the region include the June 1982 storms in which the most severe flooding occurred along the Mill River in Hamden (and along the Wepawaug River in Orange and Milford) and the historic floods of 1955 and 1936.

8. References

CTDEEP. (2012). *Connecticut Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters.* Hartford: Connecticut Department of Energy and Environmental Protection.

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CTDEEP. (2016). *State of Connecticut v. The United Illuminating Company Partial Consent Order Number COWSPCB 15-001.* Hartford: Connecticut Department of Energy and Environmental Protection.

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RWA. (2018). *Whitney Environmental Management Plan*. Retrieved April 5, 2018, from Regional Water Authority: https://www.rwater.com/conservation-stewardship/whitney-environmental-management-plan

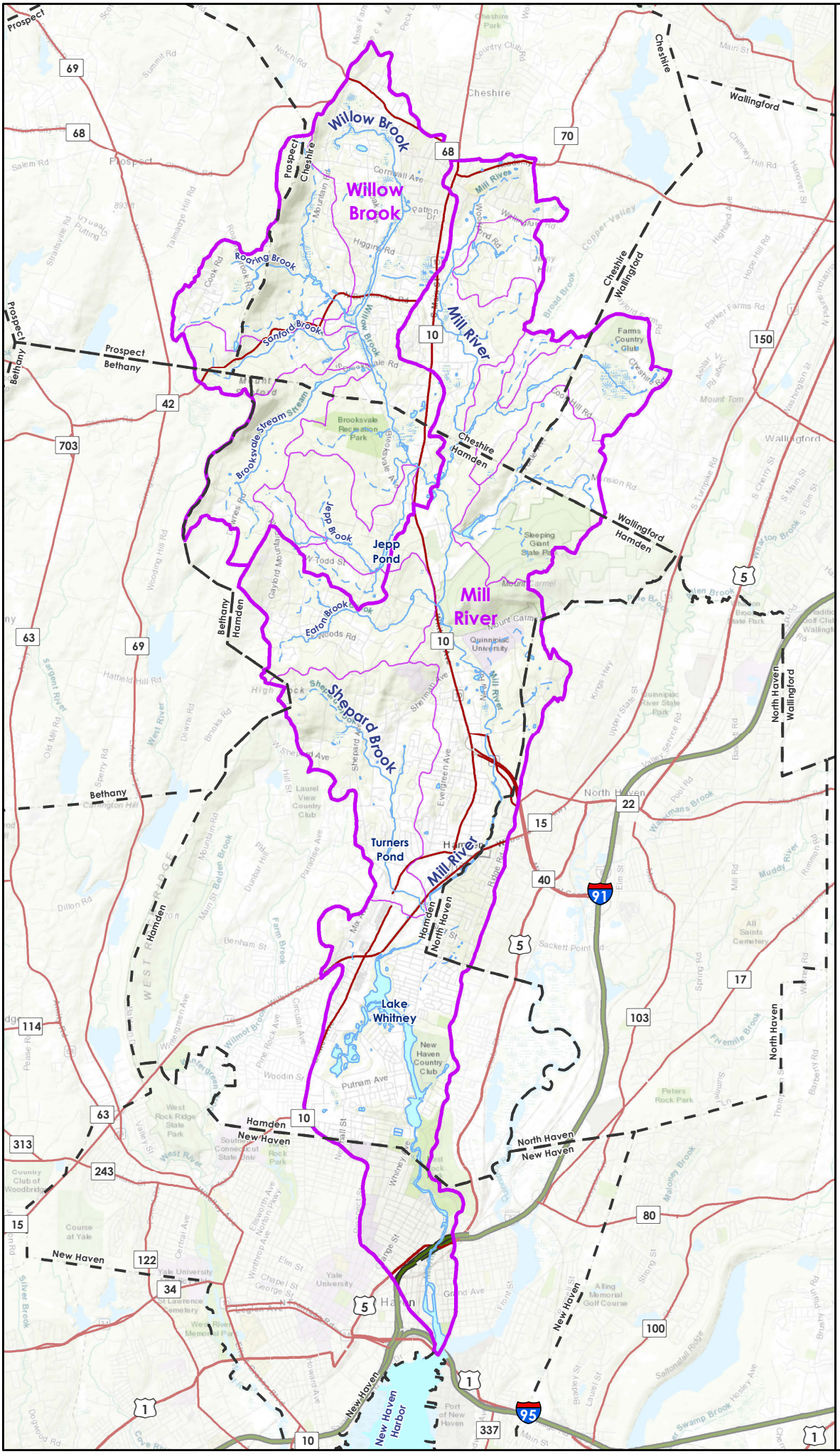

Figure 1

Mill River Watershed Based Plan

Watershed Overview

Major Roads

- Interstate
- US
- State
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Subregional Basins
- Local Basins
- Town Boundary

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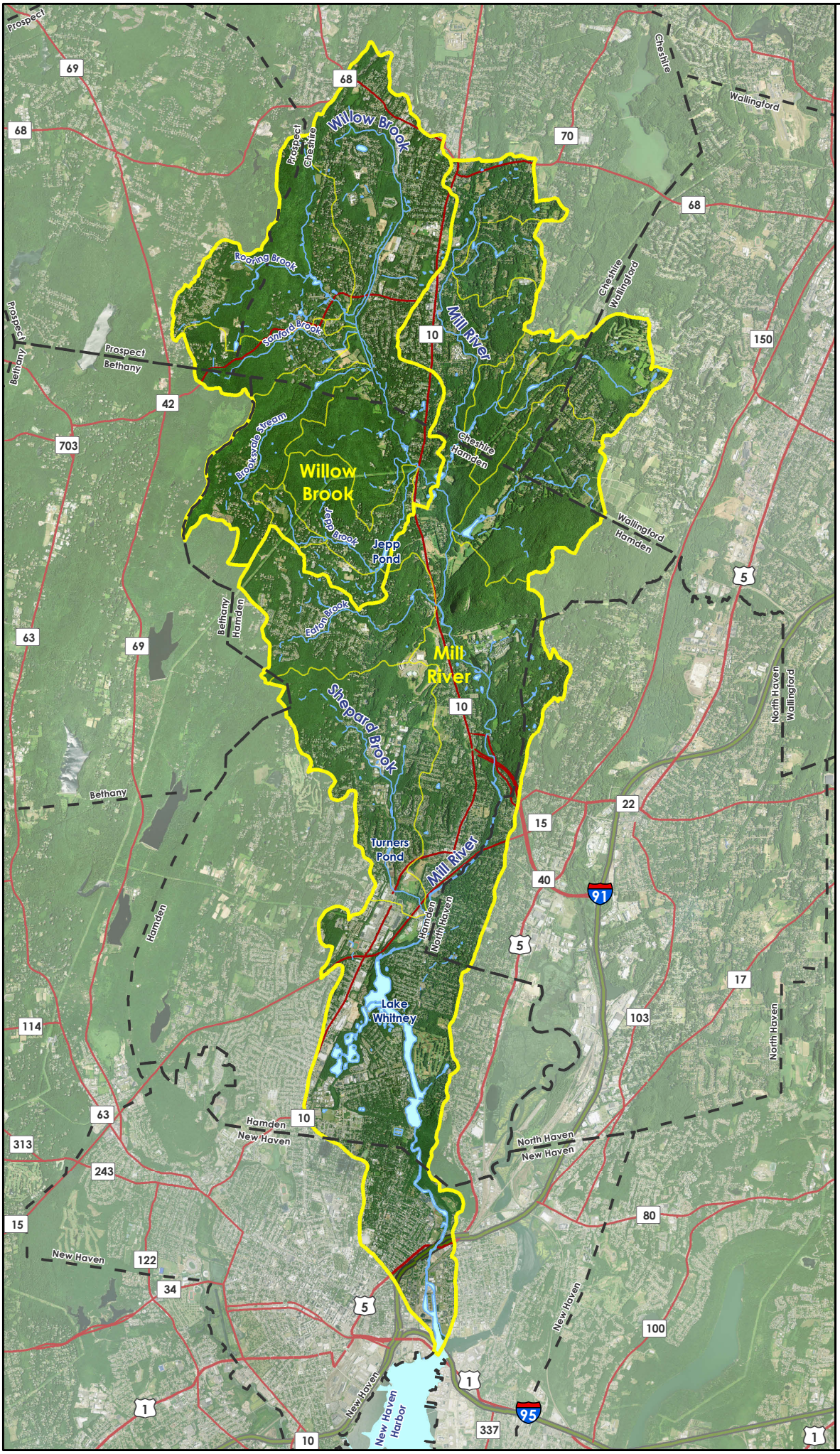

