THE HOCKANUM RIVER STATE OF THE WATERSHED REPORT

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Prepared for:

North Central Conservation District, Inc.

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Disciplines to Deliver

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1.0 INTRODUCTION

The Hockanum River watershed encompasses an approximately 77 square-mile (49,000 acres) drainage area in north central Connecticut. The Hockanum River is a major tributary of the Connecticut River that originates in the hills near Shenipsit Lake in Ellington and flows southwesterly into the Connecticut River valley to its confluence with the Connecticut River in East Hartford (Figure 1-1). The mean annual flow of the Hockanum River at East Hartford is approximately 116 cubic feet per second (cfs). The Hockanum River is approximately 25 miles in length and drops approximately 490 feet in elevation. The Hockanum River watershed drains large portions of Manchester, Vernon, Ellington, and Tolland, and smaller portions of East Hartford, South Windsor, Bolton, Stafford, Glastonbury, and Somers (see Table 1-1).

Table 1-1. Land Area of Municipalities in the Hockanum River Watershed

Town Name	Town Acreage	Acreage in Watershed	% of Town in Watershed	% of Watershed
Manchester	17,706	14,425	81.5	29.2
Vernon	11,598	10,978	94.7	22.2
Ellington	22,139	8,650	39.1	17.5
Tolland	25,738	7,103	27.6	14.4
East Hartford	12,024	2,704	22.5	5.5
South Windsor	18,368	2,457	13.4	5.0
Bolton	9,432	2,002	21.2	4.1
Stafford	37,583	745	2.0	1.5
Glastonbury	33,416	226	0.7	0.5
Somers	18,324	70	0.4	0.1
Totals	**206,326**	**49,358**		100.0

Major tributaries and associated subwatersheds of the Hockanum River include the Tankerhoosen River, Charters Brook, Marsh Brook, South Fork Hockanum River, and Shenipsit Lake. Shenipsit Lake is the area's largest lake and serves as a water supply for Vernon and several neighboring communities. Other significant impoundments in the watershed include Paper Mill Pond in Vernon, and Laurel Lake and Union Pond in Manchester (Hockanum River Watershed Association, 1998).

As illustrated in Figure 1-2, the Hockanum River flows through an increasingly urbanized landscape as it travels downstream. The most heavily urbanized areas of the watershed include the major transportation corridors, regional shopping and commercial areas, and the major population centers of Vernon, Manchester, and East Hartford. Land use practices within the watershed communities affect the quality of the waters that flow into the Hockanum River and its tributaries. The Hockanum River is included in Connecticut's Unified Watershed Assessment as a category 1 (impaired) watershed. The River is on the Connecticut Department of Environmental Protection's (DEP) *2004 List of Connecticut Waterbodies Not Meeting Water Quality Standards* (April 28, 2004) from Shenipsit Lake to the mouth at the Connecticut River. Impairments are listed as aquatic life support and primary contact recreation. Potential sources of these impairments include municipal point sources (landfills and wastewater treatment plants), urban runoff and storm sewers, agriculture, channelization and habitat modification, and

erosion and sedimentation (DEP, 2004a). The lower portion of the Tankerhoosen River, from its confluence with the Hockanum River to Tankerhoosen Lake, Vernon, is also included on DEP's *2004 List of Connecticut Waterbodies Not Meeting Water Quality Standards* (April 28, 2004) for aquatic life support impairment due to unknown causes/sources.

As discussed in subsequent sections of this report, the major water quality issues in the Hockanum River watershed include high turbidity and floatables, organic enrichment and algal growth, and elevated bacteria in various reaches of the Hockanum River and its impoundments. Historical water quality monitoring data collected by the USGS indicates a general upstream to downstream decline in water quality in both the Hockanum and Tankerhoosen Rivers, although the data also suggests potential sources of dissolved copper and low dissolved oxygen in upstream reaches of the Hockanum River. The greatest impacts are observed in the central and lower portions of the watershed. This trend mirrors the overall development patterns in the watershed. Numerous historical impoundments within the watershed act as barriers to fish passage along the Hockanum River and its tributaries

Despite the water quality issues in the watershed, the Hockanum River provides a variety of recreational uses. An annual spring canoe race in Manchester brings many enthusiasts to the river. The Hockanum River Linear Park in Manchester contains a network of riverside hiking trails that provide easy access to the river and help promote stewardship of the river, as well as protect areas of the river and adjacent habitat from further development (Connecticut River Watch Program, 2000). The Friends of the Hockanum River Linear Park, the Hockanum River Watershed Association, and other watershed groups, together with the North Central Conservation District and the DEP River Watch Program, are actively involved in protection and restoration efforts throughout the watershed.

Figure 1-1. Hockanum River Watershed

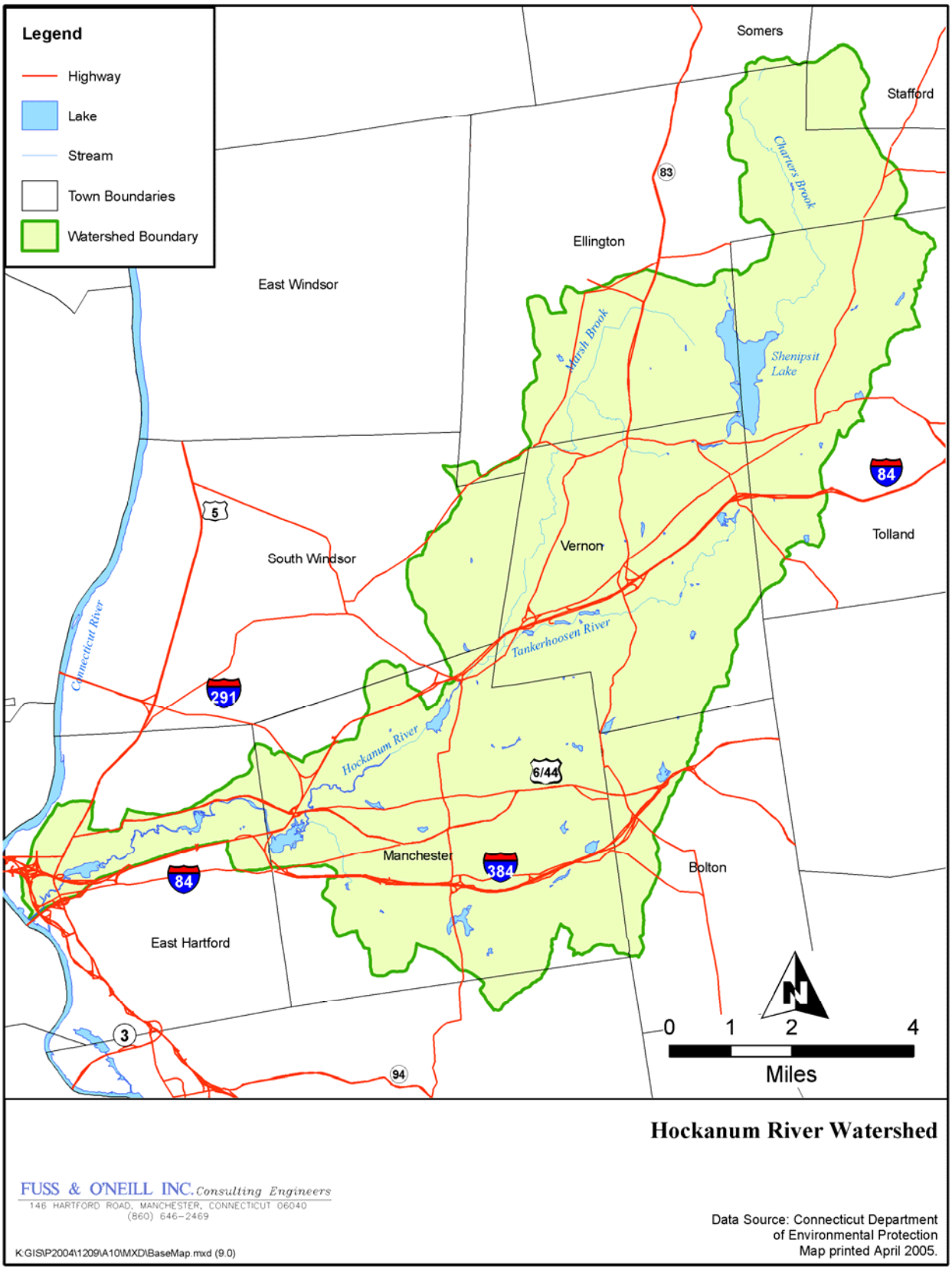
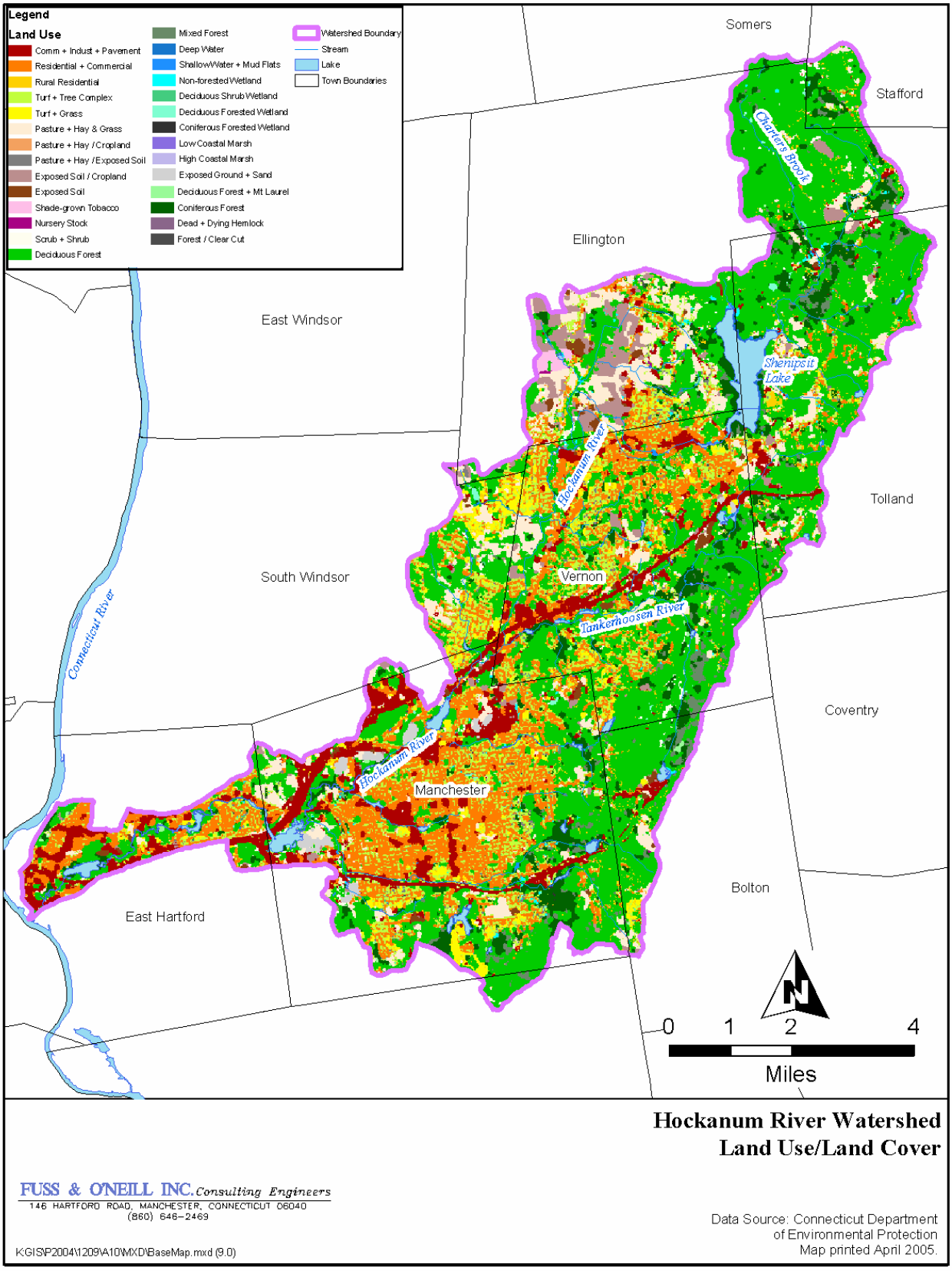


Figure 1-2. Land Use/Land Cover



2.0 HISTORICAL PERSPECTIVE

2.1 Geology

The Hockanum River watershed is comprised of two distinct geological zones - the Central Valley and the Eastern Uplands. The Central Valley began forming about 225 million years ago when the super-continent Pangaea began to break apart. Connecticut was located near the center of Pangaea close to the equator, creating a hot wet climate. A large rift formed a long, narrow valley through the middle of the state, eventually filling with sediments from the eroding hills to the east and west. The sediments were compacted into soft, easily eroded, red and brown sandstones through which the Connecticut River flows (Mattabesset River Stakeholder Group, September 2000).

The headwaters of the Hockanum originate in an area with a vastly different geological composition: metamorphic bedrock. Metamorphic rocks have been subjected to the intense heat and pressure of the Earth's interior and become a cohesive, strong structure. This mineral "weld" is much more resistant to erosion than the brownstone of the Central Valley. The different rate of erosion of these materials has created an abrupt rise along what is known as the Eastern Wall, along what is now the Bolton Range located near the Vernon-Manchester town line.

Drastic changes in surficial geology have occurred within Connecticut since the formation of these geological regions. Above the sandstone and metamorphic bedrock lie extensive glacial deposits, or "glacial till", left as the large glaciers receded. Melting glacier ice formed rivers which sorted glacial till into layers of sand and gravel, or "stratified drift". The Hockanum River flows through hills of glacial till in the steep Eastern Uplands and then drops into the stratified drift of the Central Valley (Bell, 1985).

2.2 Population and Industry

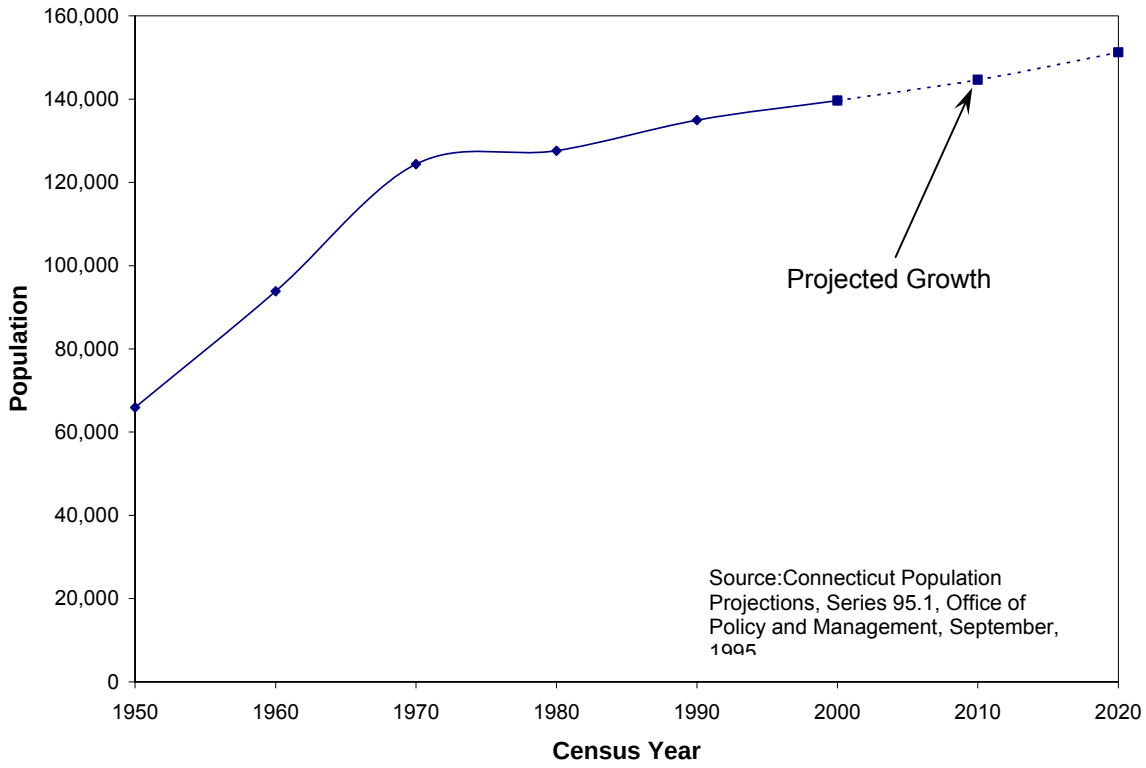
Beginning about 10,000 years ago, as the last glacial ice retreated from the New England, Native American populations settled Connecticut and the areas along the Hockanum River. The river was used by Native Americans as a source of fish and a travel route to the Connecticut River (Hockanum River Watershed Association, 1998). The Podunks of East Hartford and Manchester, the Nipmucks of Ellington and Tolland, and the Mohegans near the river's mouth were among the tribes that farmed corn in the fertile river floodplains of the Hockanum River. In addition to agriculture, the tribes used the land within the watershed for hunting, gathering, and fishing.

European settlers brought a marked change in land use to Connecticut. Land was cleared and agriculture was the primary use through the Revolutionary War era. However, the availability of more fertile lands in western New York, northern Ohio, and Pennsylvania led to the great migration of Connecticut farmers during the 1800s. Those who stayed worked in the many factories that arose along the rivers and streams, and manufacturing became a major economic force (Gibbons et al., 1992).

The Hockanum River and its major tributary, the Tankerhoosen River, were no exception to the development patterns across Connecticut. From the headwaters at Shenipsit Lake to the confluence with the Connecticut River, the elevation drop of the Hockanum (almost 500 feet in 25 miles) was ideally suited to power a wide variety of mills. The rapid drop and numerous waterfalls along the Hockanum River in Vernon near the outlet of Shenipsit Lake were ideal sites for waterpower development. During the eighteenth and nineteenth centuries, numerous mills associated with the textile, cotton-wool, energy, and paper industries were built near these waterfalls and in other areas in the watershed. Although alternate forms of manufacturing power put most of the mills out of business by the 1950s, dozens of the mill buildings and their associated dams remain an integral component of the river. Rapid population growth in the post-war era of the 1950s and 1960s slowed significantly as developable land became scarce (see Figure 2-1).

Today, the population of the Hockanum River watershed is approximately 140,000, which is nearly double the population of the watershed in the 1950s. Rapid commercial and residential development has occurred in the watershed since the 1970s, with a continued decline in industrial uses. Significant commercial development along the major transportation corridors and residential development in the watershed has increased watershed impervious coverage and contributed to degraded water quality in portions of the Hockanum River and its tributaries. Numerous historical impoundments within the watershed also continue to serve as barriers to fish passage along the Hockanum River and its tributaries.

Figure 2-1. Population Growth in the Hockanum River Watershed Since 1950



2.3 Restoration Efforts

Since the 1970s, the Hockanum River has been the focus of a number of local and regional efforts to improve the overall condition of the river. Volunteer groups have been conducting trash cleanups, streamwalks, streambank plantings, and trail maintenance projects along the river since the 1970s (Hockanum River Watershed Association, 1998). In 1995, the Tolland and Hartford County Soil and Water Conservation Districts (now referred to as the North Central Conservation District) initiated a watershed management project with funding from the DEP. This project was possible through a grant from the U.S. Environmental Protection Agency (EPA) nonpoint source pollution program under Section 319 of the Clean Water Act. The project has focused on identifying and reducing pollution problems associated with stormwater runoff. Restoration of fish and wildlife habitat is also a component of the project. Highlights of activities undertaken as part of this project are summarized in Table 2-1.

Table 2-1. Summary of the Hockanum River Watershed NPS Program Activities

Year	Activity Description
Year 1	• Preparation of NPS displays • NPS workshop for Town of Bolton • Hosted NEMO workshop for watershed towns • Installed and designed Stormtreat system for East Hartford McDonalds • Spring river cleanup • Storm drain stenciling
Year 2	• Spring river cleanup • Storm drain stenciling • Design and installation of Vortex system demonstration in South Windsor • Coordination with UConn on stormwater treatment system monitoring • BMP manual developed for businesses • Initiation of business outreach program
Year 3	• Spring river cleanup • Continued assistance to UConn sampling of stormwater treatment systems • Continued development of BMP manual for businesses • Business owner outreach
Year 4	• River cleanups • Continued business outreach program • Meetings with Town staff from the watershed towns • Developed RFP for watershed municipalities to conduct stormwater retrofit projects
Year 5	• Continuation of business outreach program • Continuation of planning efforts within the Hockanum River Watershed Association and watershed towns

Source: North Central Conservation District, Inc.