Figure 2

Mill River Watershed Based Plan

Watershed Aerial

Major Roads

- Interstate
- US
- State
- Stream
- Intermittent Stream
- Open Water
- Subregional Basins
- Local Basins
- Town Boundary

N
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S

0 0.5 1 1.5 2

Miles

Sources:
CT ECO
Aerial Imagery (2016)
CT DEEP
Hydrography (2005)
MAGIC
Municipalities (1984)
Roads (2010)

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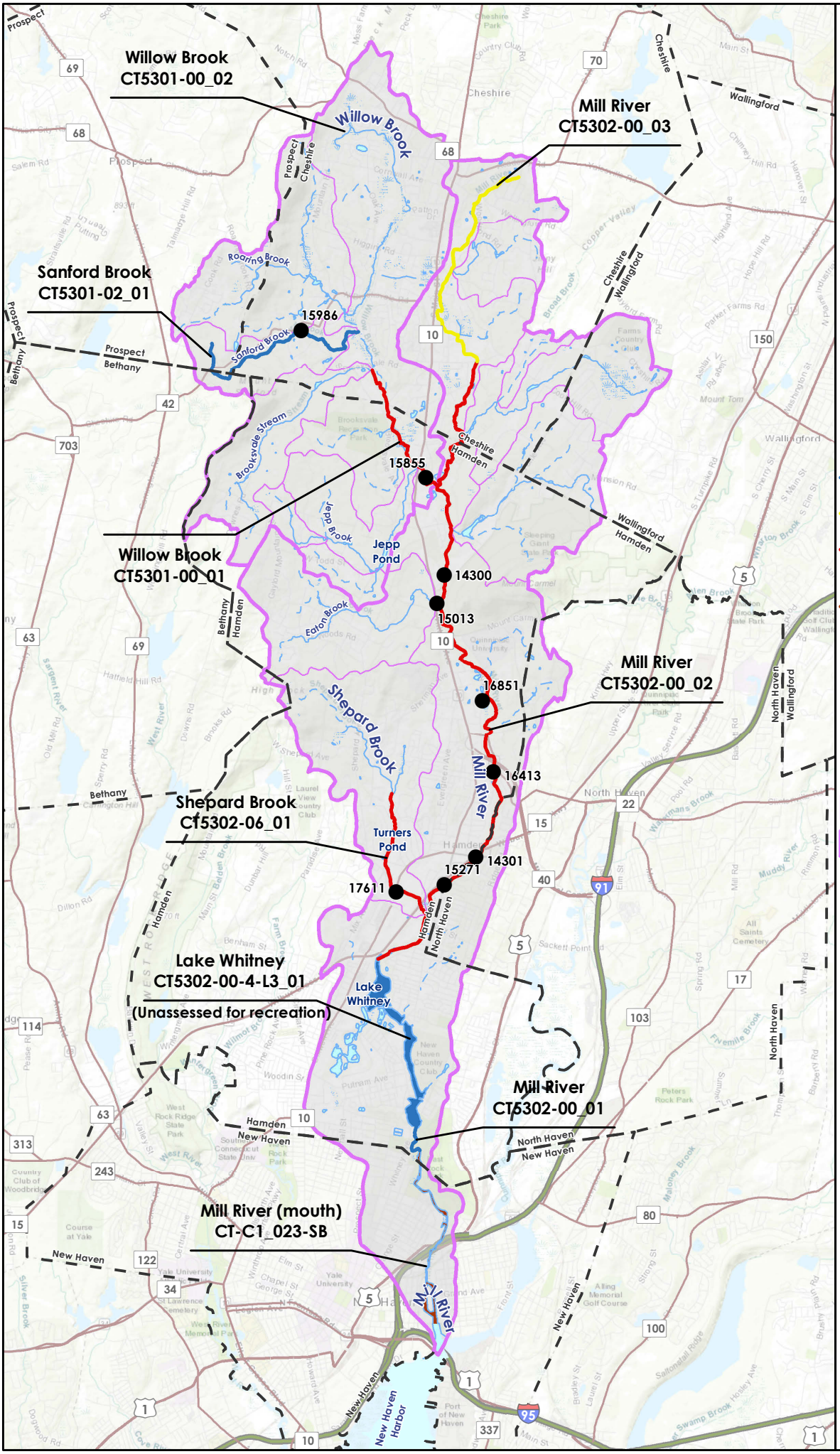

Figure 3

Mill River Watershed Based Plan

Impaired Waters

Segment Name
305b List ID

- DEEP Ambient Water Quality Monitoring Stations
- Fully Supporting
- Impaired - Aquatic Life
- Impaired - Recreation
- Impaired - Aquatic Life, Recreation, and Shellfishing
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Local Basins
- Subregional Basins

0 0.5 1 1.5 2
Miles

Sources:
CT DEEP
Hydrography (2005)
Impaired Waters (2014)
Ambient Water Quality Monitoring Stations (2018)
MAGIC
Municipalities (1984)
Roads (2010)

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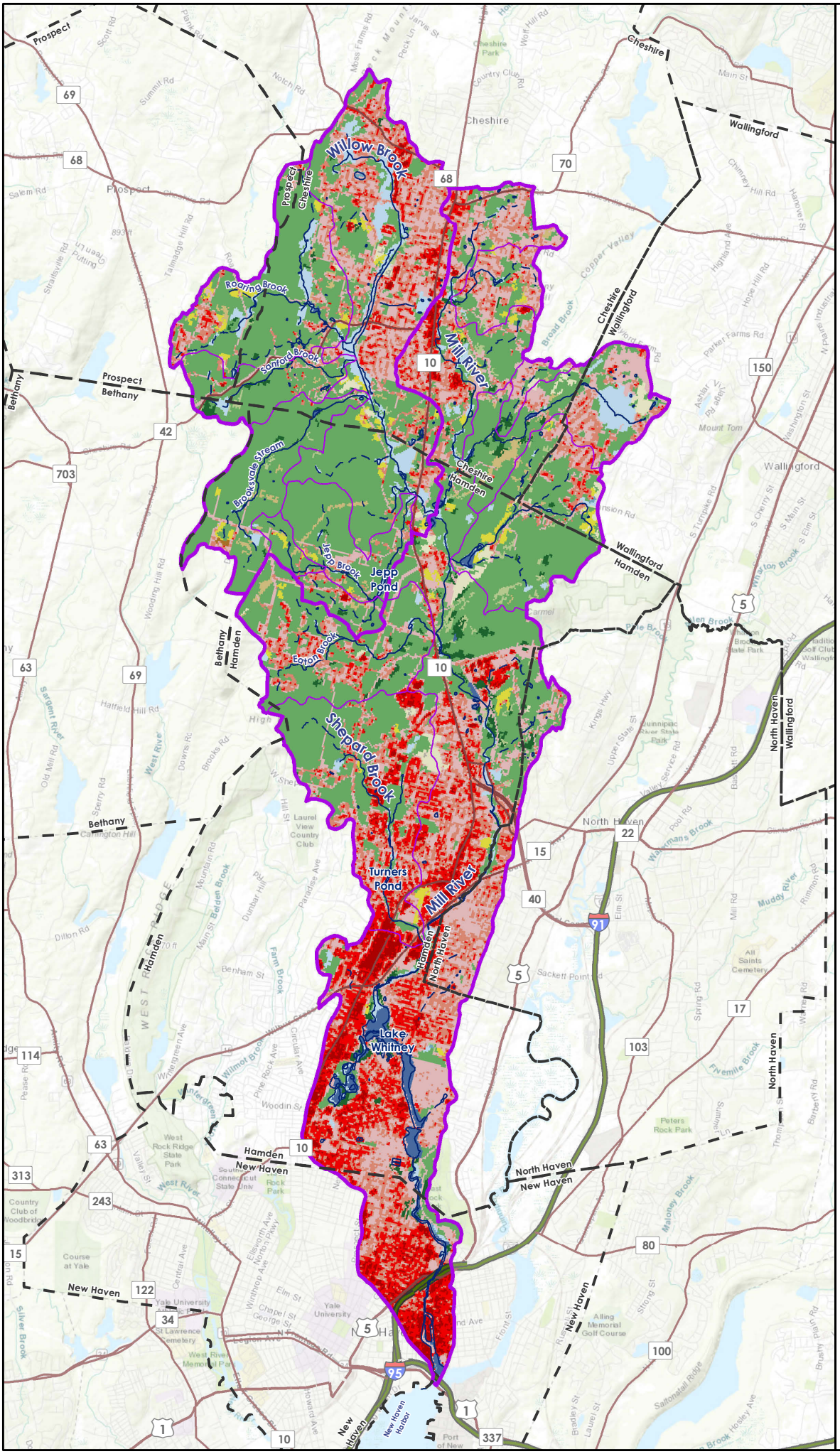

Figure 4
Mill River Watershed Based Plan

Land Cover

Land Cover Type

- Open Water
- Developed, Open Space
- Developed, Low Density
- Developed, Medium Density
- Developed, High Density
- Barren
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands
- Stream
- Intermittent Stream
- Local Basins
- Subregional Basins

Sources:
USGS
NLCD (2011)
CT DEEP
Hydrography (2005)
MAGIC
Municipal Boundaries (1984)
Roads (2010)

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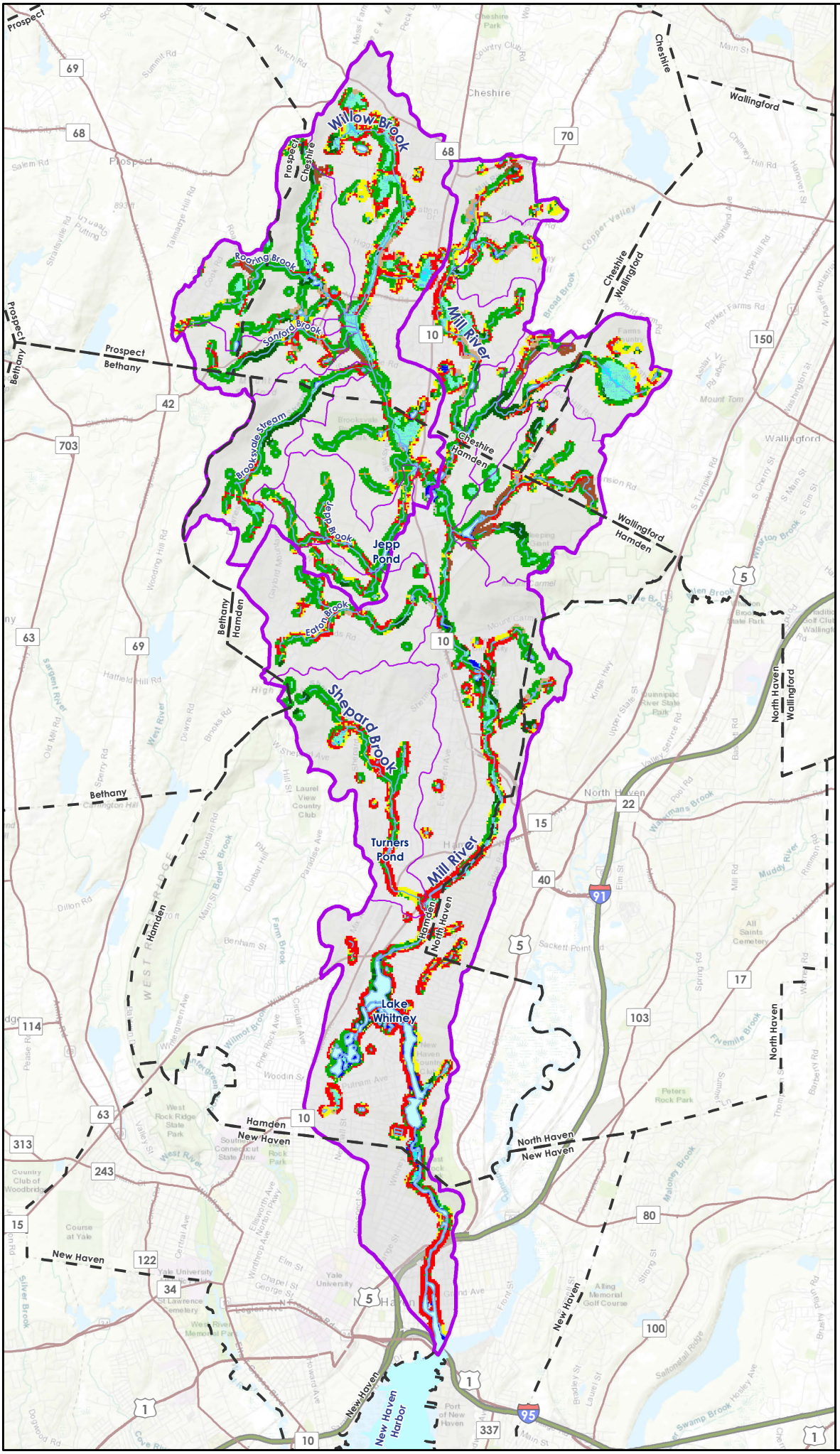