The DEP River Restoration Grant program has funded several river restoration and bank stabilization projects along the Hockanum River and its tributaries, including projects in East Hartford, Vernon, and Manchester. Currently, the Town of Vernon is undertaking a river bank stabilization project along the Hockanum River in the Rockville section of Vernon. The Hockanum River Watershed Association also sponsors periodic river clean-ups and outreach education activities (CRWP, 2001).

The Connecticut River Watch Program (CRWP), a volunteer water quality monitoring, protection, and improvement program for the Connecticut River and its tributaries, is working closely with the HRWA and North Central Conservation District to develop and support a community-based river monitoring and assessment program in the Hockanum River watershed. The CRWP monitoring program has included stream walk surveys and rapid bioassessments (cost-effective biological survey techniques) along the Hockanum and Tankerhoosen Rivers.

The Connecticut DEP also conducts routine ambient water quality and benthic monitoring at approximately twelve locations along the Hockanum and Tankerhoosen Rivers. The data assist in documenting the chemical and biological quality of surface waters within the watershed and will be used to support the development of a Total Maximum Daily Load (TMDL), which will address sources of water quality impairment in the Hockanum and Tankerhoosen Rivers.

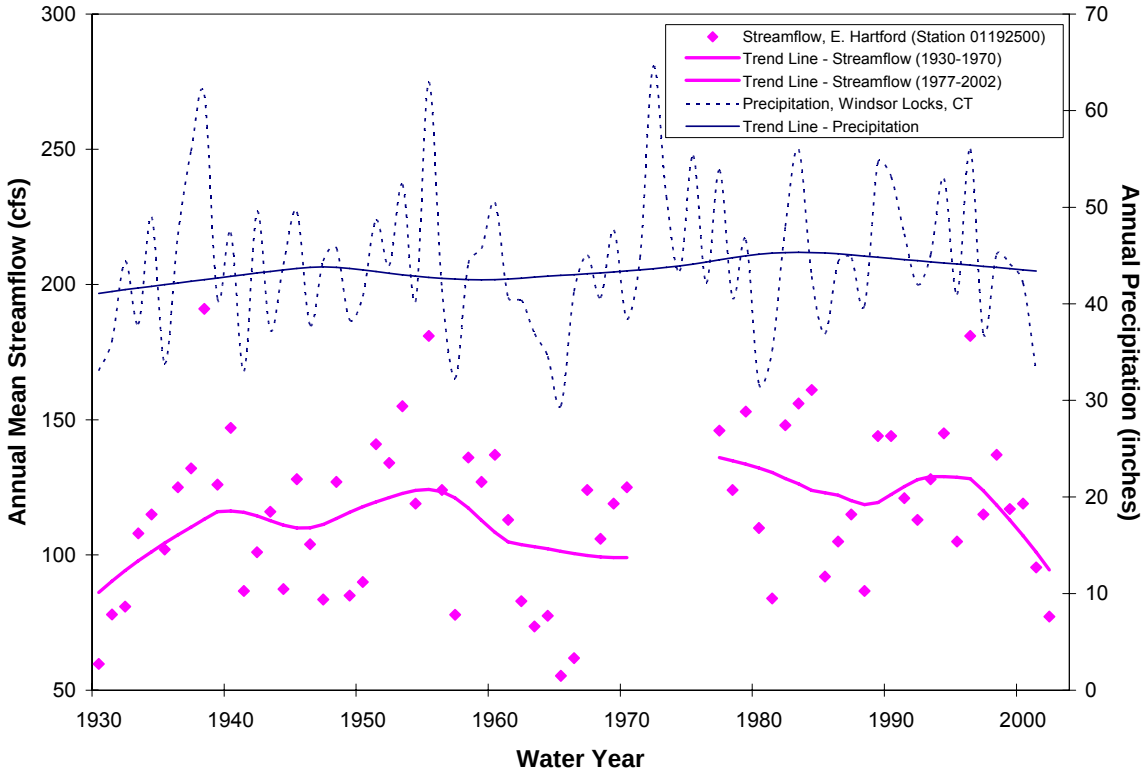
3.0 WATER RESOURCES

3.1 Water Quantity

Streamflow in the Hockanum River is continuously gaged at the East Hartford U.S. Geological Survey (USGS) station (#01192500), located approximately ¼ mile west of the Manchester/East Hartford town line and 3 miles upstream of the confluence with the Connecticut River. This location receives flow from approximately 95 percent of the Hockanum River watershed (73.4 of the 77 square miles), and is referred to hereafter as the "East Hartford" stream gage. Instrumentation at the site measures the river depth or "stage", which is converted to a volumetric flow rate (cubic feet per second) via a rating curve. The USGS has measured streamflow at the East Hartford site since the early 1900s, allowing long-term analysis of streamflow trends in the watershed.

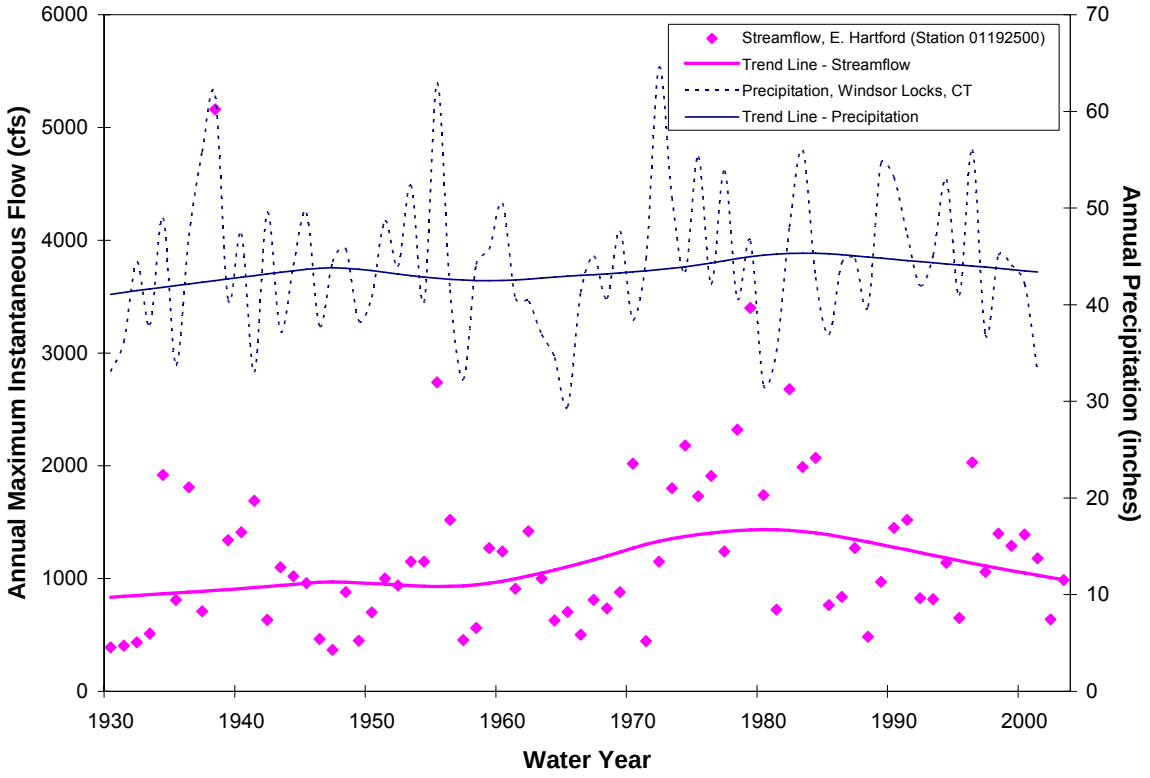
Mean annual streamflow at East Hartford is shown graphically in Figure 3-1. The time series plot also depicts annual precipitation recorded at Bradley International Airport in Windsor Locks, Connecticut (National Weather Service, http://www.erh.noaa.gov/er/box/). Note that a data gap exists during the 1970s. The mean annual flow of the Hockanum River at East Hartford for the period of record is approximately 116 cubic feet per second (cfs). Higher mean annual flows in the river generally coincide with years having higher precipitation, such as in 1938, 1955, 1983, and 1996, and vice versa.

Figure 3-1. Mean Annual Streamflow, East Hartford



Peak annual streamflow at East Hartford, which is the annual maximum instantaneous flow recorded at this location each year, is depicted graphically in Figure 3-2. Annual precipitation recorded at Windsor Locks, Connecticut is also included for reference. The highest peak flow on record (5,160 cfs or approximately 44 times the mean annual flow) at East Hartford occurred on September 21, 1938. Similar to mean annual flow, higher peak flows in the Hockanum River generally coincide with years having higher precipitation and vice versa.

Figure 3-2. Annual Maximum Streamflow, East Hartford



Interpretation of trends in mean annual streamflow, annual maximum streamflow, and annual precipitation was aided by the use of a locally weighted scatterplot smoothing technique (LOWESS), which graphically smooths the pattern of the data over time (Schertz et al., 1991). LOWESS is a linear regression tool commonly used to analyze hydrologic data without assuming a specific model (such as a straight line or predefined distribution). It serves as a visual aid by showing the natural trend of the center of mass of the data. The LOWESS trend lines for mean annual streamflow, annual maximum streamflow, and annual precipitation are shown as solid lines on the graphs in Figures 3-1 and 3-2.

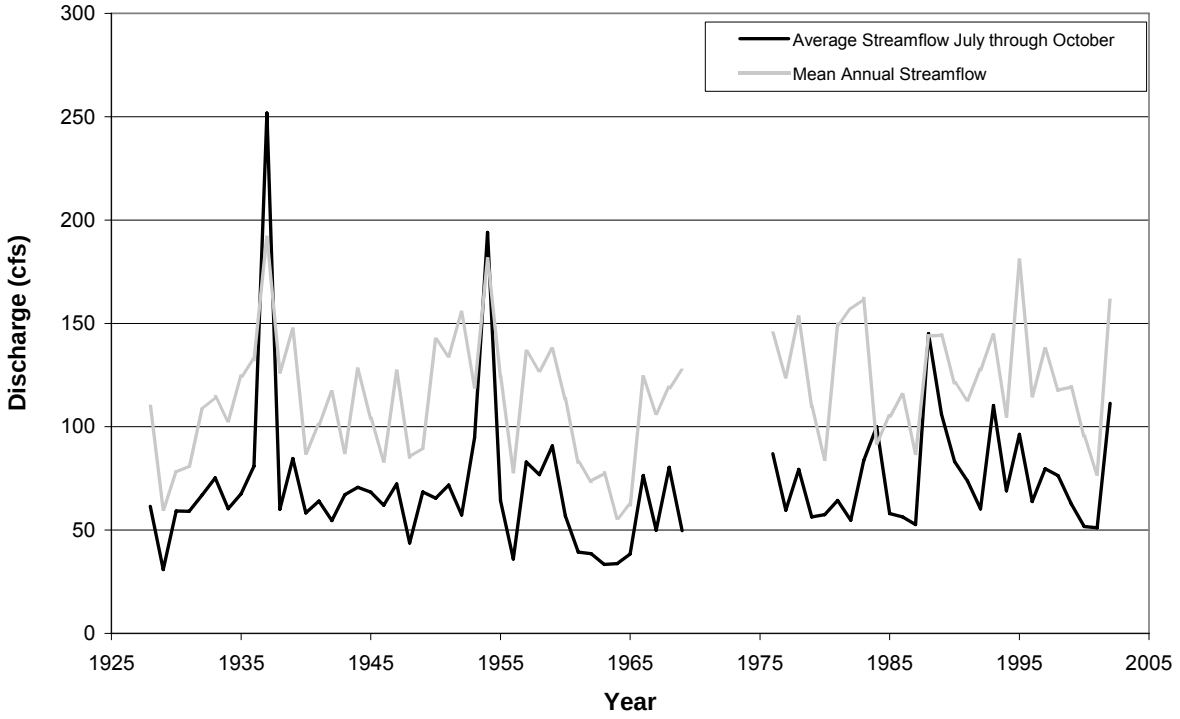
The LOWESS line for mean annual streamflow in Figure 3-1 shows considerable variability throughout the period of record. A general trend of increasing mean annual flows is apparent between 1930 and 1970, while a general decreasing trend in mean annual streamflow has been observed since 1977. Over this same time period, there has been a slight upward trend in annual precipitation in north-central Connecticut.

Annual maximum streamflow exhibits a more pronounced temporal trend, as depicted by the LOWESS lines in Figure 3-2. A marked increase in annual maximum flow occurred at the East Hartford gage location between 1960 and 1980, which corresponds to a period of rapid population growth and urbanization of portions of the watershed. Although there was also a trend of increasing annual precipitation over this same time period, a comparable precipitation trend occurred between 1930 and 1950, without a corresponding trend of similar magnitude for peak flows. The data suggest a gradual change in watershed hydrology as a result of development and urbanization, which is consistent with numerous studies that have documented the link between watershed development and peak discharge rates in urbanized streams (Center for Watershed Protection, 2003). Increasing impervious coverage reduces natural infiltration into the soil, leading to a greater fraction of rainfall that becomes surface runoff. Additionally, storm drainage systems and modified stream channels allow for rapid transport of runoff to the watershed outlet. These two effects of development, both of which have occurred in the Hockanum River Watershed, lead to an increase in peak storm flow.

Also of note in Figure 3-2 is a general decreasing trend in annual maximum streamflow at East Hartford since the mid-1980s, which may reflect the corresponding trend in annual precipitation over the same time period. Additional data are necessary to better evaluate the significance of this apparent trend.

Development of the landscape with impervious surfaces decreases infiltration and groundwater recharge, which can potentially decrease streamflow during dry periods. Figure 3-3 depicts average streamflow of the Hockanum River at East Hartford during the months of July, August, September, and October. These months represent the period of lowest mean monthly streamflow at the East Hartford gaging station over the period of record. The time series of average streamflow during the period July through October shown in Figure 3-3 does not indicate a strong increasing or decreasing trend in low flows over the period of record. With the exception of several significant flood events in 1938 and 1955, there does appear to be a slight increase in the variability of July-August streamflow starting in the mid-1960s, which may be a reflection of increasing impervious cover resulting from development of the watershed during this period. A statistical analysis of the daily streamflow data would be required to further evaluate potential trends in low flows at this location.

Figure 3-3. Average Streamflow July through October, East Hartford



3.2 Water Quality

3.2.1 Classifications and Impairments

The Federal Clean Water Act (CWA) was developed to protect the nation's surface waters. Through authorization of the CWA, the United States Congress declared as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water wherever attainable". Connecticut Water Quality Standards are established in accordance with Section 22a-426 of the Connecticut General Statutes and Section 303 of the CWA. The Water Quality Standards are used to establish priorities for pollution abatement efforts. Based on the Water Quality Standards, Water Quality Classifications establish designated uses for surface and ground waters and identify the criteria necessary to support these uses. The Water Quality Classification system classifies inland surface waters into four different categories ranging from Class AA to D. Table 3-1 summarizes the Connecticut Surface Water Quality Classifications.

Table 3-1. Connecticut Inland Surface Water Quality Classifications

Designated Use	Class AA	Class A	Class B	Class C	Class D
Existing/proposed drinking water supply	●				
Potential drinking water supply	●	●			
Fish and wildlife habitat	●	●	●	Class C and D waters may be suitable for certain fish and wildlife habitat, certain recreational activities, industrial	
Recreational use	●	●	●		
Agricultural and industrial use	●	●	●		

				use, and navigation

Source: DEP Surface Water Quality Standards, December 17, 2002

Figure 3-4 depicts the Water Quality Classifications of surface waters in the Hockanum River watershed. Surface waters throughout much of the upper and central portions of the Hockanum River watershed are classified as AA or A, with Shenipsit Lake and numerous other impoundments serving as drinking water supplies for Vernon, Manchester, and neighboring communities. A segment of the Hockanum River downstream of Shenipsit Lake in the Rockville section of Vernon is classified as Class C with a goal of Class B criteria. The Dobsonville Ponds along the Tankerhoosen River have a Class B designation. Much of the lower third of the Hockanum River, downstream of the most heavily developed areas of the watershed in Vernon and Manchester, are classified as Class C or Class D. The goal for these portions of the Hockanum River is attainment of Class B criteria and designated uses.

The CWA (Federal Clean Water Act) requires states to:

1. Adopt Water Quality Standards,
2. Assess surface waters to evaluate compliance with Water Quality Standards,
3. Identify those waters not currently meeting Water Quality Standards, and
4. Develop Total Maximum Daily Load (TMDL) analysis and other management plans to bring water bodies into compliance with Water Quality Standards.

The majority of the Hockanum River and a portion of the Tankerhoosen River do not meet Water Quality Standards for at least one of their designated uses. Table 3-2 summarizes the location of the impaired waters and the impaired designated uses. Use support is labeled as either partially-supporting (P) or non-supporting (N). TMDLs provide the framework to restore impaired waters by establishing the maximum amount of a pollutant that a water body can assimilate without adverse impact to aquatic life, recreation, or other public uses. The DEP is currently conducting a stressor identification evaluation to determine the most likely cause of the aquatic life impairments in the Hockanum River and the Tankerhoosen River. The *2004 List of Connecticut Waterbodies Not Meeting Water Quality Standards* includes a priority ranking system for development of a TMDL specific to the contaminants in each impaired segment: high (H), medium (M), low (L), or under study (T).

As summarized in Table 3-2, the primary impairments in the Hockanum River are associated with aquatic life support, suspected to be caused by high turbidity, organic enrichment, and unknown causes, and primary contact recreation due to elevated concentrations of bacteria and algal growth. Municipal point sources (landfills and wastewater treatment plants), urban runoff and storm sewers, agriculture, channelization and habitat modification, and erosion and sedimentation are the major sources or suspected sources of the impairments (DEP, 2004a). The causes and sources of impairment in the lower reaches of the Tankerhoosen River have not been identified and are currently listed as "unknown."