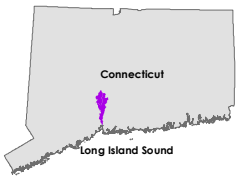
Figure 5

Mill River Watershed Based Plan

300-Foot Riparian Zone Land Cover

Land Cover Type

- Developed
- Turf and Grass
- Other Grass
- Agricultural Field
- Deciduous Forest
- Coniferous Forest
- Water
- Non-forested Wetland
- Forested Wetland
- Barren
- Utility ROW
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Subregional Basins
- Local Basins



0 0.5 1 1.5 2

Miles

Sources:
UCONN CLEAR
Land Cover (2015)
CT DEEP
Hydrography (2005)
MAGIC
Municipal Boundaries (1984)
Roads (2010)

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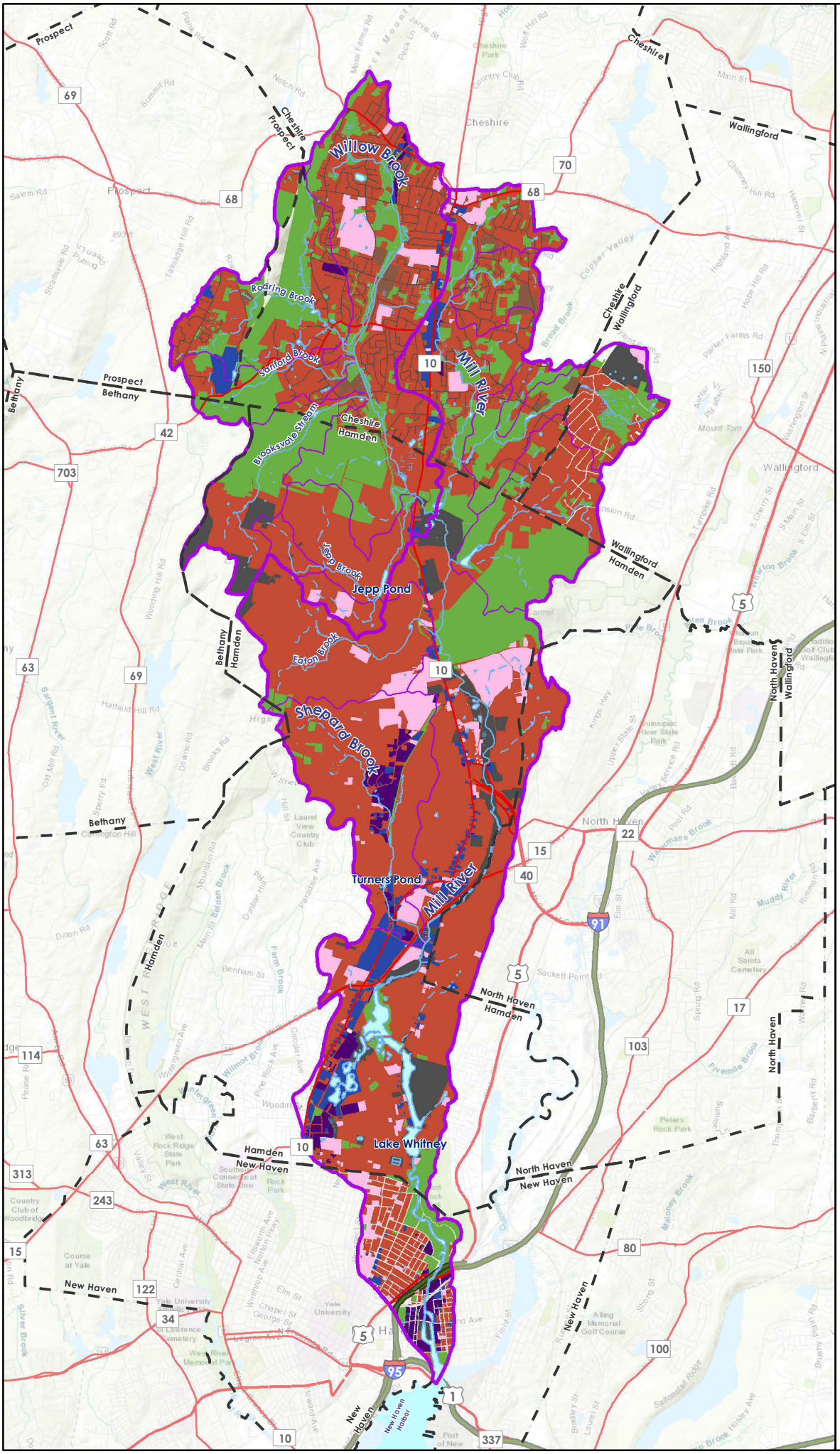


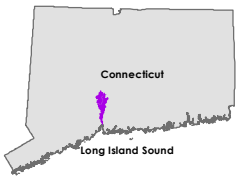
Figure 6

Mill River Watershed Based Plan

Land Use

Land Use

- Residential (all densities)
- Commercial
- Institutional
- Industrial
- Transportation and Other
- Agriculture
- Forest, Water, Open Space
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Subregional Basins
- Local Basins



0 0.5 1 1.5 2

Miles

Sources:
NVCOG, SCRCOG
Land Use (2016, 2017)
CT DEEP
Hydrography (2005)
MAGIC
Municipal Boundaries (1984)
Roads (2010)

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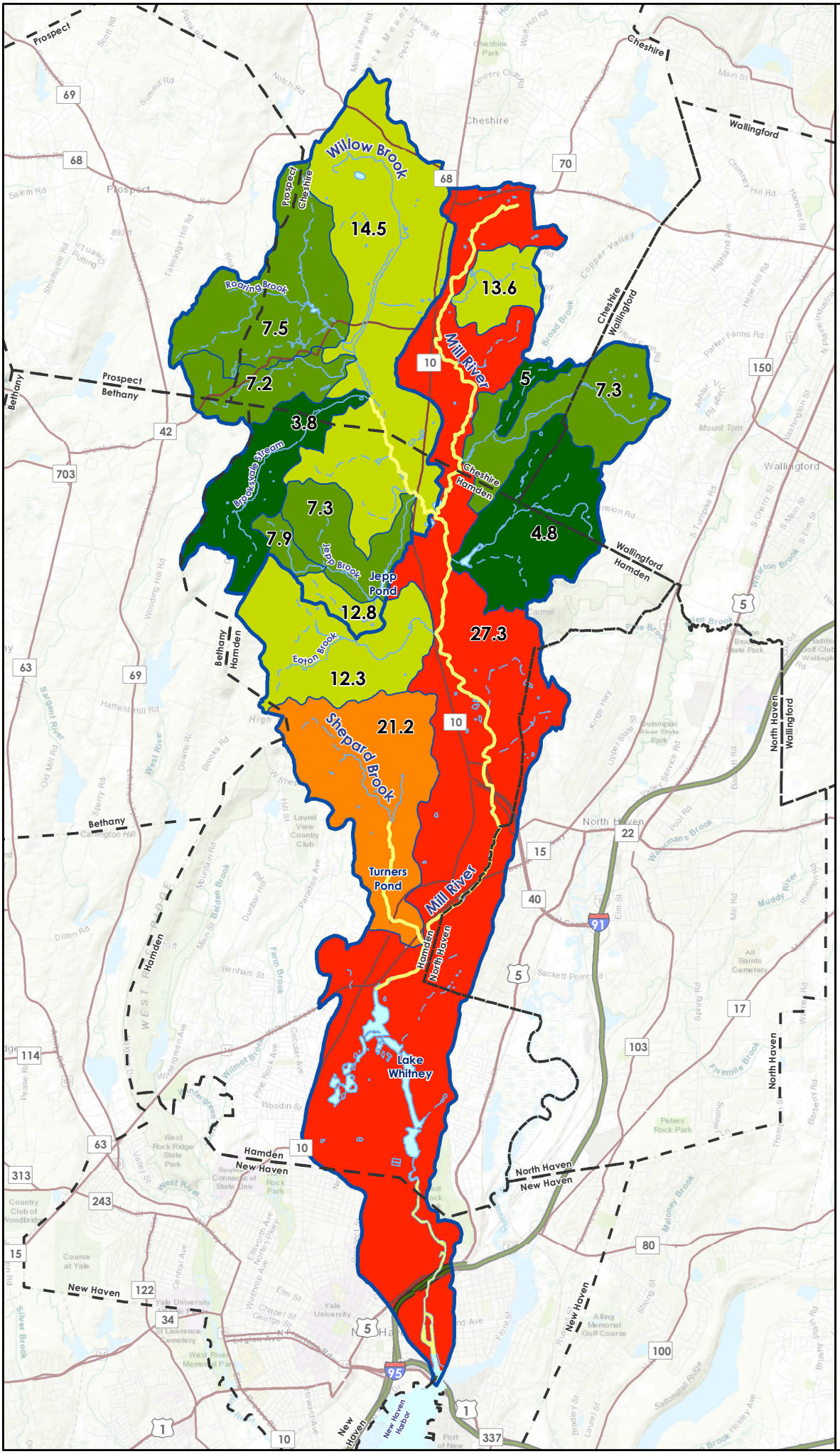

Figure 7

Mill River Watershed Based Plan

Impervious Cover

Impervious Cover by Local Basin

- < 5%
- 5 - 10%
- 10 - 15%
- 20 - 25%
- > 25%
- Impaired Waterbody
- Stream
- Intermittent Stream
- Open Water
- Local Basins
- Subregional Basins

0 0.5 1 1.5 2

Miles

Sources:
CT ECO
Impervious Cover (2012)
CT DEEP
Hydrography (2005)
MAGIC
Municipalities (1984)
Roads (2010)

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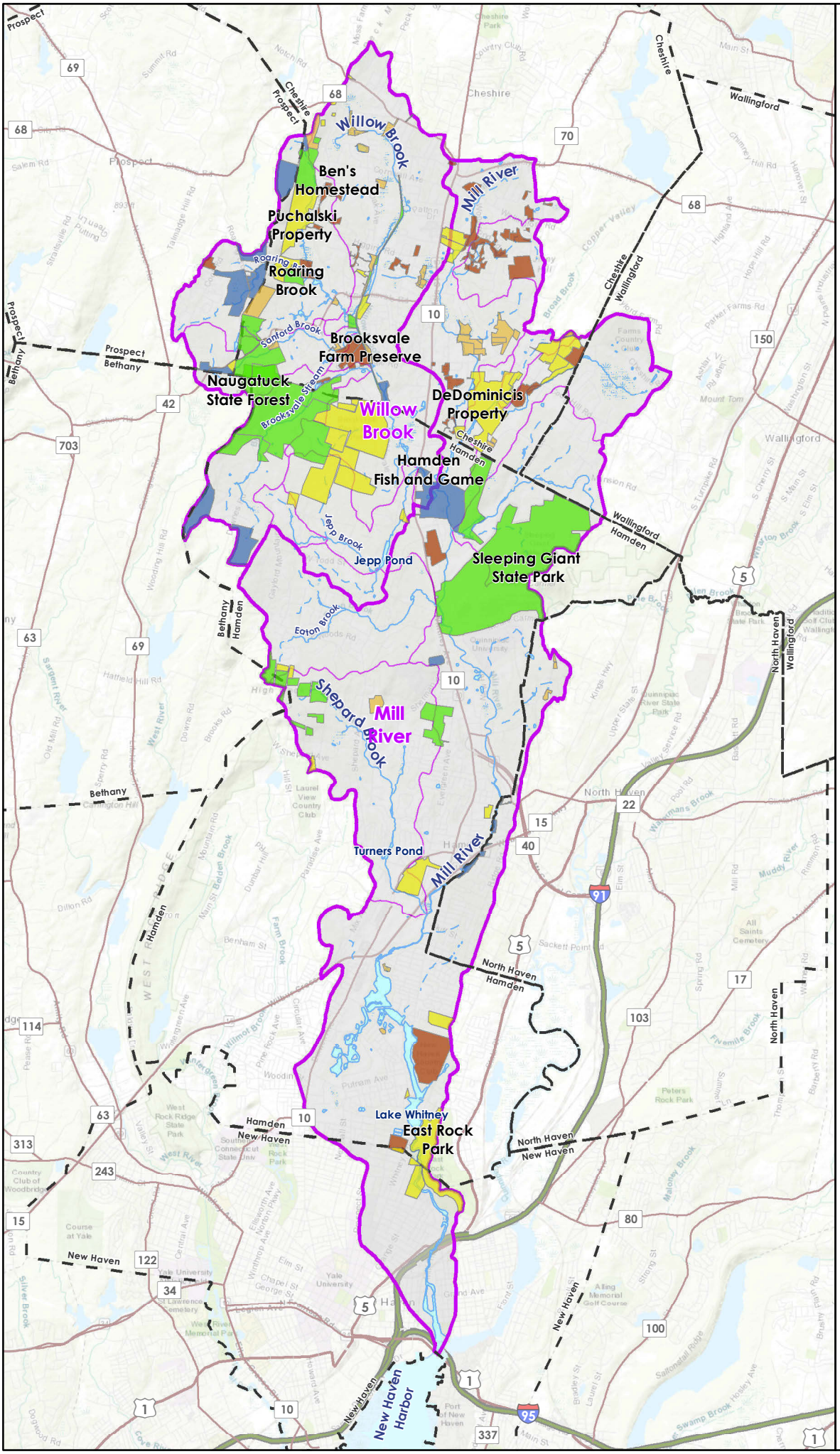


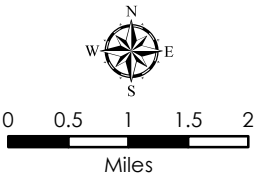
Figure 8

Mill River Watershed Based Plan

Protected Open Space

Ownership

- Land Trust
- Municipal
- Private
- State
- Regional Water Authority
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Local Basins
- Subregional Basins



Sources:
NVCOG
Open Space (2017)
CT DEEP
Open Space (2015)
Hydrography (2005)
MAGIC
Municipalities (1984)
Roads (2010)