Figure 3-4. Surface Water Bodies and Water Quality Classifications

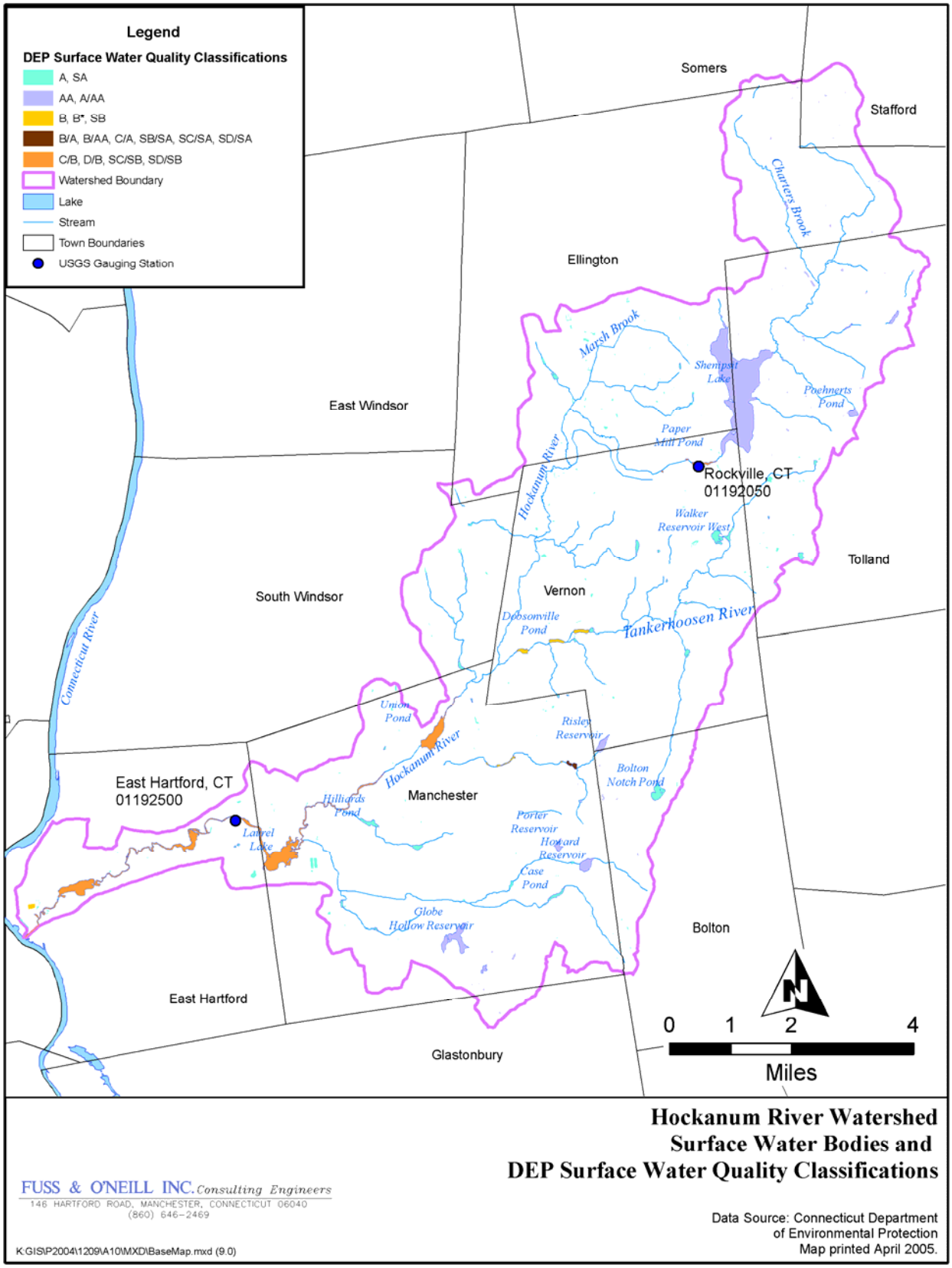


Table 3-2. Hockanum River Watershed Impaired Waters

Location Description	Waterbody Segment Length	Impaired Designated Use	Use Support	Cause	TMDL Priority	Potential Source
Hockanum River						
From mouth at Connecticut River, E. Hartford, US to 1st dam at Scotland Impoundment	4.10 miles	Aquatic Life Support	P	Cause unknown	M	Source Unknown
From 1st dam at Scotland Impoundment US to confluence with South Fork of Hockanum	3.60 miles	Aquatic Life Support	P	Cause unknown* (Turbidity)	M	Municipal Point Sources, Urban Runoff
		Primary Contact Recreation	N	Bacteria	L	
From confluence with the South Fork of the Hockanum River (Laurel Lake) US to Union Pond	3.40 miles	Aquatic Life Support	P	Cause unknown	M	Urban Runoff
Union Pond, on Hockanum River in Manchester at Union Street	50.0 acres	Aquatic Life Support	P	Organic enrichment	H	Contaminated Sediments, Erosion & Sedimentation, Urban Runoff
		Fish Consumption	N	Pesticides	H	
		Primary Contact Recreation	P	Algal growth	H	
From inlet to Union Pond US to 1 mile DS of Dart Hill Road	3.20 miles	Aquatic Life Support	P	Cause unknown	T	Urban Runoff
From 1 mile DS of Dart Hill Road to Vernon WWTP	2.30 miles	Aquatic Life Support	P	Cause unknown	T	Municipal Point Sources, Urban Runoff
		Primary Contact Recreation	P	Bacteria	L	
From Vernon WWTP to Vernon Ave	3.80 miles	Aquatic Life Support	P	Cause unknown*, (Turbidity), (Copper), (Lead), (Organic Enrichment)	T	Agriculture, Channelization, Habitat Modification, Hydromodification Urban Runoff
		Primary Contact Recreation	N	Bacteria	L	
From Vernon Ave (outlet of culvert) US to Paper Mill Pond (inlet of culvert)	0.70 miles	Aquatic Life Support	N	Habitat Alterations	NA	Channelization, Hydromodification
		Primary Contact Recreation	N	Flow Alterations	NA	
From Paper Mill Pond US to Shenipsit Lake	0.70 miles	Aquatic Life Support	P	Cause Unknown	T	Source Unknown
Tankerhoosen River						
From mouth at Hockanum River US to Tankerhoosen Lake	1.70 miles	Aquatic Life Support	P	Cause Unknown	T	Source Unknown

Source: DEP, April 2004

T – currently under study and may lead to TMDL development if results of investigation warrant implementing a TMDL as the solution to remedy the water quality impairment.

H – high priority for which there is assessment information that suggests that a TMDL may be needed to restore the water quality impairment.

M – medium priority for which there may be insufficient information to assess whether a pollutant is causing the impairment or that other programs are likely to remedy the water quality impairment.

L – low priority for TMDL development because other programs are likely to remedy the water quality impairment.

NA – not applicable
P – partially supporting
N – Not supporting
* "Cause unknown" is included here because of aquatic life impairment has not been verified.
US – upstream
DS – downstream

3.2.2 Monitoring Data

Water quality in the Hockanum River has been impacted by land use practices and development within the watershed, as evidenced by the impairments described in the previous section. Available chemical and biological monitoring data reflect the degraded water quality of the Hockanum River and a general upstream-downstream trend of decreasing water quality, which is consistent with the development patterns in the watershed.

USGS Water Quality Monitoring Data

Historical water quality monitoring has been performed by the USGS at two locations along the Hockanum River (see Figure 3-4). The Rockville monitoring location (USGS #01192050) represents 25.5 square miles (approximately 33 percent) of the watershed. Water quality monitoring at East Hartford occurs at the same location as the previously mentioned streamflow gaging station, representing 73.4 square miles of the watershed (approximately 95 percent). Although the Rockville water quality monitoring location is located closer to the headwaters of the Hockanum River, just downstream of Shenipsit Lake, it also receives flow from areas located in the urbanized Rockville Center. The Rockville monitoring location provides a useful comparison to the East Hartford water quality monitoring site because it is upstream of the two municipal wastewater treatment plants that discharge treated effluent to the Hockanum River, as well as the majority of the developed areas of Vernon and Manchester.

The periods of record for the Rockville and East Hartford monitoring locations date back to 1954, but the time series are sparse until the early 1990s. Routine monitoring data are available at both locations from the early 1990s through 2003. This period of record was selected to assess temporal and spatial trends in water quality in the watershed. The following paragraphs summarize water quality trends at the Rockville and East Hartford monitoring locations for selected water quality parameters.

Temperature, pH, and Dissolved Oxygen

Temperature, pH, and dissolved oxygen are general indicators of water quality. Time series plots of these parameters are provided as Figures 3-5 through 3-10.

Water temperature generally reflects seasonal fluctuations in ambient temperatures. Extreme temperature fluctuations in the river may be indicative of thermal pollution due to stormwater runoff from impervious surfaces or high-temperature wastewater discharges. Seasonal variability in water temperature is similar at the Rockville and East Hartford monitoring locations. On average, water temperatures are somewhat higher at East Hartford than at Rockville, likely due to thermal enrichment associated with stormwater runoff from the urbanized areas of Vernon and Manchester. Several extreme temperatures were measured at the East Hartford monitoring location in the early and mid-1990s. In one instance, the temperature of the Hockanum River exceeded the established limit of 85ºF (approximately 29 degrees Celsius) contained in the Connecticut Water Quality Standards (referred to as "CTWQS" in the following plots).

Figure 3-5. Water Temperature – Rockville, Connecticut (USGS # 01192050)

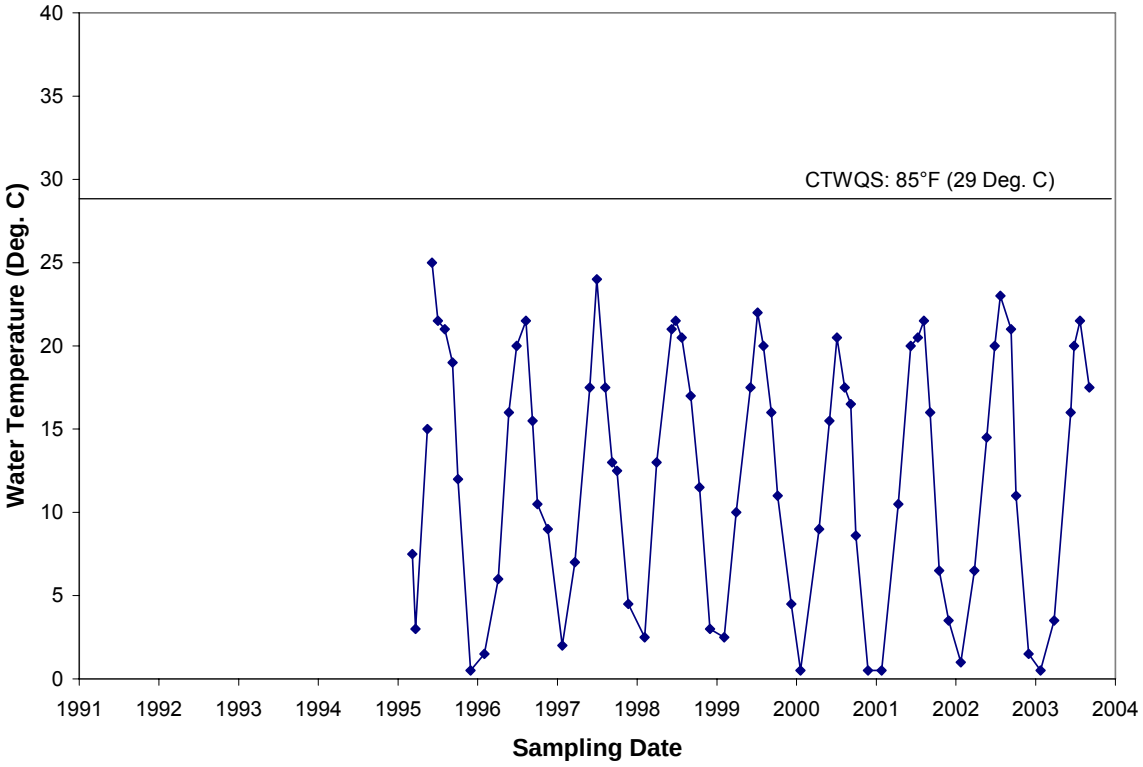


Figure 3-6. Water Temperature – East Hartford, Connecticut (USGS # 01192500)

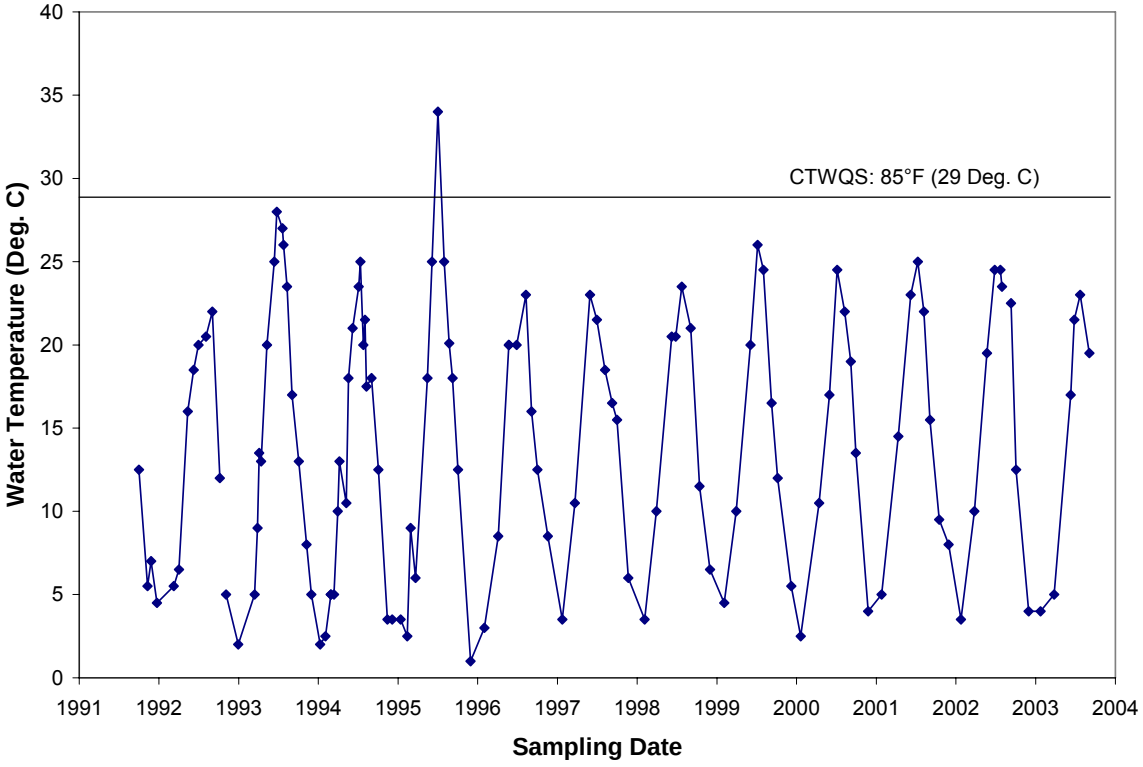


Figure 3-7. Water pH – Rockville, Connecticut (USGS # 01192050)

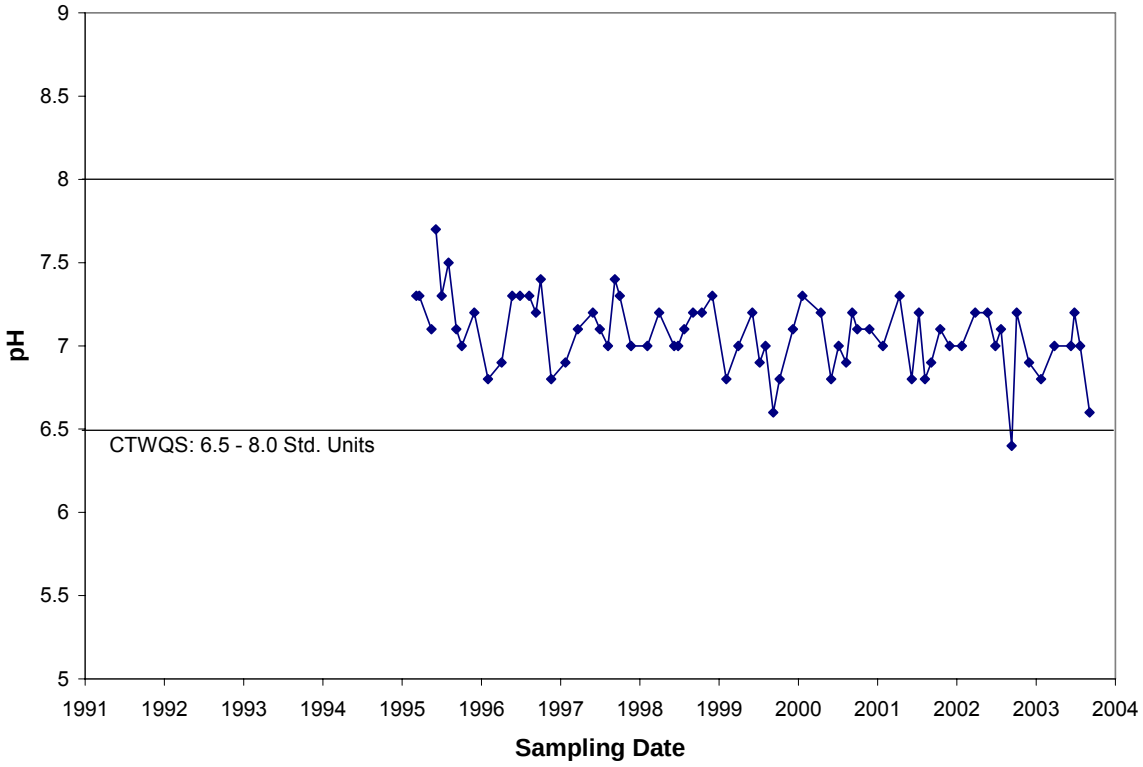


Figure 3-8. Water pH – East Hartford, Connecticut (USGS # 01192500)

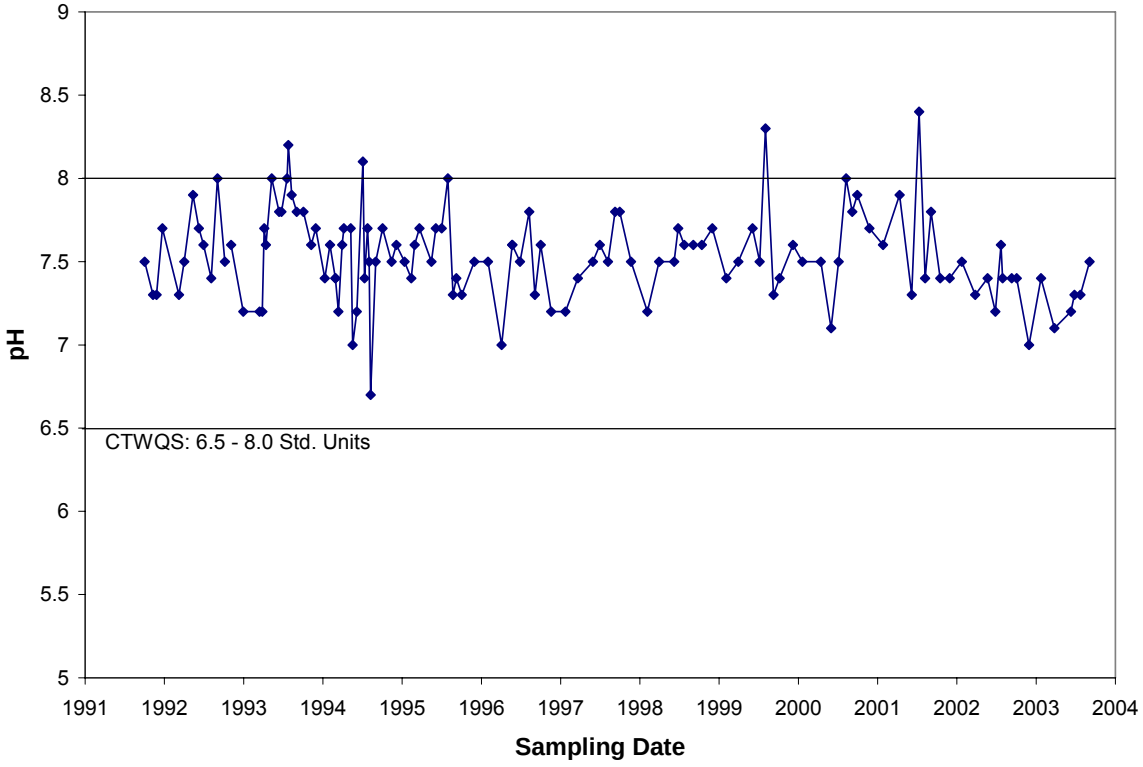


Figure 3-9. Dissolved Oxygen – Rockville, Connecticut (USGS # 01192050)

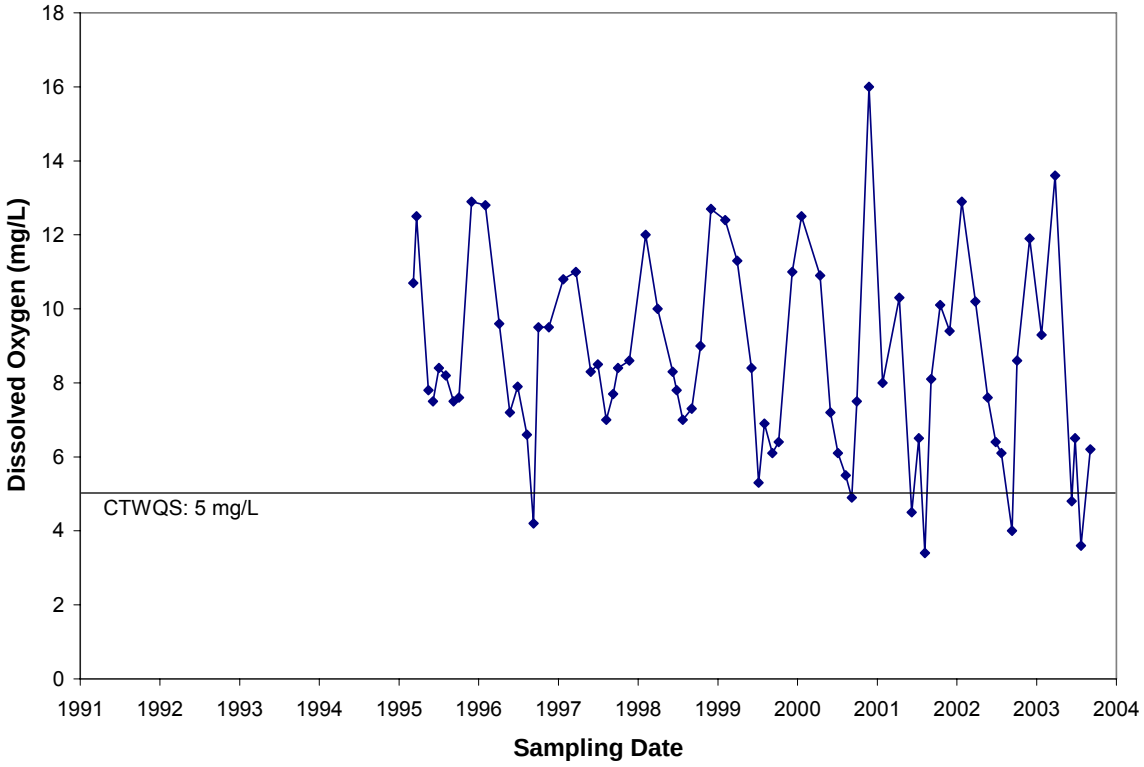
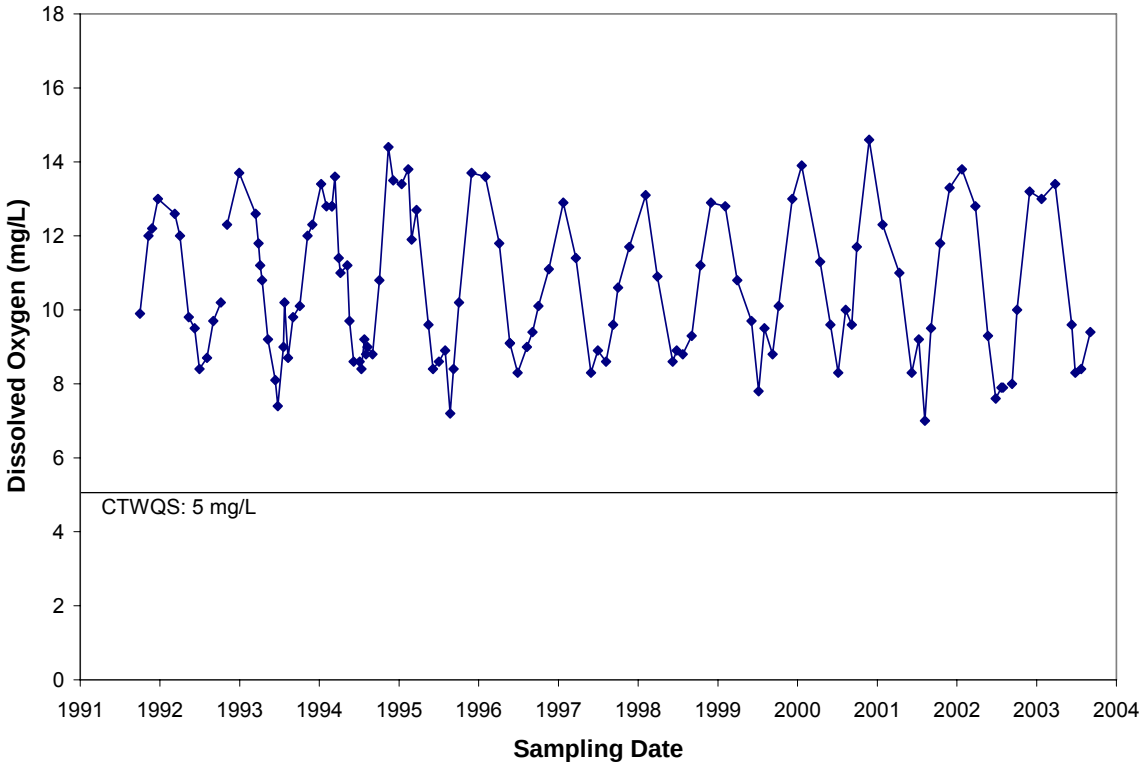


Figure 3-10. Dissolved Oxygen – East Hartford, Connecticut (USGS # 01192500)



pH is the measure of the acidity or alkalinity of a solution. 6.5 to 8.0 is considered an acceptable range of pH for most surface waters (Connecticut Water Quality Standards). Extreme fluctuations from this range are detrimental to water quality and aquatic organisms. pH values measured at Rockville are generally within this range, except on one occasion in 2002 when the measured pH was slightly below 6.5. The pH of the Hockanum River at East Hartford is generally more variable and somewhat higher than at Rockville.

Dissolved oxygen is an important indicator of habitat quality and ecosystem condition. Dissolved oxygen is necessary in aquatic systems for the survival and growth of aquatic organisms. The Connecticut Water Quality Standards establish a criterion for dissolved oxygen of 5 mg/L. Prolonged exposure to dissolved oxygen below this level may increase organisms' susceptibility to environmental stresses (CCRPA, 2004). The dissolved oxygen measured in the river at the Rockville monitoring location is more variable than at East Hartford, resulting in several excursions below the 5 mg/L threshold during late summer or early fall. These results may reflect seasonal oxygen depletion in Shenipsit Lake, which is upstream of the Rockville monitoring location.

Turbidity

Turbidity is a measure of the amount of light intercepted by the water column due to the presence of suspended and dissolved matter. Turbidity is measured in Nephelometric Turbidity Units (NTU). The Connecticut Water Quality Standards establish a turbidity criterion of 5 NTU over ambient levels.

Suspended particulates such as clay, silt, sand, suspended algae, industrial wastes, and sewage reduce the clarity of water bodies in the Hockanum River Watershed. Although pristine streams experience an increase of suspended solids during erosive high flow events, development within the watershed has caused a persistent higher turbidity. Increased turbidity reduces the amount of light available for aquatic vegetation. Less photosynthesis and decaying plants depletes oxygen levels in the water, and thus degrades fish habitat. Additionally, fine particulate sediment abrades sensitive fish and insect gills. Silt accumulating on the stream bed can suffocate newly hatched larvae and fill in spaces inhabited by benthic aquatic organisms. Sources of turbidity in the Hockanum River include soil erosion associated with construction, wastewater discharges, urban stormwater runoff, and stream bank disturbances.

Figures 3-11 and 3-12 depict time series of turbidity monitoring data at Rockville and East Hartford over the period of record, while Figure 3-13 summarizes average annual turbidity measured at both locations. Figure 3-13 also includes an EPA "Reference Condition" (shown as a dashed line on the figure), which has been derived as baseline criteria for each region of the U.S. The value shown on the figure represents the 25th percentile of data from surface waters in the Eastern Coastal Plain Ecoregion (Ecoregion XIV) that are minimally impacted by human activities and believed to be protective of aquatic life and recreational uses.

Figure 3-11. Turbidity – Rockville, Connecticut (USGS # 01192050)

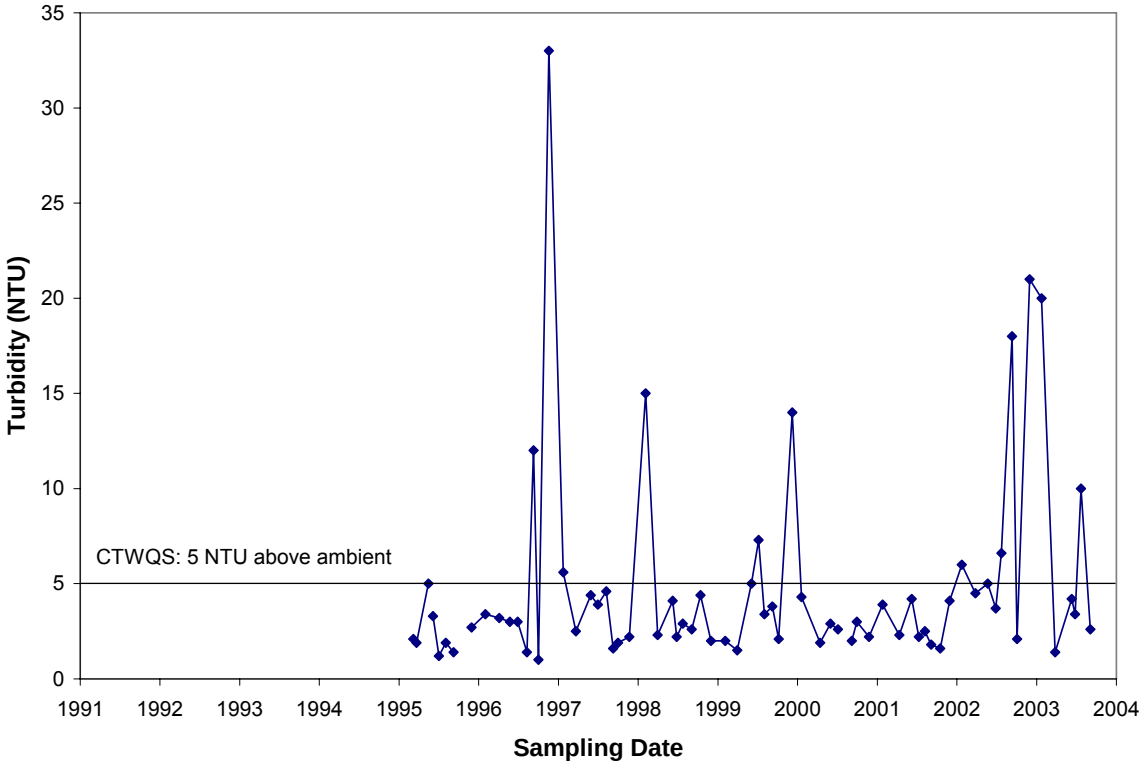


Figure 3-12. Turbidity – East Hartford, Connecticut (USGS # 01192500)

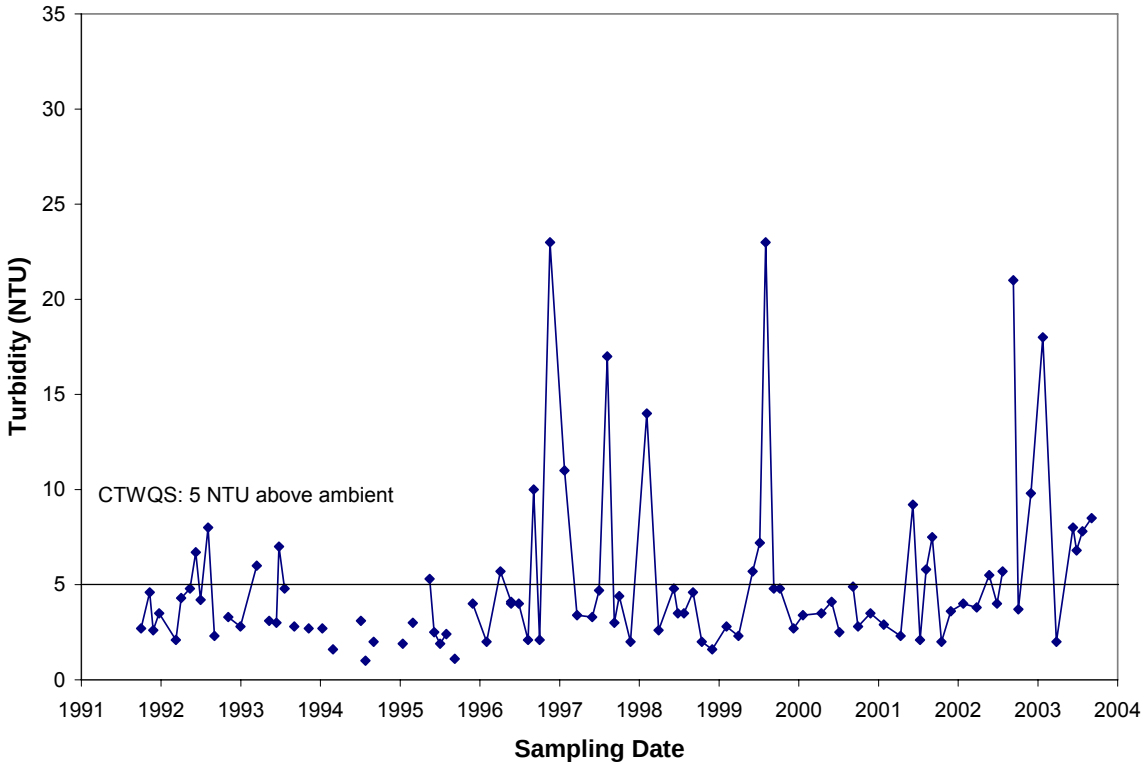
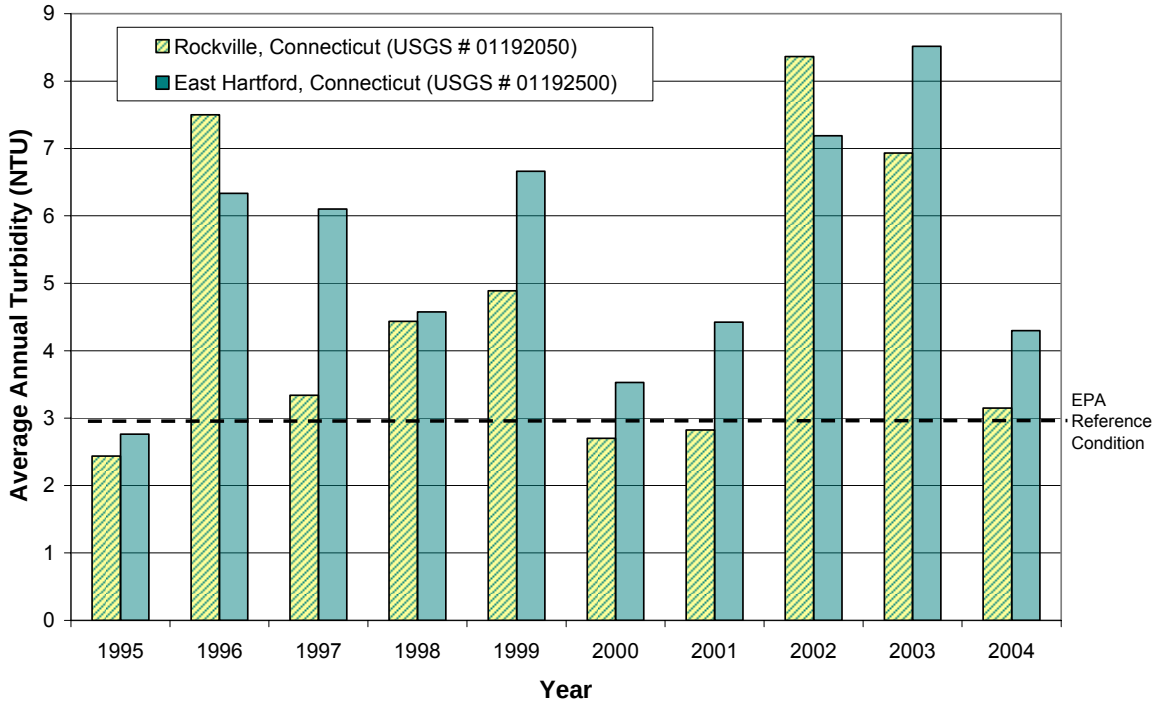


Figure 3-13. Average Annual Turbidity



Measured turbidity in the Hockanum River is highly variable, which is indicative of the ubiquitous nature of sediment sources in the watershed. Construction activities near the river may temporarily increase suspended sediment in stormwater runoff, but eventual stabilization of construction sites would likely eliminate or reduce the source. Heavy rainfall may also contribute to stream channel erosion, which could result in sudden increases in river turbidity levels.

A sharp increase in turbidity at both monitoring locations occurred in late 1996, with several episodic increases in turbidity occurring since then at both locations. These increases in turbidity significantly exceed the DEP Water Quality Standard criterion of 5 NTU above ambient levels and the EPA Reference Condition of 3.04 NTU. Although it is difficult to attribute the turbidity excursions to a particular source, it is clear that excessive turbidity is a significant water quality issue in the Hockanum River.

Fecal Coliform

Fecal coliform is a bacterial organism historically used as an indicator of sanitary quality in surface waters. The DEP abandoned fecal coliform as a water quality indicator in 2002 in favor of other bacterial indicators such as Enterococci and *Escherichia Coli*. However, fecal coliform was historically monitored by the USGS at both Rockville and East Hartford. Figures 3-14 and 3-15 summarize fecal coliform concentrations measured at each location. The former Water Quality Standard criterion for fecal coliform (10% of samples shall not exceed 400 colonies per 100 mL) is also included in the figures for reference. A log-scale is used for these plots to aid in visualizing the data.

Figure 3-14. Fecal Coliform – Rockville, Connecticut (USGS # 01192050)

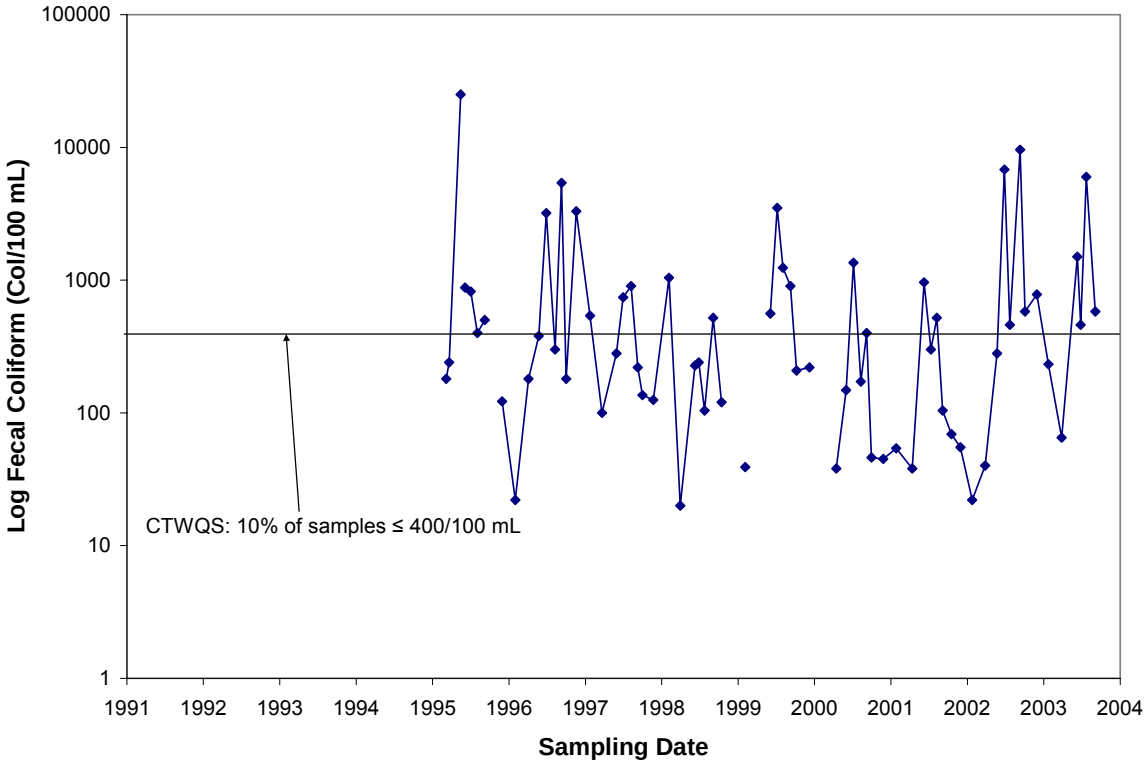
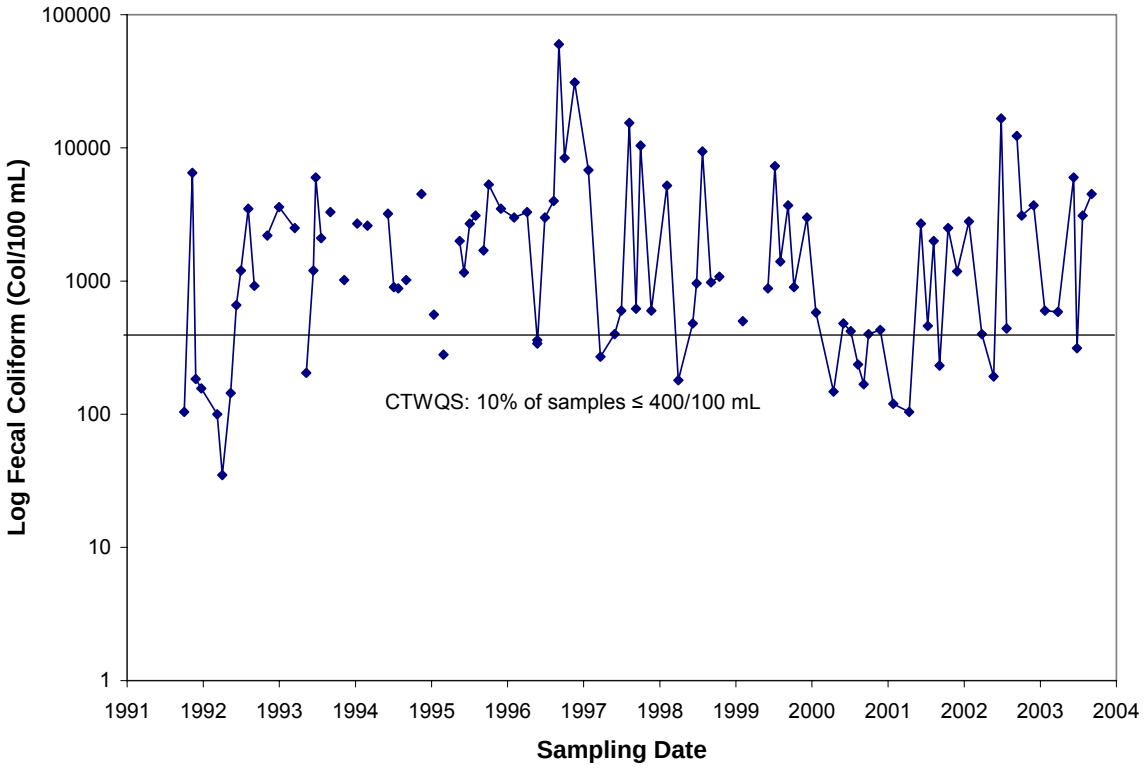


Figure 3-15. Fecal Coliform – East Hartford, Connecticut (USGS # 01192500)



Elevated fecal coliform concentrations have been measured at both Hockanum River monitoring locations since the early to middle 1990s. Fecal coliform concentrations in the river are generally higher at the East Hartford monitoring location than at Rockville, which is likely attributable to the point and nonpoint sources of bacteria (wastewater treatment plant effluent, urban stormwater runoff, pet waste, waterfowl, septic systems, landfills, etc.) in the central and lower portions of the watershed between the two monitoring locations.