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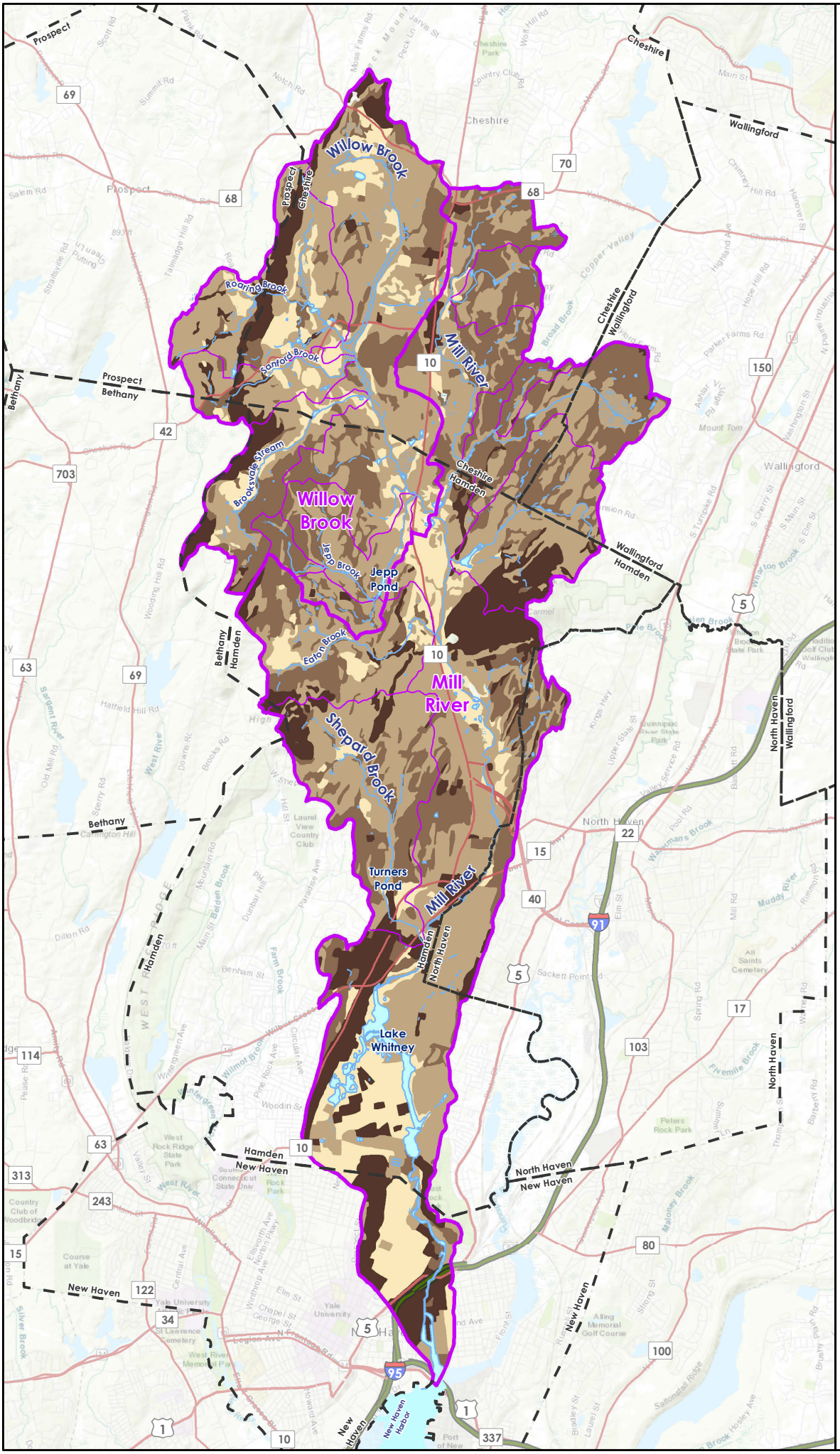

Figure 9

Mill River Watershed Based Plan

Hydrologic Soil Groups

Hydrologic Soil Group

- A - High infiltration potential
- B - Moderate infiltration potential
- C - Moderately poor infiltration potential
- D - Low infiltration potential
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Local Basins
- Subregional Basins

0 0.5 1 1.5 2

Miles

Sources:
USDA SSURGO
Hydrologic Soil Groups (2017)
CT DEEP
Hydrography (2005)
MAGIC
Municipalities (1984)
Roads (2010)

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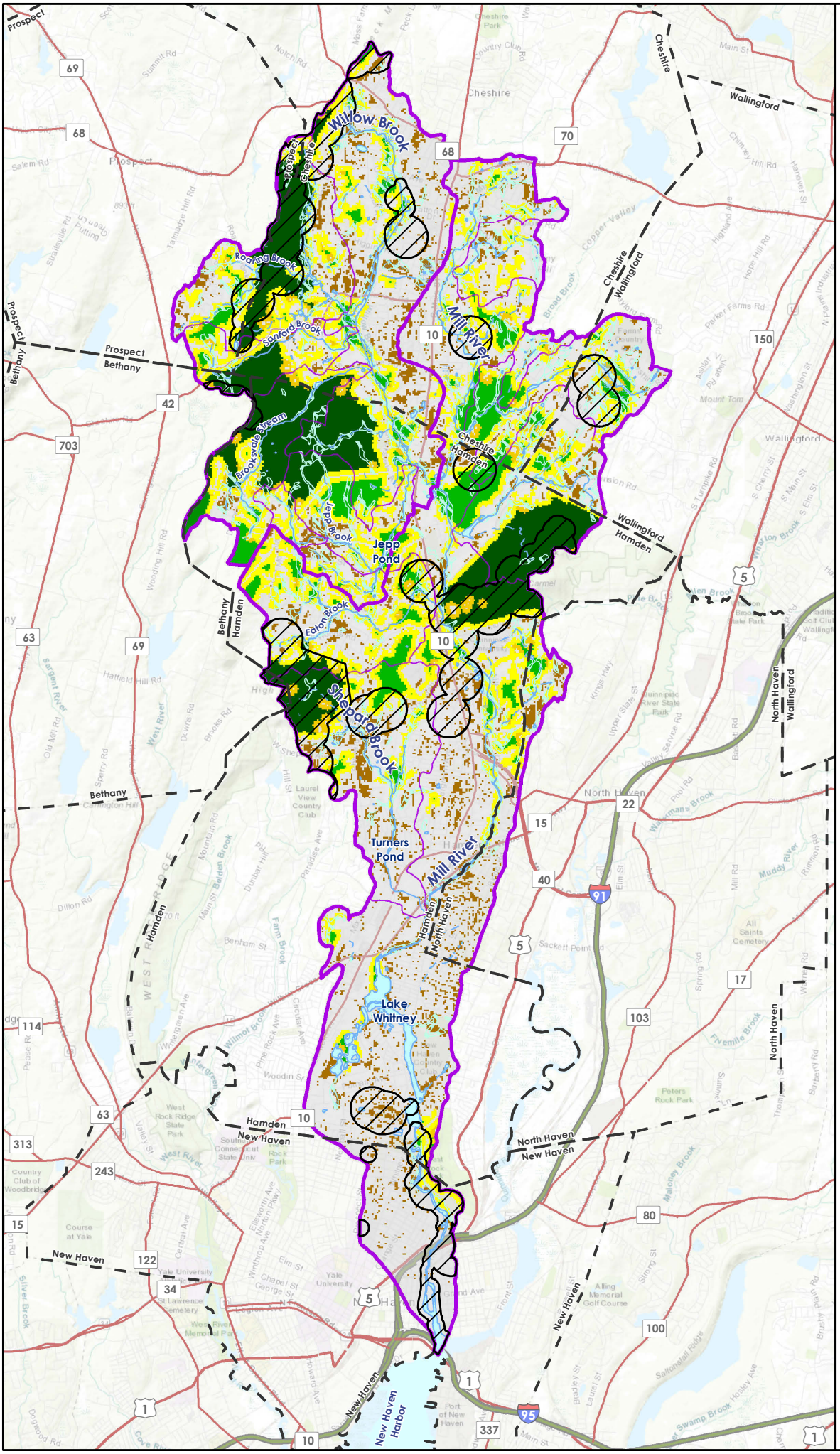