Nitrogen

Excessive nitrogen loadings have led to hypoxia, a condition of low dissolved oxygen, in Long Island Sound. Nitrogen fuels the growth of algae in the Sound, which eventually decays, consuming oxygen in the process (DEP, 2001). A Total Maximum Daily Load (TMDL) for nitrogen has been developed for Long Island Sound, which will restrict nitrogen loadings from point and nonpoint sources throughout Connecticut.

Figures 3-16 and 3-17 are time series plots of total nitrogen concentrations (ammonia nitrogen, organic nitrogen, nitrite nitrogen, and nitrate nitrogen) at Rockville and East Hartford, respectively. The EPA recommended Total Nitrogen criteria for rivers in Ecoregion XIV of 0.71 mg/L is also provided for comparison (EPA, 2000). Nitrogen concentrations at both locations exhibit seasonal fluctuations and are above the EPA Reference Condition value. Nitrogen concentrations are significantly higher at East Hartford than at Rockville, which reflects the significant contribution of nitrogen from the municipal wastewater treatment plants and other sources of nitrogen in the watershed such as precipitation and atmospheric deposition, urban stormwater runoff, septic system effluent, agricultural runoff, and animal waste.

Total nitrogen loading is calculated by the product of effluent concentration and flow rate, which yields a "pounds per day" loading rate. Figure 3-18 summarizes average annual loadings of total nitrogen in the Hockanum River at Rockville and East Hartford. The annual nitrogen loading rate at East Hartford is approximately 10 times greater than the nitrogen loading rate at Rockville. As described in Section 3.5, a large percentage of the total nitrogen load between the Rockville and East Hartford monitoring locations is associated with treated effluent from the Vernon and Manchester wastewater treatment plants. Additional information on nitrogen loadings associated with the municipal wastewater treatment plants in the watershed is presented in Section 3.5.

Figure 3-16. Total Nitrogen – Rockville, Connecticut (USGS # 01192050)

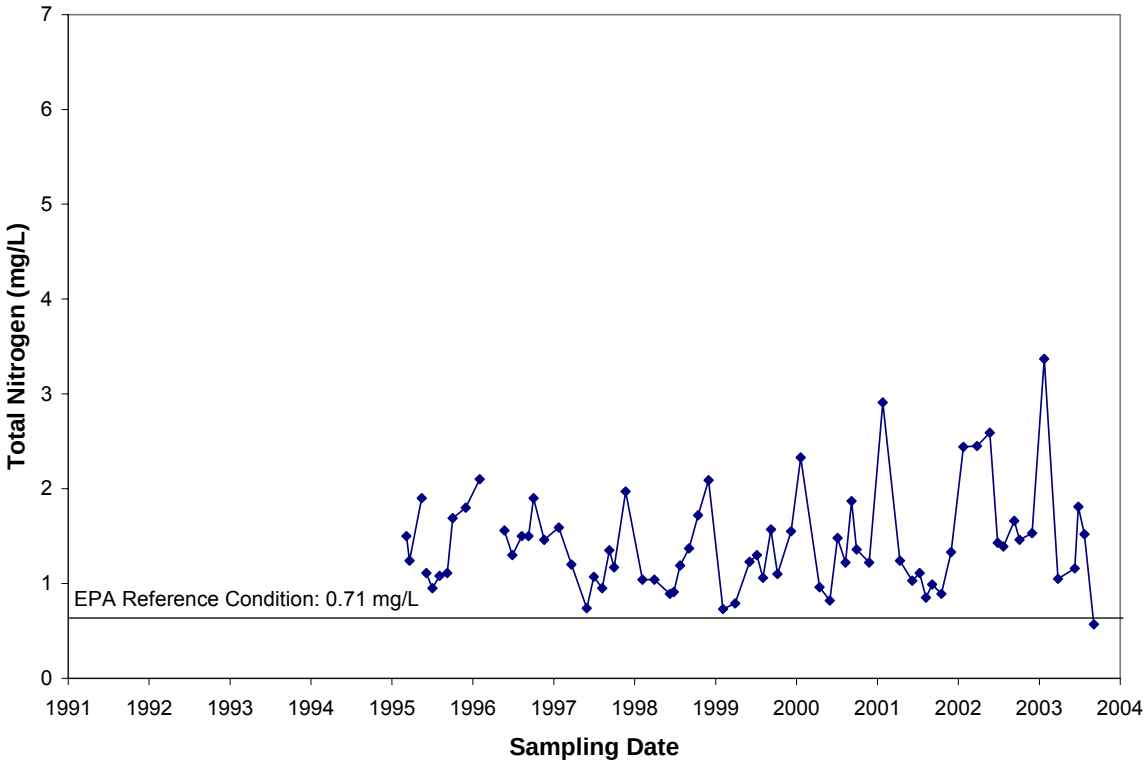


Figure 3-17. Total Nitrogen – East Hartford, Connecticut (USGS # 01192500)

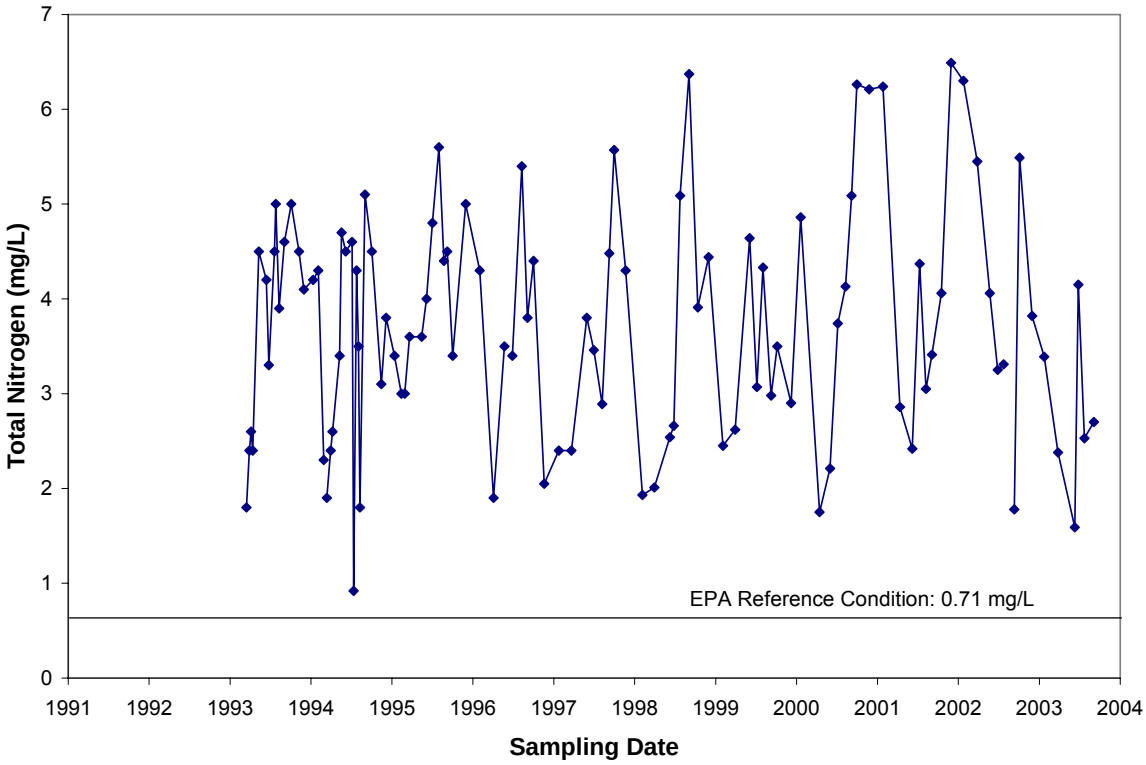
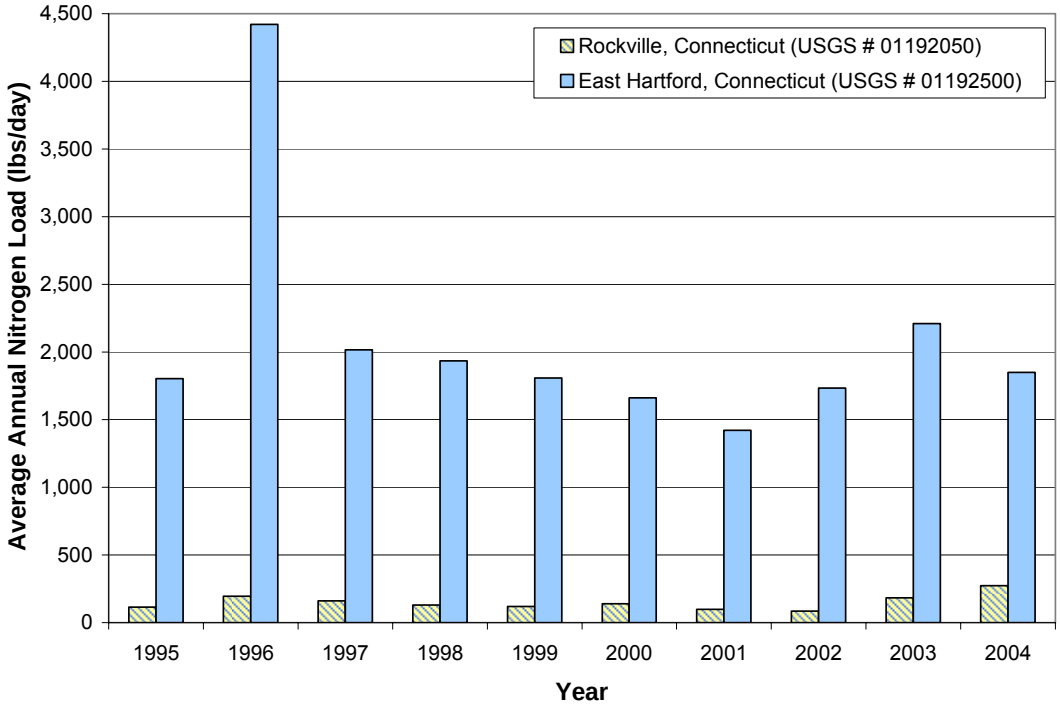


Figure 3-18. Average Annual Nitrogen Load



Phosphorus

Phosphorus is typically the growth-limiting nutrient in freshwater systems and is responsible for the growth of algae and eutrophication of fresh water bodies such as lakes, ponds, and low-gradient streams. According to the Connecticut Water Quality Standards (DEP, 2002), spring and summer phosphorus concentrations for lakes that would be expected to result in full support for contact recreational uses are less than 0.03 mg/L. This is consistent with the EPA recommended Total Phosphorus criteria for rivers in Ecoregion XIV (EPA, 2000). Total phosphorus concentrations measured at Rockville (Figure 3-19) are at or slightly above the threshold value of 0.03 mg/L, with peak concentrations exceeding the threshold by an order-of-magnitude on an annual basis. Total phosphorus concentrations at East Hartford exhibit more variability than at Rockville and are consistently well above the threshold value of 0.03 mg/L. The elevated phosphorus levels in the Hockanum River are consistent with the observed organic enrichment and algal growth in certain reaches and impoundments of the river, which is a cause of impairment for aquatic life support and contact recreation, particularly during low-flow conditions.

Figure 3-19. Total Phosphorus – Rockville, Connecticut (USGS # 01192050)

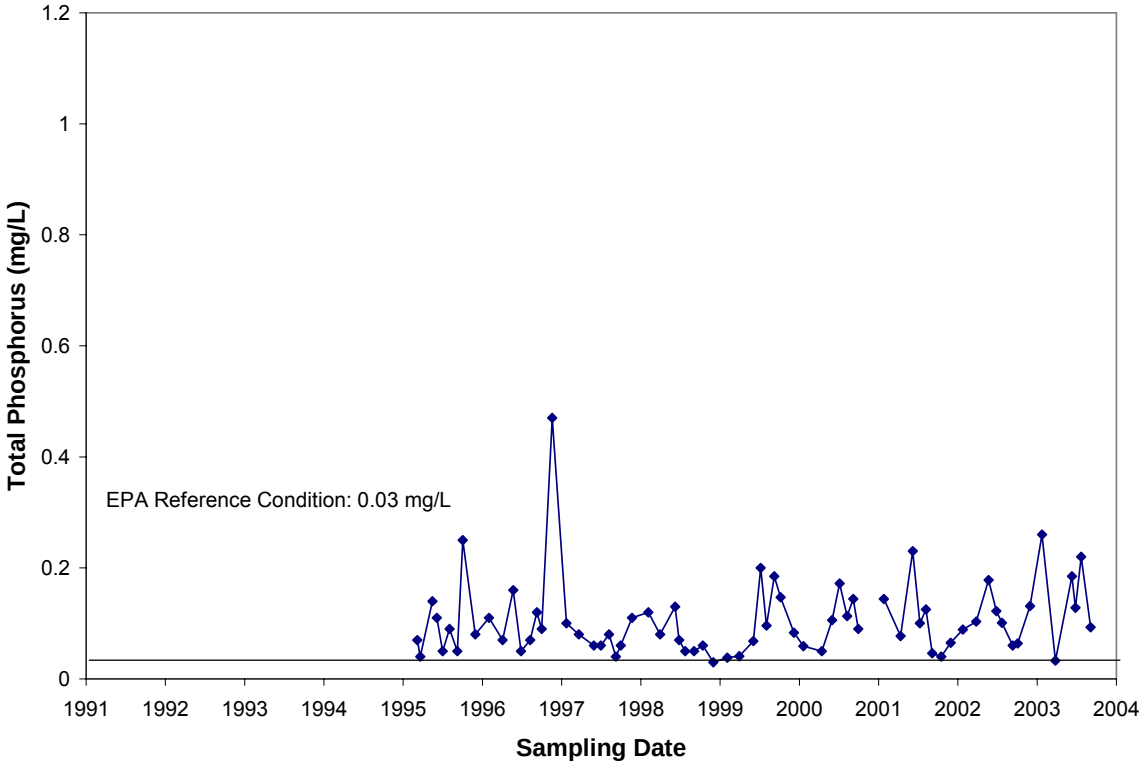
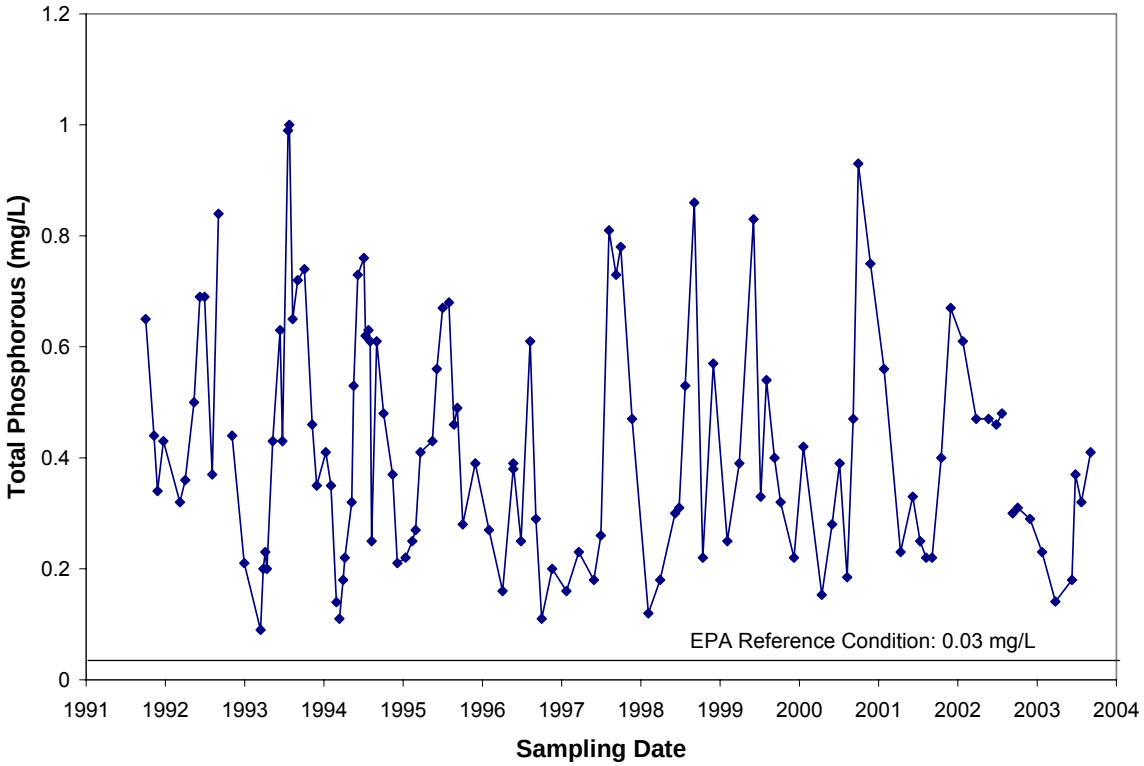


Figure 3-20. Total Phosphorus – East Hartford, Connecticut (USGS # 01192500)



Copper

The presence of heavy metals such as such as copper, lead, zinc, mercury, and cadmium in surface waters can be toxic to aquatic organisms, can bioaccumulate, and have the potential to contaminate drinking water supplies. Many major rivers in Connecticut have copper levels that exceed Connecticut's Copper Water Quality Criteria. Although metals generally attach themselves to the solids in stormwater runoff or receiving waters, recent studies have demonstrated that dissolved metals, particularly copper and zinc, are the primary toxicants in stormwater runoff from industrial facilities throughout Connecticut (DEP, 2004b).

Figures 3-21 and 3-22 summarize dissolved copper concentrations at the Rockville and East Hartford monitoring locations relative to the Connecticut Water Quality Standards freshwater chronic aquatic life criterion of 4.8 micrograms per liter (ug/L). Biological integrity is impaired when the ambient concentration exceeds this value on more than 50 percent of days in any year (Connecticut Water Quality Standards, 2002). As depicted in Figure 3-21, approximately 10 exceedances of the chronic aquatic life criterion have been measured at the Rockville site since 1998, which indicates a source of metals in the upstream reaches of the Hockanum River. At East Hartford, dissolved copper concentrations were at or slightly above the chronic aquatic life criterion in the early to mid-1990s, but have been primarily below the criterion since 1995. The relatively lower copper concentrations at East Hartford are also likely attributable to dilution effects. The data suggest that metals are a potential source of impairment in the Hockanum River.

Figure 3-21. Dissolved Copper – Rockville, Connecticut (USGS # 01192050)

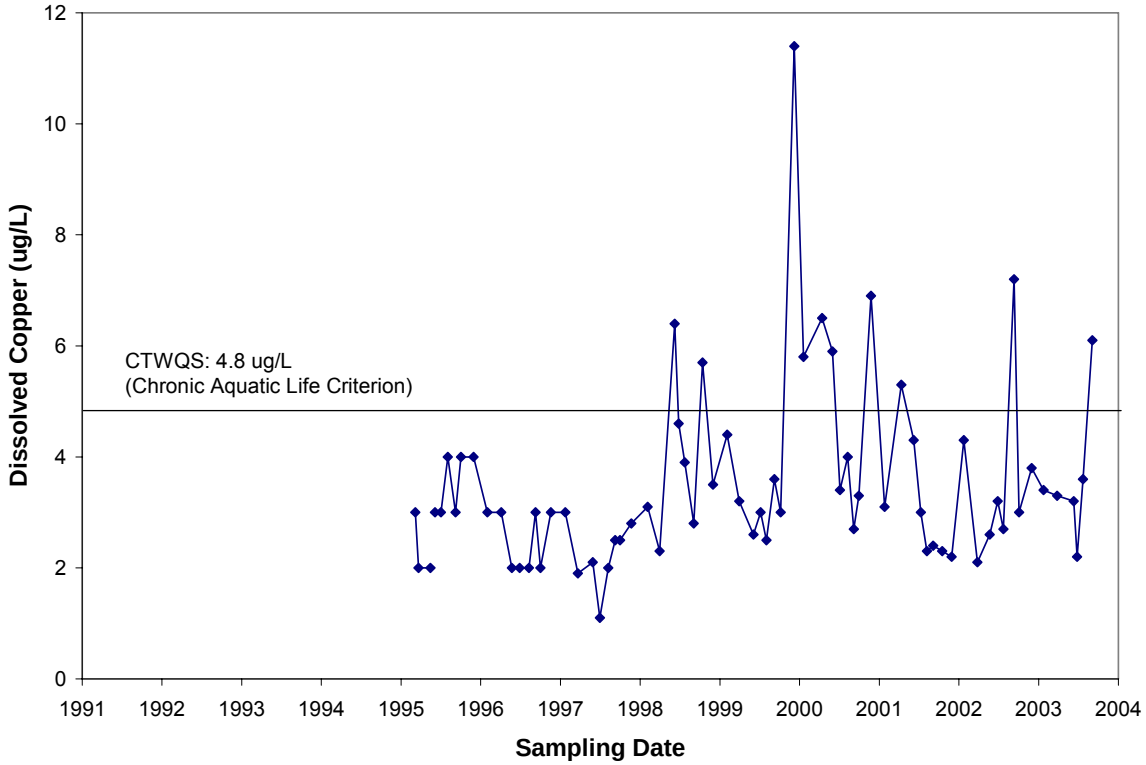
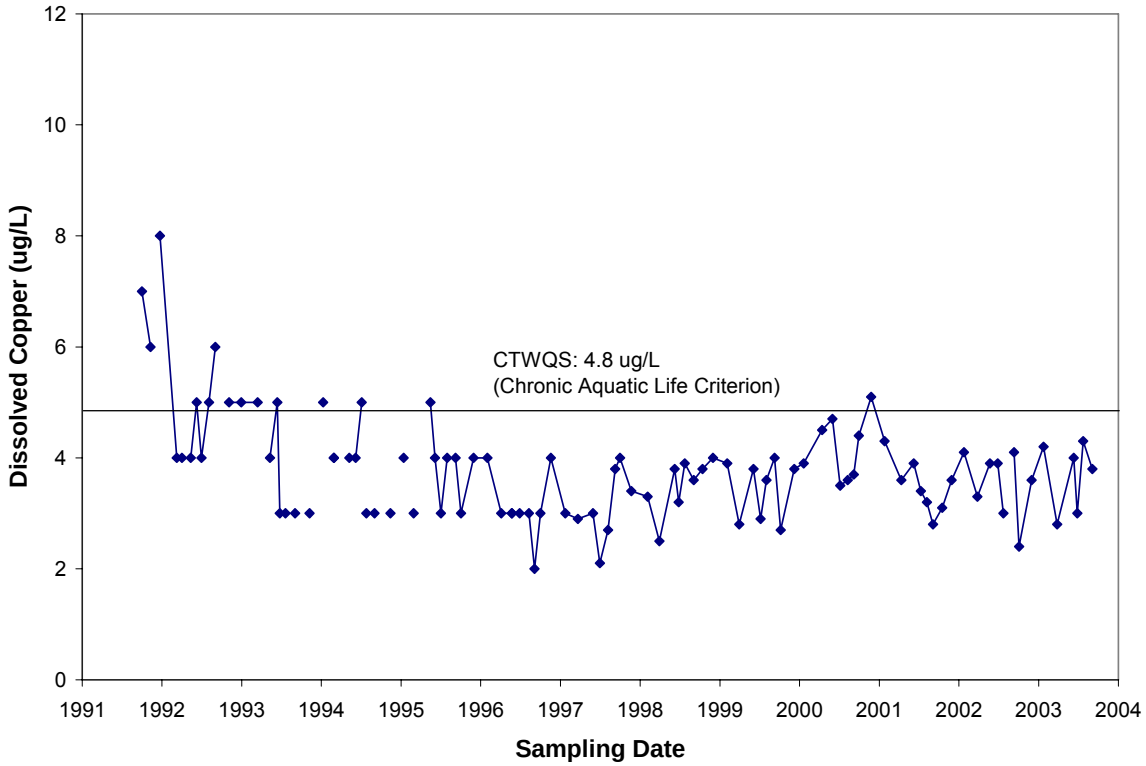


Figure 3-22. Dissolved Copper – East Hartford, Connecticut (USGS # 01192500)



DEP Water Quality Monitoring Data

The Connecticut Department of Environmental Protection has collected water quality monitoring data for the Hockanum and Tankerhoosen Rivers to support the development of a TMDL that will address sources of water quality impairment in the Hockanum and Tankerhoosen Rivers. Data analysis is in progress; the results of the analysis were unavailable at the time this report was published.

3.2.3 Benthic Macroinvertebrates

Benthic macroinvertebrates are bottom dwelling aquatic organisms that can be seen with the unaided eye. Examples of such organisms include stonefly, mayfly, and caddisfly nymphs. Benthic macroinvertebrates are used as indicators of water quality for several reasons:

- Many are sensitive to pollution,
- The composition of the community is a good reflection of long-term water quality,
- They cannot easily escape pollution, and
- They are easy to collect.

DEP Benthic Monitoring

The Connecticut Department of Environmental Protection has collected benthic monitoring data for the Hockanum and Tankerhoosen Rivers to support the development of a TMDL that will address sources of water quality impairment in the Hockanum and Tankerhoosen Rivers. Data analysis is in progress; the results of the analysis were unavailable at the time this report was published.

Connecticut River Watch Program Rapid Bioassessments

The Connecticut Department of Environmental Protection has capitalized on this concept in a program called Rapid Bioassessment in Wadeable Streams and Rivers by Volunteer Monitors (RBV). This program trains volunteers to collect benthic macroinvertebrates from shallow riffle areas by disturbing the stream bottom and catching the dislodged organisms in a net.

The RBV protocol is a screening tool designed to help identify streams with pollution-sensitive benthic macroinvertebrate communities, and to identify streams with either very high or very poor water quality. There are 26 organisms included in the RBV protocol and are easily identified by their distinct shape, structure, color, or behavior. Each benthic macroinvertebrate also provides key information about the stream environment. RBV organisms are categorized in one of three groups:

- *Most Wanted* – Most sensitive to pollution, requiring a narrow range of environmental conditions. Abundant numbers are a sign of a non-impaired stream.

- *Moderately Wanted* – Less sensitive to pollution and found in a variety of water quality conditions. Abundant numbers are not a strong indicator of upstream water quality.

- *Least Wanted* – Least sensitive to pollution and tolerant of the widest range of conditions. Samples with this majority indicate some level of water quality impairment.

The Connecticut River Watch Program, in cooperation with the Hockanum River watershed stakeholder groups and the DEP, performed RBVs in 2002, 2003, and 2004 in the Hockanum River and its main tributary, the Tankerhoosen River. Results from the Hockanum River Rapid Bioassessment are summarized in the following table, which includes the occurrence (percentage and total number) of different types of organisms in each RBV category by site and as compared with a high-quality reference values. The state-wide reference values are a compilation of RBVs from unimpaired streams around Connecticut. Good representation (3 or more) of organisms in the *most wanted* category is an indicator of very good water quality. Sites with 5 or more organisms in the *most wanted* category are considered by DEP to have reference conditions and are in full support of the standards for aquatic life (Connecticut River Watch Program, May 2004).

Table 3-3. Benthic Macroinvertebrate Sampling Results

Site #	Year	River	Location	Most	Moderate	Least	Total #
HR2	2002	Hockanum	Lower Butcher Rd., Ellington	30% (3)	40% (4)	30% (3)	10
HR9a	2002	Hockanum	Behind Adams Mill Restaurant, Manchester	0% (0)	50% (4)	50% (4)	8
HR7d	2003	Gages Brook	Behind Tolland Ag. Center at footbridge, Vernon	50% (6)	25% (3)	25% (3)	12
	2004	Gages Brook	Behind Tolland Ag. Center at footbridge, Vernon	43% (3)	57% (4)	0% (0)	7
HR7b	2002	Tankerhoosen	Bolton Road, Vernon	50% (6)	50% (6)	0% (0)	12
	2003	Tankerhoosen	Bolton Road, Vernon	40% (4)	50% (5)	10% (1)	10
	2004	Tankerhoosen	Bolton Road, Vernon	14% (1)	72% (5)	14% (1)	7
HR7a	2002	Tankerhoosen	Tunnel Road, Vernon	47% (8)	29% (5)	24% (4)	17
	2003	Tankerhoosen	Tunnel Road, Vernon	41.5% (5)	41.5% (5)	17% (2)	12
	2004	Tankerhoosen	Tunnel Road, Vernon	60% (3)	40% (2)	0% (0)	5
HR7c	2002	Tankerhoosen	Downstream of Dobsonville Pond, Vernon	20% (2)	60% (6)	20% (2)	10
HR7	2002	Tankerhoosen	Near confluence with Hockanum River	15% (2)	46% (6)	39% (5)	13
	2003	Tankerhoosen	Near confluence with Hockanum River	31% (4)	31% (4)	38% (5)	13
	2004	Tankerhoosen	Near confluence with Hockanum River	12.5% (1)	50% (4)	37.5% (3)	8
DEP Reference - median percentages compiled from quality streams around state				47% (7)	40% (6)	13% (2)	15

Source: Connecticut River Watch Program. DEP Reference site statistics provided by Mike Beauchene, DEP, based on DEP collected data from high quality streams including the Natchaug River, Eightmile River, Sandy Brook, Salmon River, Saugatuck River, Green Fall River, and Whitford Brook.

Along the Hockanum River, three of the *most wanted* organisms were identified at the upstream location in Ellington, indicative of good water quality, while none of the *most wanted* organisms were identified behind the Adams Mill Restaurant in Manchester, indicating poor water quality. Similarly, within the Tankerhoosen River watershed, the best representation of *most wanted* organisms was found at the Gages Brook and Bolton Road sites in Vernon, while fewer *most wanted* organisms were found at the Tunnel Road site, downstream of Dobsonville Pond, and near the confluence with the Hockanum River.

It is important to note that while sites with 5 or more *most wanted* organisms are a strong indicator of aquatic life support, sites that have fewer than 4 *most wanted* organisms do not definitively indicate impairment or degradation, just that the additional most wanted organisms were not documented by volunteers using the RBV protocol. In these instances, DEP recommends conducting additional assessments to verify species present, determining possible impacts of upstream land use, and evaluating the possibility of errors in conducting the RBV (Connecticut River Watch Program, March 2005). The RBV protocol is intended as a screening tool and not a definitive assessment method.

Although a general decrease is seen in the numbers of *most wanted* organisms at sites that were assessed during multiple years, this variability is more likely due to differences in sampling, observation and preservation techniques, and the team member experience during each sampling event.

Tankerhoosen River State of the Watershed Assessment

Benthic macroinvertebrate surveys were also conducted in 2004 by Jane Seymour, Wildlife Consultant, as part of a "State of the Watershed Assessment of the Tankerhoosen River Watershed" undertaken by the Vernon Conservation Commission, in partnership with the Friends of the Hockanum River Linear Park, Inc. and the Hockanum River Watershed Association.

Riffle dwelling stream invertebrates were collected to assess stream quality. Invertebrates were collected in the upper Tankerhoosen River on the Tancanhoosen LLC property, in Barrows Brook, and in the unnamed tributary that drains into Gages Brook just upstream from Walker's Reservoir East. The RBV protocol was used to categorize and assess the benthic macroinvertebrates found at these locations.

Three of the *most wanted* invertebrates were collected in the upper Tankerhoosen River site, just upstream from Fish and Game Road. Five *moderately wanted* were collected at this site. No *least wanted* invertebrates were collected. These results indicate high water quality at this site.

Three of the *most wanted* invertebrates were collected at Barrow's Brook, two *moderately wanted,* and one of the *least wanted*. Additional invertebrates were collected that also indicate high water quality at this site.

At the third site, the unnamed tributary of Gages Brook, no *most wanted* invertebrates were collected. Two *moderately wanted* and two *least wanted* invertebrates were collected. This site is just downstream of Interstate 84. The lack of *most wanted* invertebrates at this site may be a

result of impacts from Interstate 84, although additional sampling at this location was recommended to further assess potential highway impacts on the stream (Seymour, 2004). Additional benthic macroinvertebrate monitoring is proposed for selected locations within the Tankerhoosen River watershed as part of the ongoing "State of the Watershed Assessment" for the Tankerhoosen River.

3.2.4 Water Quality Summary

Major findings regarding the water quality of the Hockanum River watershed are summarized as follows:

- The majority of the Hockanum River and a portion of the Tankerhoosen River do not meet Connecticut Water Quality Standards for at least one of their designated uses. The primary impairments in the Hockanum River are associated with aquatic life support, caused by high turbidity, organic enrichment, and unknown causes, and primary contact recreation due to elevated concentrations of bacteria and algal growth. The causes and sources of impairment in the lower reaches of the Tankerhoosen River have not been identified and are currently listed as "unknown."

- Historical water quality monitoring has been performed by the USGS at two locations along the Hockanum River – Rockville and East Hartford. Ambient water quality monitoring has also been performed by the Connecticut DEP in support of potential TMDL development efforts. Available chemical and biological monitoring data reflect the degraded water quality of the Hockanum River and a general upstream-downstream trend of decreasing water quality, which is consistent with the development patterns in the watershed. The exceptions to this trend are dissolved oxygen and dissolved copper concentrations, which are more variable and higher (in the case of dissolved copper) and lower (in the case of dissolved oxygen) at Rockville than East Hartford.

- On average, water temperatures are somewhat higher at East Hartford than at Rockville, likely due to thermal enrichment associated with stormwater runoff from the urbanized areas of Vernon and Manchester. The pH of the Hockanum River at East Hartford is generally more variable and somewhat higher than at Rockville. Late summer or early fall excursions of dissolved oxygen below the 5 mg/L threshold at Rockville likely reflect seasonal oxygen depletion in Shenipsit Lake.

- Areas of floatables and litter have been identified along the Hockanum and Tankerhoosen Rivers (primarily in Vernon, Manchester, and East Hartford) and in areas of commercial development and along roads and highways in developed areas of the watershed.

- Excessive turbidity is a significant water quality issue in the Hockanum River. Measured turbidity in the Hockanum River is highly variable, indicative of construction activities near the river, stream channel erosion, and other possible sources. Turbidity levels in the Hockanum River experienced a sharp increase in the mid-1990s, with several episodic increases in turbidity occurring since then.

- Upstream and downstream reaches of the Hockanum River have experienced elevated fecal coliform concentrations. Fecal coliform concentrations are generally higher at the downstream locations due to the point and nonpoint sources of bacteria in the central and lower portions of the watershed including wastewater treatment plant effluent, urban stormwater runoff, pet waste, waterfowl, septic systems, and landfills.

- Nitrogen concentrations and loadings are significantly higher at East Hartford than at Rockville, which reflects the significant contribution of nitrogen from the municipal wastewater treatment plants and other sources of nitrogen in the watershed such as precipitation and atmospheric deposition, urban stormwater runoff, septic system effluent, agricultural runoff, and animal waste. Recent monitoring data indicates that nitrogen loadings from watershed sources other than the Vernon and Manchester wastewater treatment plants accounted for approximately one-third of the total nitrogen load in the Hockanum River at East Hartford (see Section 3.5).

- Elevated phosphorus levels in the Hockanum River are consistent with the observed organic enrichment and algal growth in certain reaches and impoundments of the river, which is a cause of impairment for aquatic life support and contact recreation, particularly during low-flow conditions.

- Heavy metals are a potential source of impairment in the Hockanum River. Exceedances of the chronic aquatic life criterion for copper have been measured at the Rockville site, which indicates a source of metals in the upstream reaches of the Hockanum River. The relatively lower copper concentrations at East Hartford may be attributable to dilution effects.

3.3 Wetlands & Watercourses

Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Wetlands and buffer zones between watercourses and developed areas help to preserve stream water quality by filtering pollutants, encouraging infiltration of stormwater runoff, and protecting against stream bank erosion. The Connecticut Inland Wetlands and Watercourses Act gives the DEP and municipalities jurisdiction to regulate new development and redevelopment within and adjacent to wetlands and watercourses. Inland Wetland and Watercourse regulations of the watershed communities are discussed further in the Land Use section of this report.

Figure 3-23 depicts the extent and distribution of wetland soils in the Hockanum River watershed, based on USDA Natural Resources Conservation Service (NRCS) soil classifications and associated DEP mapping. Approximately 10% of the watershed area (approximately 5,360 acres) is mapped as wetland soils (alluvial and floodplain soils, poorly drained soils, and very poorly drained soils). The concentration of wetland soils is generally greatest in the undeveloped portions of the watershed. Ellington, Tolland, and Stafford have

extensive wetland systems that have been largely undisturbed by development. Wetland soils are also prevalent in the relatively undeveloped portions of the Tankerhoosen River watershed. The distribution of wetland soils gradually diminishes traveling downstream in the watershed. Mapped wetland soils in the heavily urbanized centers of Manchester and East Hartford are confined primarily to riparian and floodplain areas along the Hockanum River and its major tributaries.

A stream walk survey of the Hockanum River conducted in 1999 revealed that riparian buffers of less than 25 feet are common between the river and developed areas. Riparian buffers along the Tankerhoosen River were more commonly 100 feet in width or greater, although some areas along the lower reaches of the Tankerhoosen River were identified as having stream buffers of less than 25 feet, according to the results of a 2000 stream walk survey of the Tankerhoosen River.

3.4 Dams, Impoundments, & Water Supply

The historical industrial use of the Hockanum River and its major tributaries has left behind many small dams and impoundments. Most of this infrastructure is no longer used for power generation, and many of these impoundments currently provide aquatic and wildlife habitat and recreational opportunities. Many of the dams in the watershed are also an impediment to fish migration.

According to the DEP Dam Safety Regulations, the hazard classification of a dam is based on the damage potential from failure of the structure. Figure 3-24 shows the location and hazard classification of each of the 64 dams within the watershed. Many of the dams which no longer serve an integral function to industry or public use have fallen into disrepair and pose a potential hazard to downstream properties.

Several of the watershed impoundments serve as public drinking water supplies, including Shenipsit Lake and Globe Hollow, Porter, Howard, Risley and Lydall Reservoirs. Table 3-4 lists the major drinking water reservoirs within the Hockanum River watershed, as well as other significant water diversions that are regulated under the DEP Water Diversion program.

Groundwater aquifers also supply a significant amount of water to Manchester and Vernon. Manchester's 7 active wells provide approximately 36 percent of its public water, and 3 active wells along with 2 emergency wells serve the Town of Vernon. Proposed Level B aquifer protection areas associated with these wells are shown in Figure 3-25. These proposed areas will become final Level A Aquifer Protection Areas upon the approval of the final mapping by DEP. The watershed communities are required to establish land use regulations for these areas to limit potential contamination to public groundwater supplies. Private groundwater supply wells are also prevalent throughout areas of the watershed that are not served by public water supplies.