Figure 10

Mill River Watershed Based Plan

Wetlands, Forests, and Natural Diversity Database Areas

- State and Federal Listed Species & Significant Natural Communities
- Wetlands
- Patch Forest
- Edge Forest
- Perforated Forest
- Core Forest (<250 ac)
- Core Forest (250-500 ac)
- Core Forest (>500 ac)
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Subregional Basins
- Local Basins

0 0.5 1 1.5 2

Miles

Sources:
UCONN CLEAR
Forest Fragmentation (2006)
CT DEEP
Wetland Soils (2009)
Natural Diversity Database Areas (2017)
Hydrography (2005)
MAGIC
Municipal Boundaries (1984)
Roads (2010)

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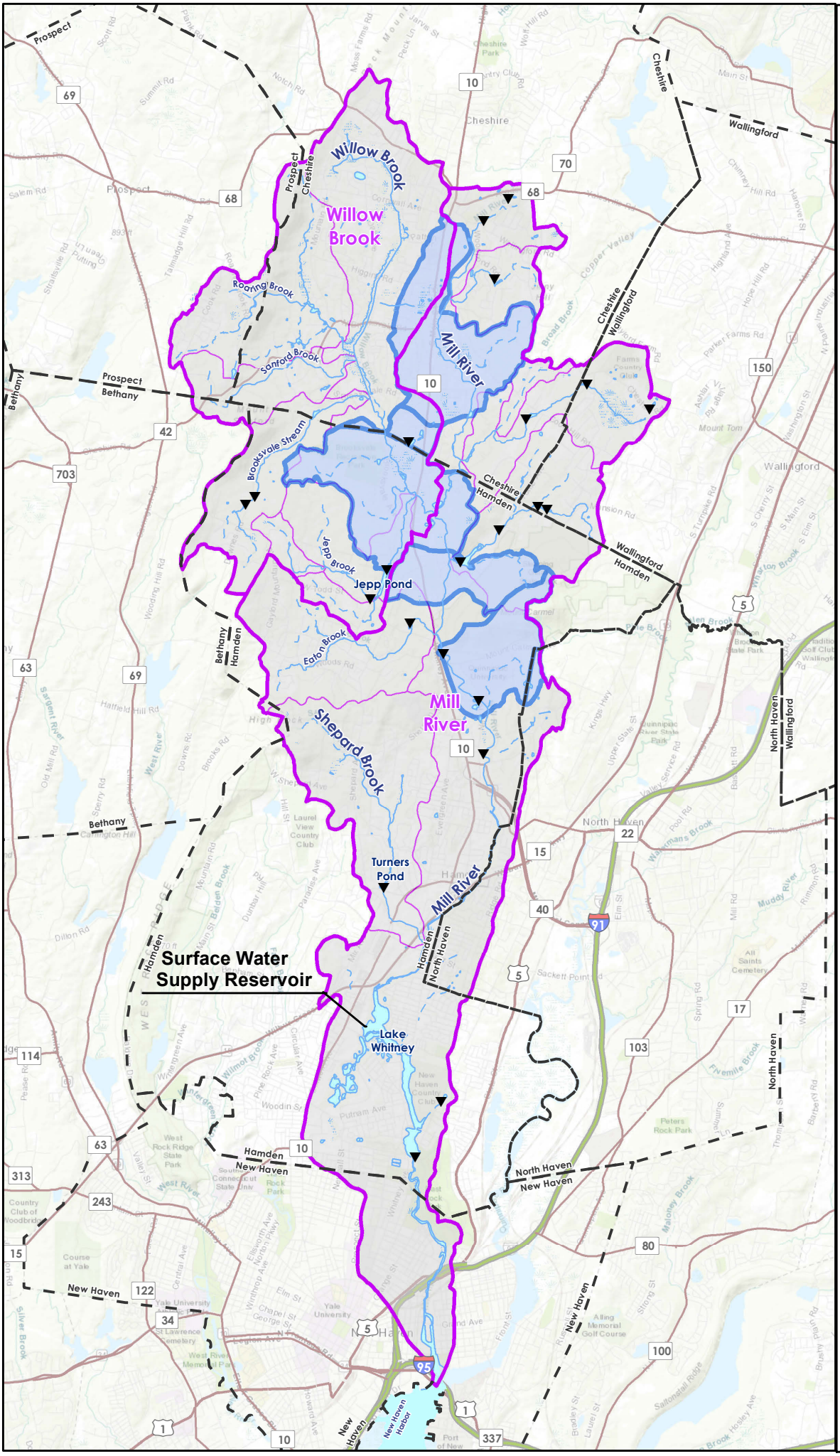

Figure 11

Mill River Watershed Based Plan

Water Resources

- Dam
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Aquifer Protection Area - Level A
- Local Basins
- Subregional Basins

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0 0.5 1 1.5 2
Miles

Sources:
CT DEEP
Aquifer Protection Areas (2016)
Hydrography (2005)
Dams (1996)
MAGIC
Municipalities (1984)
Roads (2010)