Figure 3-23. Wetland Soils

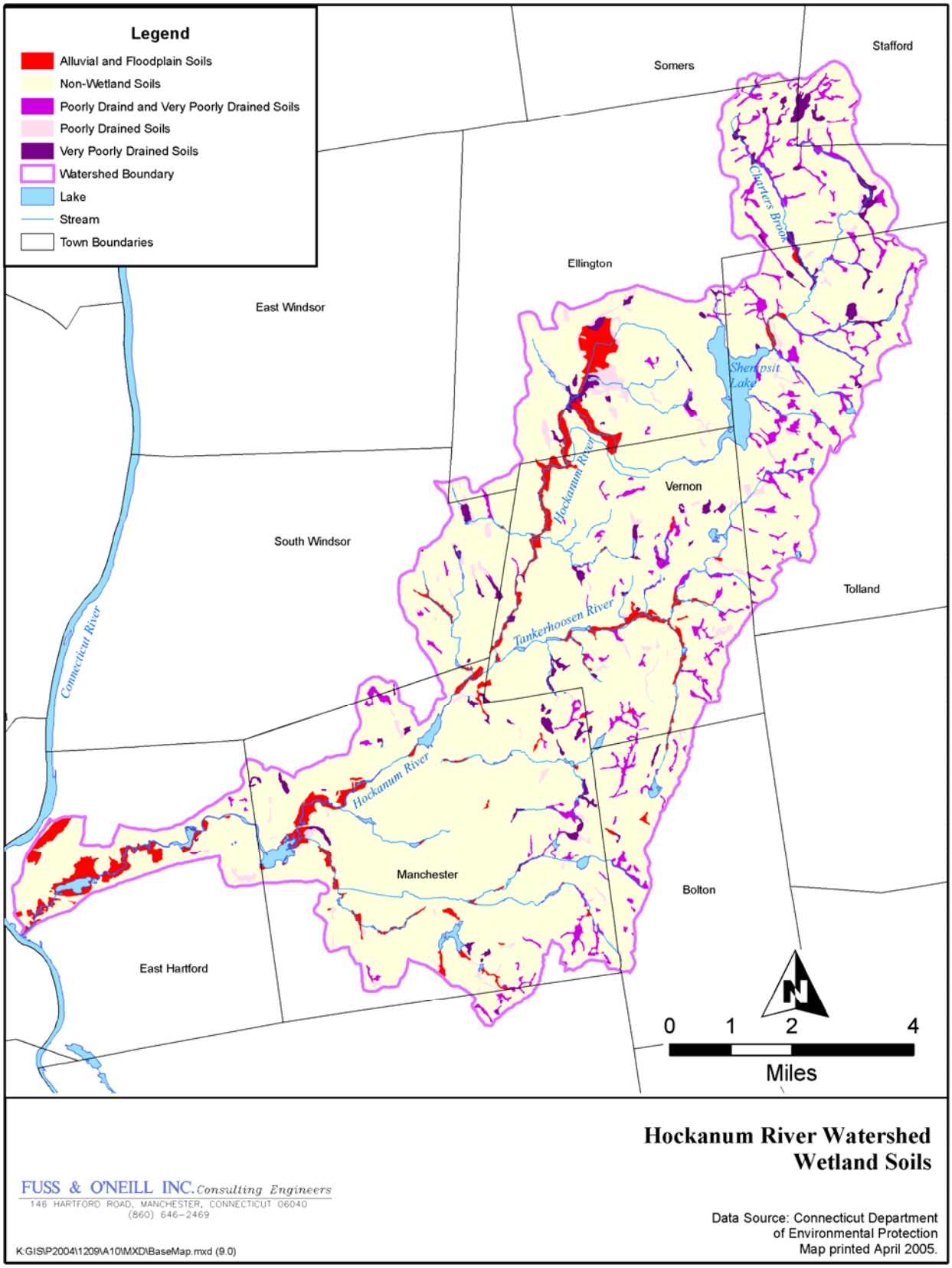


Figure 3-24. Hockanum River Watershed Dams

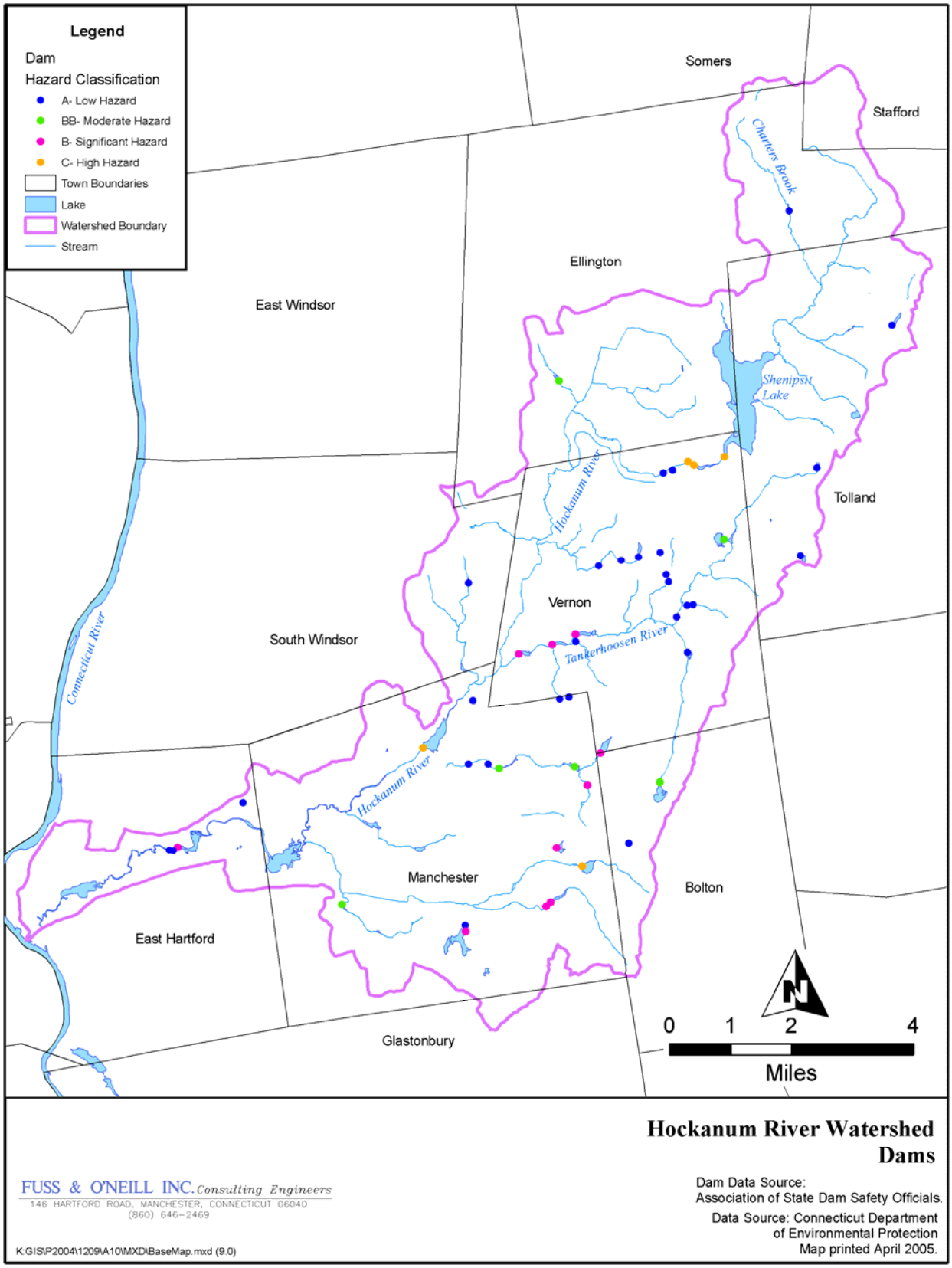
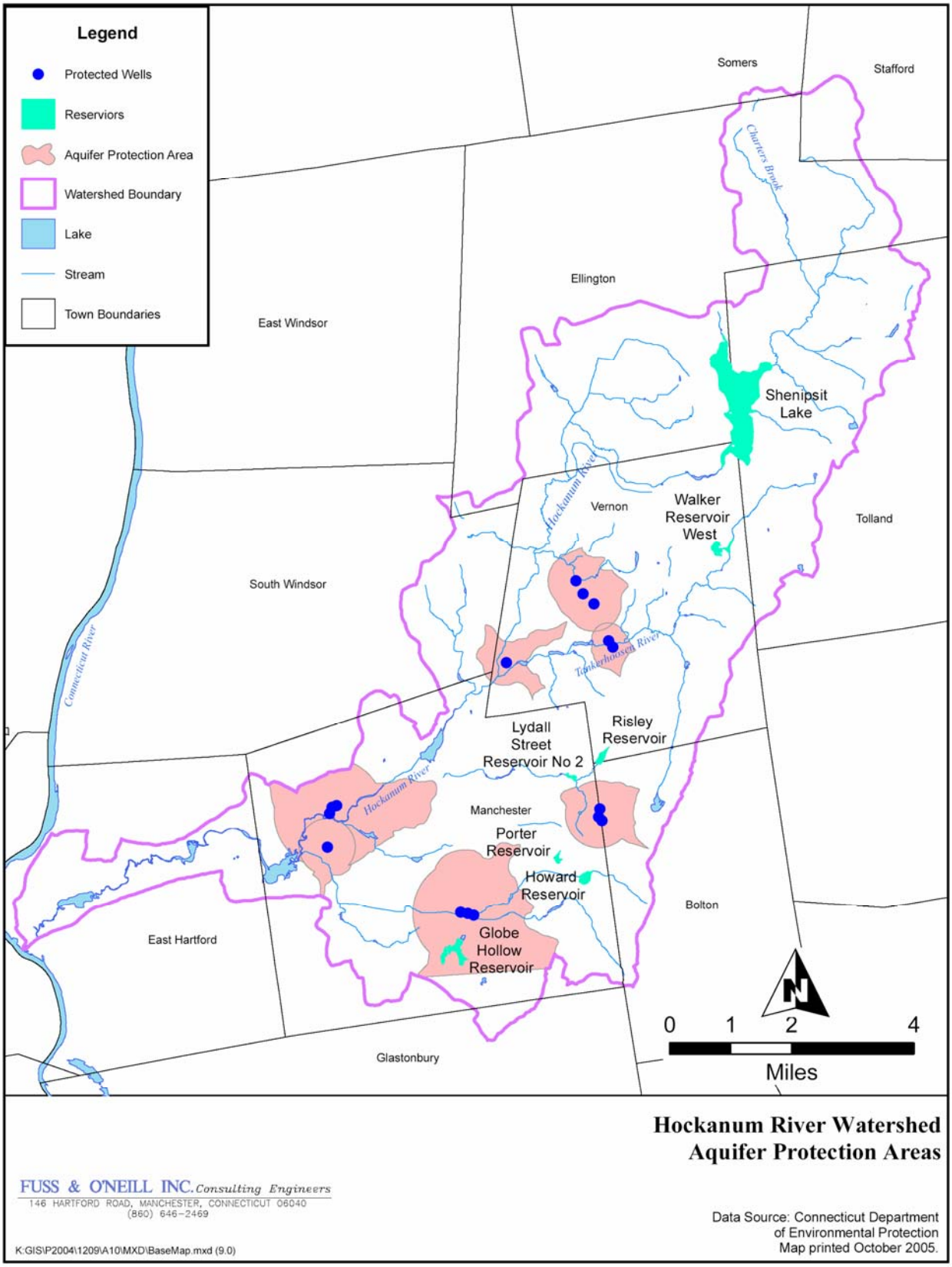


Table 3-4. Major DEP-Regulated Surface Water Diversions in the Hockanum River Watershed

Name	Name of Diversion	MGD	Town
Connecticut Water Company	Shenipsit Lake	15.0	Ellington
Manchester Water Department	Globe Hollow Reservoir	2.5	Manchester
	Howard Reservoir	3.8	Manchester
	Porter Reservoir	3.8	Manchester
	Risley & Lydall Reservoirs	1.6	Manchester
Manchester Sand & Gravel Co.	Hockanum River pumps	2.9	Manchester
	Parcel #2 Pond	2.0	Manchester
	6 Settling lagoons	2.0	Manchester
Amerbelle Corporation	Hockanum River intakes	2.9	Vernon
Manchester Country Club	Hole 11, Hole 14 Ponds	2.6	Manchester
Cellu Tissue, LLC	Hockanum River diversion	0.85	East Hartford
Lydall, Inc.	Lydall Pond	1.0	Manchester
Andrew Ansaldi	Folly Pond	0.9	Manchester

Source: DEP Water Diversion Program
MGD – million gallons per day

Figure 3-25. Aquifer Protection Areas



3.5 Wastewater Discharges

Three municipal wastewater treatment plants are located within the Hockanum River watershed and serve the municipalities of Ellington, Tolland, Vernon, Manchester, and East Hartford. Figure 3-26 shows the municipal wastewater treatment plants and associated sewer service areas in the watershed. The Vernon and Manchester Water Pollution Control Facilities (WPCF) discharge treated secondary effluent to the Hockanum River under National Pollutant Discharge Elimination System (NPDES) permits. The Vernon WPCF is located in the upper portion of the watershed near the Vernon-Ellington town line, while the Manchester WPCF is located in the western portion of Manchester upstream of Laurel Marsh. Both of these treatment plants are situated upstream of the USGS water quality monitoring station at East Hartford, and downstream of the USGS monitoring station at Rockville. The East Hartford WPCF formerly discharged treated secondary effluent to the Hockanum River near the confluence with the Connecticut River. In 2002, the outfall of the East Hartford WPCF was relocated from the Hockanum River to the Connecticut River to enhance water quality in the Hockanum River. Table 3-5 summarizes treatment process statistics for the Vernon and Manchester WPCFs for 2004.

Table 3-5. 2004 Wastewater Treatment Plant Statistics

2004 Summary	Vernon WPCF	Manchester WPCF
Design Flow (MGD)	7.1	8.25
Average Flow (MGD)	3.79	6.39
BOD Removal (%)	97.9	97.5
TSS Removal (%)	97.2	97.0

Source: Town of Vernon, Town of Manchester
MGD – million gallons per day

As described in Section 3.2.2, nitrogen has been identified as the primary pollutant causing low dissolved oxygen conditions, or hypoxia, that occurs throughout much of Long Island Sound's bottom waters each summer. Wastewater treatment plants are a significant contributor of nitrogen to Connecticut's inland surface waters and subsequently to the Sound. To address this water quality problem, DEP has established annual nitrogen removal limits for each of the Publicly Owned Treatment Works in Connecticut to reduce the annual load of nitrogen to Long Island Sound by approximately 64 percent by 2014 as part of a nitrogen wasteload allocation.

Figure 3-26. Wastewater Discharges and Other Potential Point Sources of Pollution

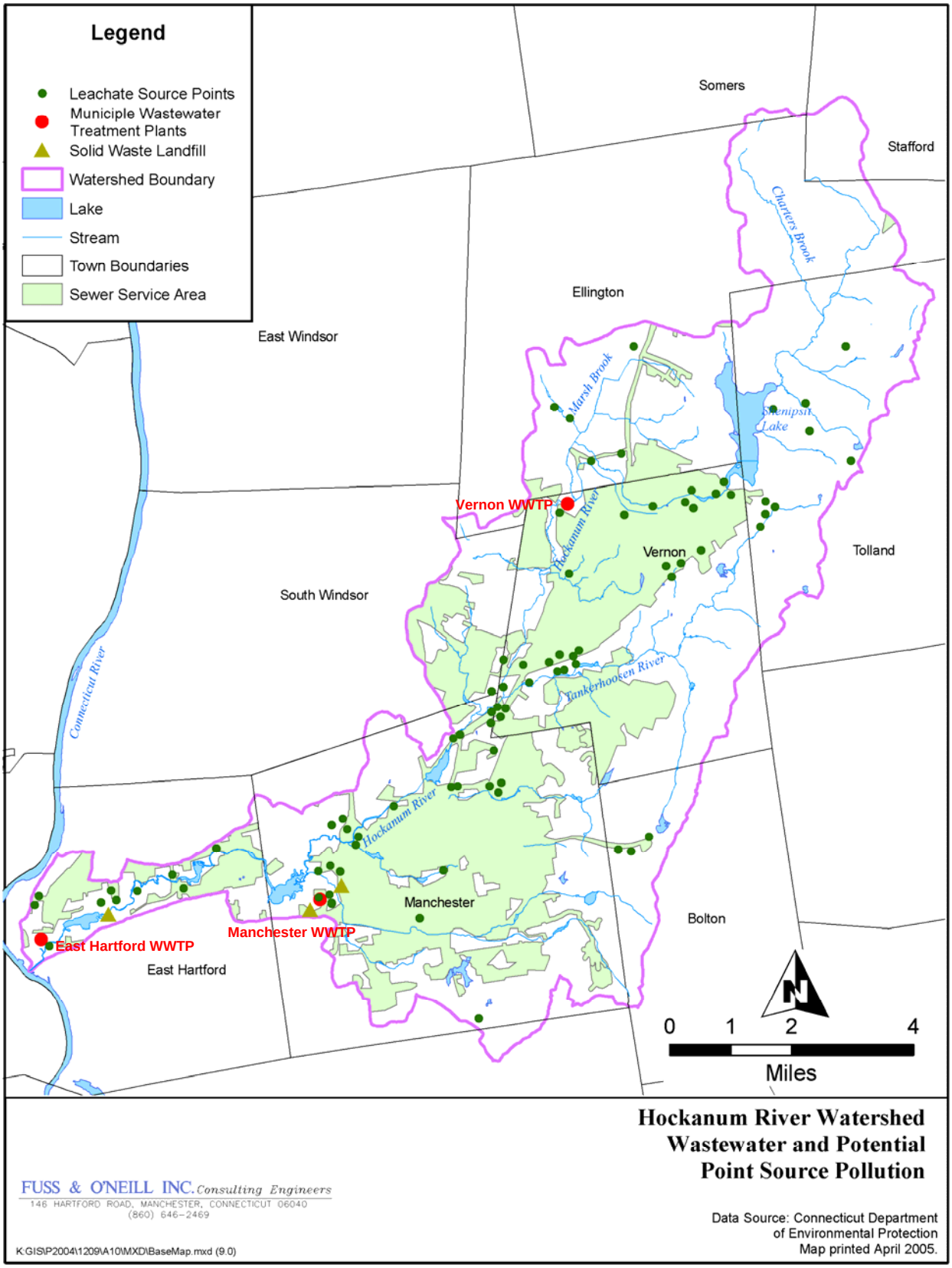
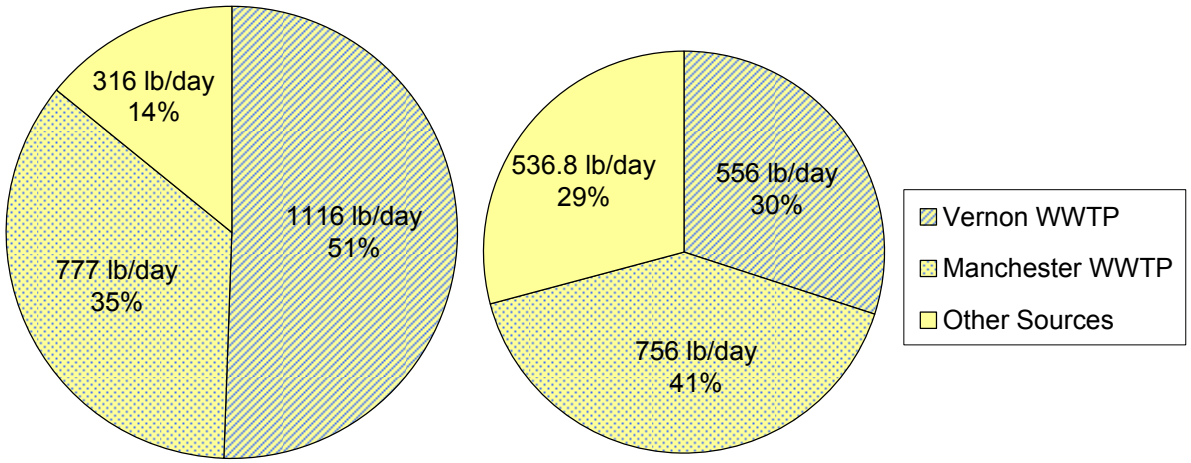


Figure 3-27. Nitrogen Loading at East Hartford, Connecticut (USGS # 01192500)



2003: 2,209 lb/day **2004:** 1,849 lb/day

Figure 3-27 illustrates the nitrogen contributions (in pounds per day loadings) of the Vernon and Manchester WPCFs, as well as other nitrogen sources (i.e., precipitation and atmospheric deposition, urban stormwater runoff, septic system effluent, agricultural runoff, and animal waste), for the years 2003 and 2004 at the East Hartford monitoring location. As depicted in Figure 3-27, the combined annual nitrogen load from the Vernon and Manchester treatment plants accounts for approximately 70 to 85 percent of the nitrogen load in the Hockanum River at East Hartford. In 2004, the Vernon WPCF experienced an approximately 50 percent reduction in effluent nitrogen loading as a result of efforts to comply with discharge limits in the DEP General Permit for Nitrogen Discharges. In 2004, nitrogen loadings from watershed sources other than the Vernon and Manchester wastewater treatment plants accounted for approximately one-third of the total nitrogen load in the Hockanum River at East Hartford.

As summarized in Table 3-6, there are approximately 20 facilities in the Hockanum River watershed with surface water discharges regulated under the NPDES permit program, which is administered by the Connecticut DEP. The facilities listed in Table 3-6 have either permitted wastewater or stormwater discharges to surface waters and include both industrial (privately-owned and municipal) facilities and municipal wastewater treatment plants. The majority of these facilities discharge directly to the Hockanum River, and all are located in the central and lower portions of the watershed.