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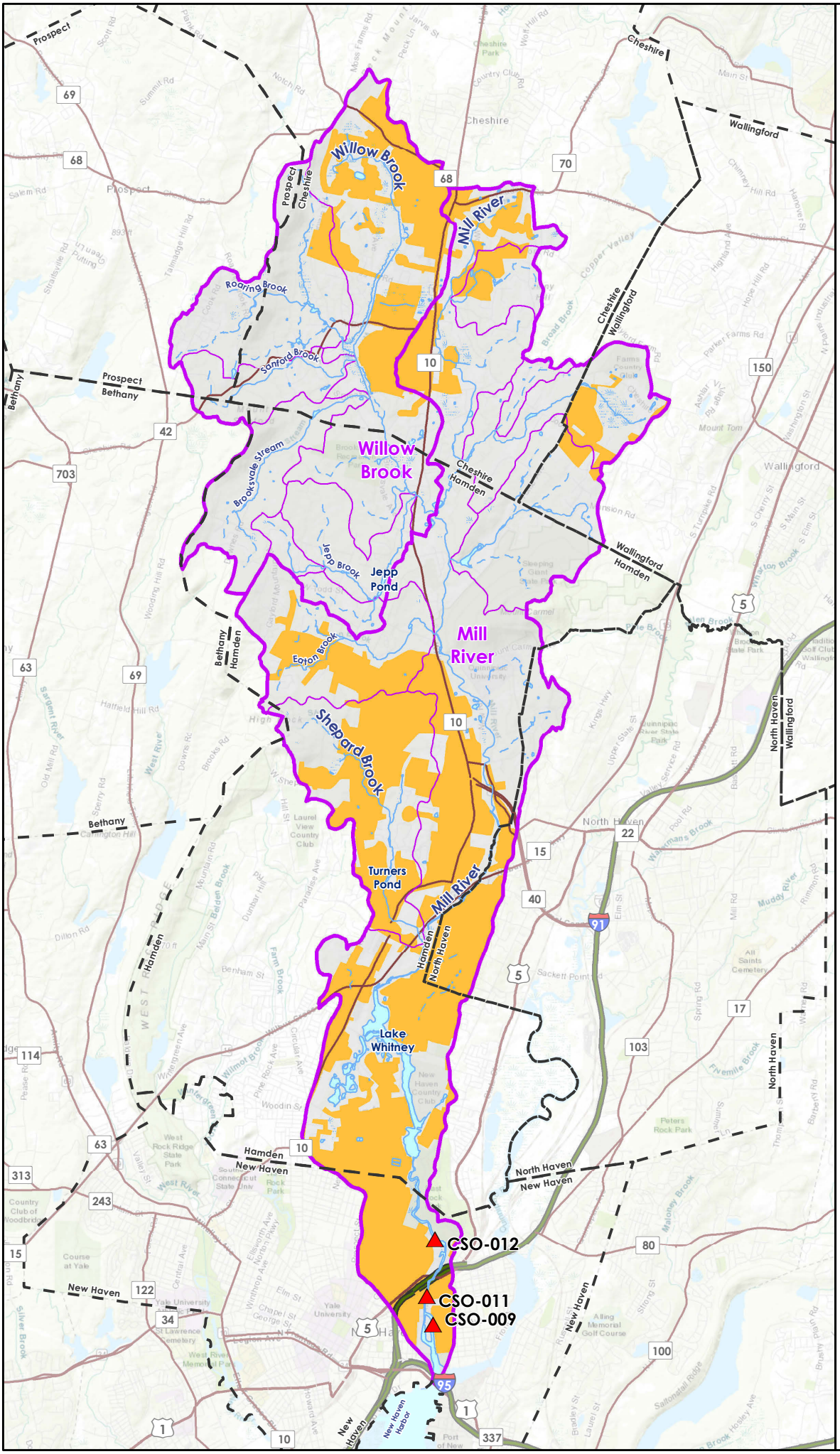
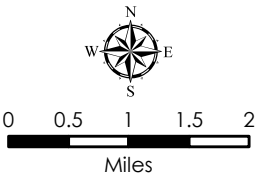


Figure 12

Mill River Watershed Based Plan

Wastewater Infrastructure

- Combined Sewer Overflow (CSO) Locations
- Sanitary Sewer Service Area
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Local Basins
- Subregional Basins



Sources:
GNHWPCA
CSO Locations (2017)
CT DEEP
Hydrography (2005)
Sewered Areas (1998)
MAGIC
Municipalities (1984)
Roads (2010)

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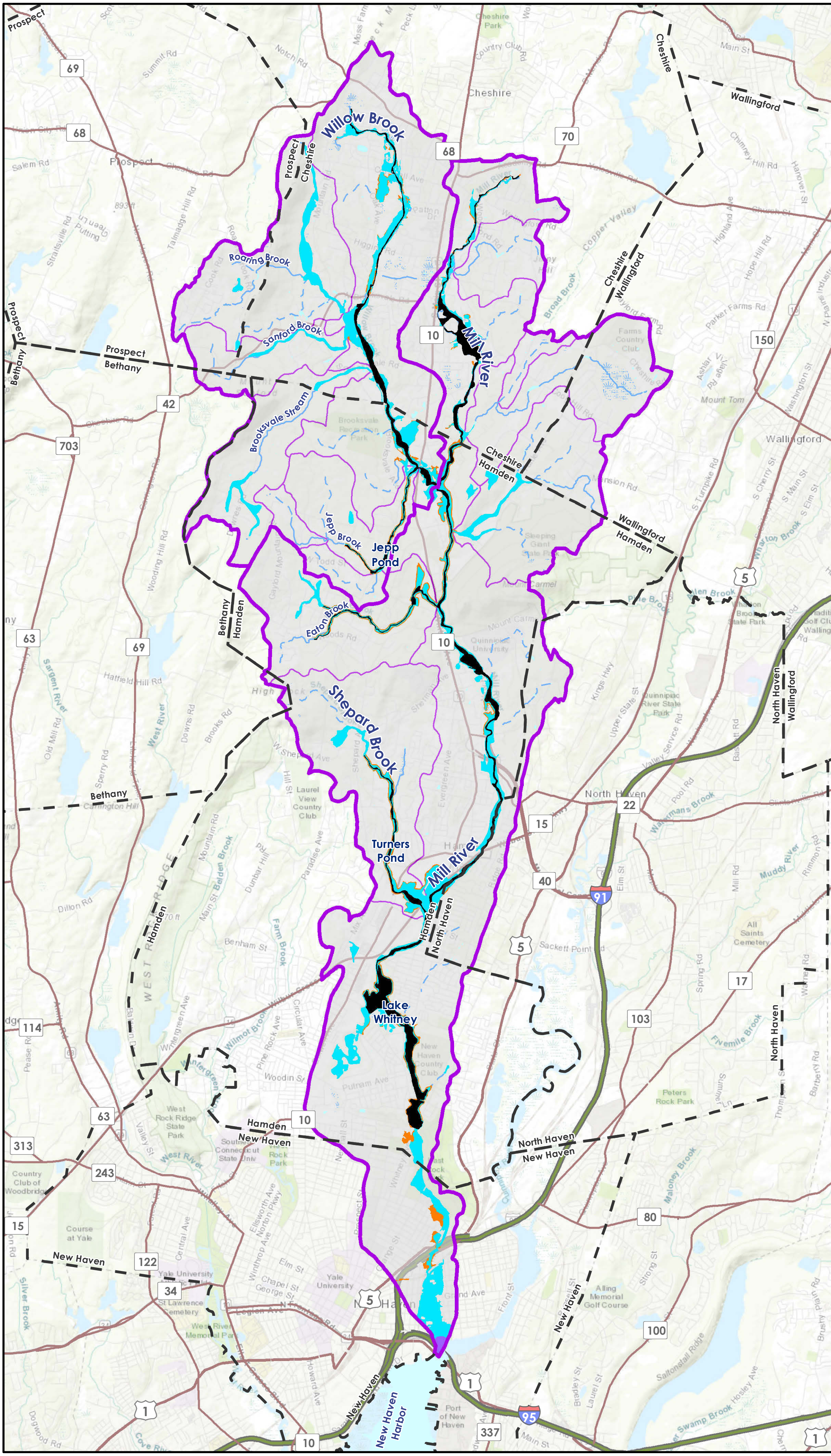


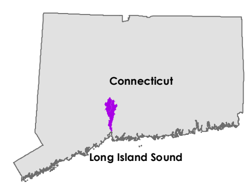
Figure 13

Mill River Watershed Based Plan

FEMA Flood Hazard Areas

Flood Hazard Zone

- 1% Annual Chance Flood
- Regulatory Floodway
- Coastal 1% Annual Chance Flood
- 0.2% annual chance Flood
- Stream
- Intermittent Stream
- Open Water
- Marsh
- Subregional Basins
- Local Basins



N
W E
S

0 0.5 1 1.5 2

Miles

Sources:
FEMA
Flood Insurance Rate Map (2014)
CT DEEP
Hydrography (2005)
MAGIC
Municipal Boundaries (1984)
Roads (2010)

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