Table 3-6. Summary of Facilities in the Hockanum River Watershed with NPDES Surface Water Discharge Permits

Facility	Town	Discharge Type	Facility	Town	Discharge Type
ABA-PGT, Inc	Manchester	SW	Manchester Sanitary Landfill	Manchester	SW
Amerbelle Textiles LLC	Vernon	SW	Media Play Plaza	Manchester	SW
Big Y Plaza	Manchester	SW	Natural Country Farms, Inc	Ellington	SW
Builders Concrete East, LLC	Manchester	SW	Northeast Tank Disposal	Manchester	SW
Cellu Tissue Corporation	East Hartford	SW, WW	Ostrinsky	Manchester	SW
Charter Oak Mall	East Hartford	SW	Parker St. Used Auto Parts, Inc.	Manchester	SW
Connecticut DOT Signs and Markings Maintenance Facility	East Hartford	SW	Phalo/Cable Design Technologies	Manchester	SW
Connecticut DOT Bolton Maintenace Facility	Bolton	SW	Pro/Mark Corporation	Manchester	SW
Connecticut DOT Maintenance Facility	Vernon	SW	Purdy Corporation	Manchester	SW
Connecticut National Guard	Manchester	SW	Revest Northeast	Manchester	WW
Donwell Company	Manchester	SW	Sam's Club	Manchester	SW
East Hartford Public Works Garage	East Hartford	SW	Sermatech Klock Company	Manchester	SW
Ellington Public Works Garage	Ellington	SW	Sermatech Mal Tool	Manchester	SW, WW
First Student, Inc.	Manchester, Vernon	SW	Smiths Aerospace Components	Manchester	SW, WW
Flint Ink Corporation	Vernon	SW	Stop & Shop #689	Manchester	SW
Gerber Scientific, Inc.	Manchester, South Windsor, Tolland	SW	Stop & Shop Store #611	Vernon	SW
Home Depot #6207	Manchester	SW	Stop & Shop Store #613	Vernon	SW
Kohl's Department Stores	Manchester	SW	Target Stores	Manchester	SW
Lowes Home Centers	Manchester	SW	Tighitco, Inc.	Vernon	SW
Mall at Buckland Hills	Manchester	SW	Tilcon Connecticut Inc.	Manchester	SW
Manchester Cinemas	Manchester	SW	Transwheel Corporation	Manchester	WW
Manchester Recycling and Fleet Maintenance Facility	Manchester	SW	Tri-City Plaza	Vernon	SW
Tri-S Environmental Services Inc.	Ellington	SW	Vernon Solid Waste Transfer Station	Vernon	SW
Turbocare	Manchester, East Hartford	SW	Vyncolit North America	Manchester	SW, WW
Vernon Public Works Garage and Salt Storage	Vernon	SW	Wal-Mart	Manchester	SW

Source: EPA Water Permit Compliance System (PCS) database, data extracted on April 15, 2005 and electronic database of active water discharge permits provided by DEP in 2005. Includes facilities registered under the DEP General Permit for the Discharge of Stormwater Associated with Industrial Activity and the DEP General Permit for the Discharge of Stormwater Associated with Commercial Activity.
SW – stormwater, WW – wastewater

3.6 Hazardous Waste Sites

Historical and current industrial and commercial development within the Hockanum River watershed poses a potential threat to surface water and groundwater supplies in the watershed. Illegal waste disposal, improper use and disposal of chemicals such as used oil, pesticides, and herbicides, and chemical spills are potential sources of contaminants from industrial and commercial facilities. As summarized in the following table, numerous hazardous waste generators are located within the watershed. The majority of these facilities are located in Vernon and Manchester in the central and lower portions of the watershed. [Note that East Hartford is excluded from the table due to the relatively small land area of East Hartford within the Hockanum River watershed.] Additionally, a total of 12 hazardous waste disposal sites are located in Vernon and Manchester. These are sites that may pose a threat to the environment or public health and are listed on the Inventory of Hazardous Waste Disposal Sites ("the Inventory"), pursuant to Section 22a-133c of the Connecticut General Statutes (CGS).

Table 3-7. Summary of Regulated Hazardous Waste Generators and Hazardous Waste/Cleanup Sites

Site Type	Number of Sites	
	Vernon	Manchester
Hazardous Waste Generators	36	97
Hazardous Waste Disposal	3	9
Leaking Underground Storage Tank	61	97
Property Transfer with Form III	14	27
Pollution Abatement Orders	1	2
Voluntary Remediation	1	1
CERCLA Sites	5 (1 on Final NPL)	9 (none on Final NPL)

Source: DEP and EPA, 2005

Table 3-7 also summarizes hazardous waste and other cleanup sites that are regulated by the DEP and/or EPA. Approximately 160 leaking underground storage tank sites are located in Vernon and Manchester. These are residential and commercial sites with releases of petroleum products from underground storage tanks. The status of these specific releases was unavailable as of the date of this study. A number of property transfer sites for which a Property Transfer Form III has been filed are also located in both communities. A Form III is filed when discharge, spillage, uncontrolled loss, seepage or filtration of hazardous waste or a hazardous substance has occurred at the site and has not been fully remediated or when the environmental conditions at the site are unknown at the time of the transfer. Several contaminated sites in the watershed are being remediated under Connecticut's Voluntary Remediation program.

A total of 14 sites in Vernon and Manchester are listed as potential hazardous waste sites that EPA has evaluated under the Comprehensive Environmental Response, Compensation, and

Liability Act (CERCLA), otherwise known as "Superfund." Of these, only one site, Precision Plating Corporation located in the Hillside Industrial Park in Vernon, is currently on the Final National Priorities List (NPL). Chromium contaminated groundwater at the site is being remediated under the direction of the DEP (EPA, http://www.epa.gov/region1/superfund/sites/precision).

4.0 LAND USE

The type and distribution of land use within a watershed have a direct impact on nonpoint sources of pollution and water quality. This section describes the land use patterns in the Hockanum River watershed, the amount of impervious coverage in the watershed as an indicator of stream health, and the municipal and regional land use planning entities and associated land use regulations in the watershed that control development and play a critical role in preserving the health of the watershed.

4.1 Watershed Land Use

Figure 1-2 depicts general land use patterns in the Hockanum River watershed. The data shown in Figure 1-2 are land cover categories derived from 2002 Landsat satellite imagery with a ground resolution of 30 meters. The land cover data in the watershed are further summarized into eleven land cover categories (Table 4-1). These eleven categories are those used in the Connecticut Land Cover Map Series and are described following the table (University of Connecticut Center for Land Use Education and Research):

Table 4-1. Hockanum River Watershed Land Cover and Land Cover Change

Land Cover Type	2002		1985		Change	
	Acres	% of basin	Acres	% of basin	Acres	% change*
Developed	16,341	32.9%	13,958	28.1%	**2,384**	**17.1%**
Turf & Grass	3,508	7.1%	3,683	7.4%	-176	-4.8%
Other Grasses and Agriculture	6,597	13.3%	6,461	13%	135	2.1%
Deciduous Forest	17,740	35.7%	20,036	40.3%	**-2,295**	**-11.5%**
Coniferous Forest	1,873	3.8%	2,066	4.2%	-193	-9.4%
Water	1,050	2.1%	1,051	2.1%	-1	-0.1%
Non-forested Wetland	103	0.2%	62	0.1%	41	65.7%
Forested Wetland	1,419	2.9%	1,604	3.2%	-185	-11.5%
Tidal Wetland	0	0%	0	0%	0	0%
Barren	974	2%	679	1.4%	295	43.4%
Utility Right-of-Way	93	0.2%	97	0.2%	-5	-4.7%

* as a percentage of the 1985 land cover area.

Source: University of Connecticut's Center for Land Use Education and Research (CLEAR).

- Developed – High density built-up areas typically associated with commercial, industrial and residential activities and transportation routes. These areas contain a significant amount of impervious surfaces, roofs, roads, and other concrete and asphalt surfaces.
- Turf & Grass – A compound category of undifferentiated maintained grasses associated mostly with developed areas. This class contains cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas. Also includes some agricultural fields due to similar spectral reflectance properties.
- Other Grasses and Agriculture – Includes non-maintained grassy areas commonly found along transportation routes and other developed areas and also agricultural fields used for both crop production and pasture.

- Deciduous Forest – Includes Southern New England mixed hardwood forests. Also includes scrub areas characterized by patches of dense woody vegetation. May include isolated low density residential areas.
- Coniferous Forest – Includes Southern New England mixed softwood forests. May include isolated low density residential areas.
- Water – Open water bodies and watercourses with relatively deep water.
- Non-forested Wetland – Includes areas that predominantly are wet throughout most of the year and that have a detectable vegetative cover (therefore not open water). Also includes some small watercourses due to spectral characteristics of mixed pixels that include both water and vegetation.
- Forested Wetland – Includes areas depicted as wetland, but with forested cover. Also includes some small watercourses due to spectral characteristics of mixed pixels that include both water and vegetation.
- Tidal Wetland – Emergent wetlands, wet throughout most of the year, with distinctive marsh vegetation and located in areas influenced by tidal change.
- Barren – Mostly non-agricultural areas free from vegetation, such as sand, sand and gravel operations, bare exposed rock, mines, and quarries. Also includes some urban areas where the composition of construction materials spectrally resembles more natural materials. Also includes some bare soil agricultural fields.
- Utility – Includes utility rights-of-way. This category was manually digitized on-screen from rights-of-way visible in the Landsat satellite imagery. The class was digitized within the deciduous and coniferous categories only.

Forest and developed areas are the predominant land uses in the Hockanum River watershed. Nearly 40 percent of the watershed consists of deciduous and coniferous forests, the majority of which are located in the northern and eastern portions of the watershed. Another approximately 40 percent of the watershed consists of commercial, industrial, residential, and transportation land uses (i.e., "urban") that follow the major transportation corridors, regional shopping and commercial areas, and the major population centers of Vernon, Manchester, and East Hartford. Development in the watershed generally intensifies from northeast to southwest along the path of the Hockanum as it flows towards its confluence with the Connecticut River. Approximately 11 percent of the watershed remains in agricultural land use (Clausen et al., 2003).

Table 4-1 also summarizes the change in land cover in the Hockanum River watershed between 1985 and 2002, based upon Landsat satellite imagery from both years as described previously. The most significant land cover changes in the watershed are a loss of approximately 2,500 acres of forested land, including a loss of several hundred acres of forested wetland, and a corresponding increase (approximately 2,400 acres) in developed land. This shift in land cover reflects the continuing residential and commercial development of the watershed.

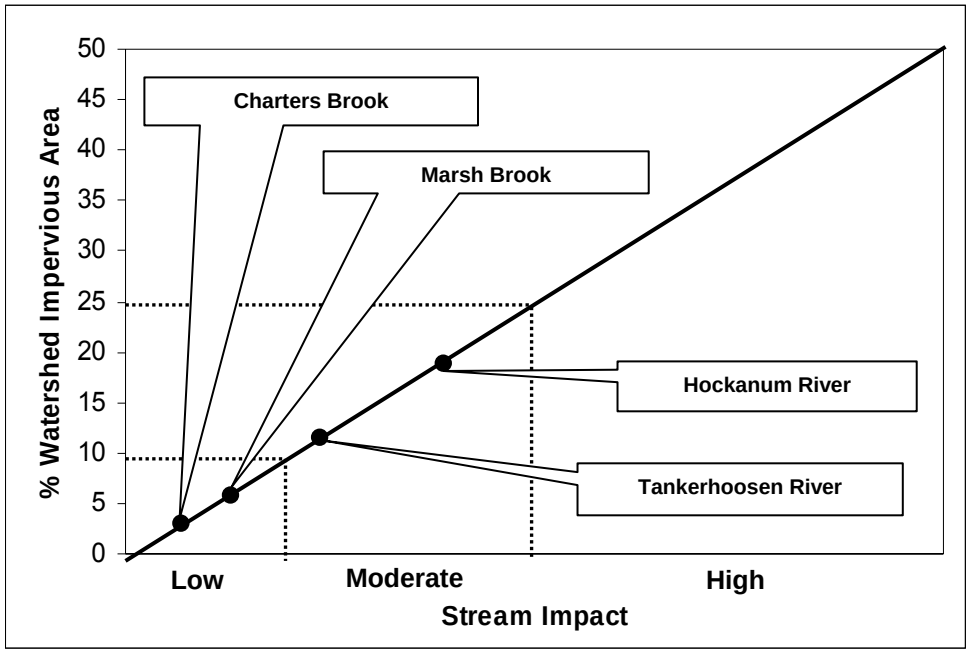
4.2 Watershed Impervious Coverage

Impervious cover has emerged as a measurable, integrating concept used to measure the overall health of a watershed. Numerous studies have documented the cumulative effects of urbanization on stream and watershed ecology (Center for Watershed Protection, 2003; Schueler et al., 1992; Schueler, 1994; Schueler, 1995; Booth and Reinelt, 1993, Arnold and Gibbons, 1996; Brant, 1999; Shaver and Maxted, 1996). Research has also demonstrated similar effects of urbanization and watershed impervious cover on downstream receiving waters such as lakes, reservoirs, estuaries, and coastal areas.

The correlation between watershed impervious cover and stream indicators is due to the relationship between impervious cover and stormwater runoff, since streams and receiving water bodies are directly influenced by stormwater quantity and quality. Although well-defined

imperviousness thresholds are difficult to recommend, research has generally shown that when impervious cover in a watershed reaches between 10 and 25 percent, ecological stress becomes clearly apparent. Between 25 and 50 percent, stream stability is reduced, habitat is lost, water quality becomes degraded, and biological diversity decreases (NRDC, 1999). Watershed imperviousness in excess of 50 percent is generally indicative of watersheds with significant urban drainage. Figure 4-1 illustrates this effect. These research findings have been integrated into a general watershed planning model known as the impervious cover model (ICM) (CWP, 2003).

Figure 4-1. Relationship Between Watershed Imperviousness and Stream Health



Source: Adapted from Schueler, 1992 and Prince George's County, Maryland, 1999.

A GIS-based impervious cover analysis was performed for the Hockanum River watershed by staff from the Department of Natural Resources Management and Engineering at the University of Connecticut (Civco, 2005). The satellite-derived land cover data described previously were used in the analysis. This technique, known as "direct impervious surface modeling", extracted impervious surface data directly from 2002 Landsat imagery to estimate the amount of impervious surface within each pixel. The DEP GIS basin layer was used to calculate the percent of imperviousness by basin. Figure 4-2 graphically summarizes the results of this analysis. Figure 4-1 summarizes the results in the context of the ICM.

The imperviousness of the Hockanum River watershed is estimated at between 19 and 20 percent. This level of imperviousness is within the range of values where ecological stress and stream impacts are apparent. As shown in Figure 4-2, impervious coverage in much of the northern and eastern portions of the watershed is less than 10 percent, consistent with the relatively good water quality and absence of impairments in these areas. Charters Brook and Marsh Brook, both headwater tributaries of the Hockanum River, are estimated to have approximately 3 and 6.4 percent impervious coverage, respectively. Progressing into the

developed areas of Vernon and Manchester, watershed imperviousness in the central portions of the watershed is generally between 10 and 30 percent, with several sub-basins in the 30 to 50 percent range. This trend is generally consistent with the upstream to downstream trend of decreasing water quality in the Hockanum River, with several exceptions as noted previously in this report. Impervious coverage in the Tankerhoosen River is estimated at approximately 12 percent, which is near the lower threshold of stream impacts.

The results of this analysis provide an initial diagnosis of potential stream and receiving water quality within the watershed study area. The analysis method and ICM are based on several assumptions and caveats, which limits its application to screening-level evaluations. Some of these assumptions of the ICM include:

- Requires accurate estimates of percent impervious cover, which is defined as the total amount of impervious cover over a subwatershed area. The resolution of the land cover data used in the evaluation is relatively coarse, although sufficient for a screening-level analysis.

- Predicts potential rather than actual stream quality.

- Does not predict the precise score of an individual stream quality indicator but rather predicts the average behavior of a group of indicators over a range of impervious cover.

- The 10 percent and 25 percent thresholds are approximate transitions rather than sharp breakpoints.

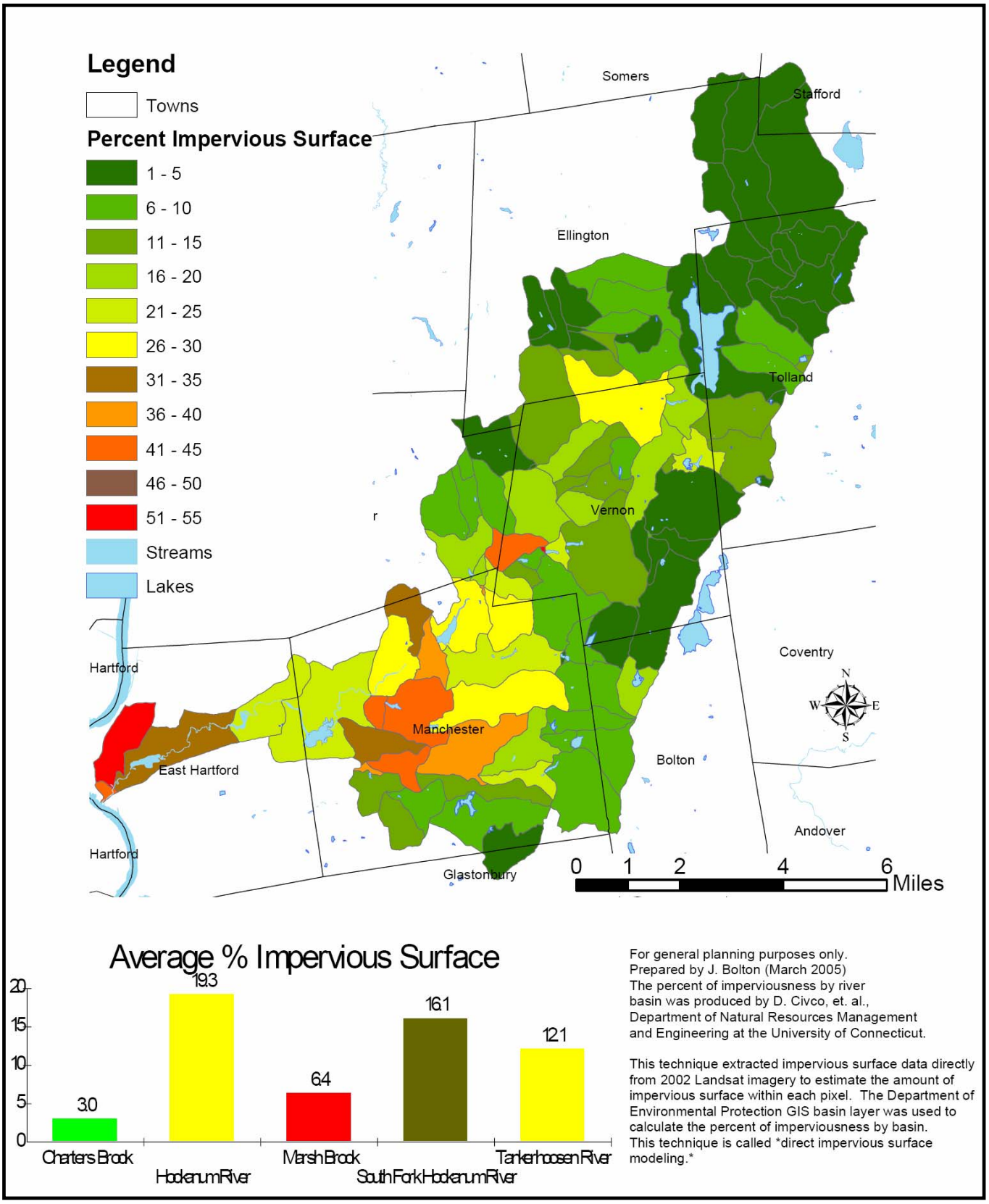
- The ICM has not been validated for lakes, reservoirs, aquifers, and estuaries.

- Does not currently predict the impact of watershed best management practices (treatment or non-structural controls).

- Does not consider the geographic distribution of the impervious cover relative to the streams and receiving waters. Effective impervious cover (impervious cover that is hydraulically connected to the drainage system) has been recommended as a better metric, although determining effective impervious cover requires extensive and often subjective judgment as to whether it is connected or not.

- Impervious cover is a more robust and reliable indicator of overall stream quality beyond the 10 percent threshold. The influence of impervious cover on stream quality is relatively weak compared to other potential watershed factors such as percent forest cover, riparian community, historical land use, soils, agriculture, etc. for impervious cover less than 10 percent.

Figure 4-2. Hockanum River Watershed Impervious Coverage



4.3 Land Use Planning

4.3.1 Municipal Planning

Municipal land use regulations control patterns of new development and redevelopment and can play a significant role in protecting water quality in a watershed. These commonly include local plans of conservation and development, zoning regulations, subdivision regulations, inland wetland regulations, and stormwater regulations, all of which influence the type and density of development that can occur within a watershed. Local land use regulations often vary by town within a watershed, and regulations are periodically revised in response to development pressure, shifts in attitude toward natural resource protection, and political and socioeconomic factors.

A land use questionnaire was distributed to the watershed municipalities in April 2005 by the North Central Conservation District. The towns of Stafford, Glastonbury, and Somers were excluded due to their relatively small percentage of land area within the Hockanum River watershed. The purpose of the questionnaire was to obtain information from the municipalities on the current land use regulations in each town, including information on wetlands and watercourses regulations, zoning regulations, plans of development, open space planning, and stormwater regulations. The following sections summarize information obtained from the questionnaires.

Local land use regulations are administered by various Town commissions, boards, and agencies. Land use commissions in the Hockanum River watershed communities are summarized below (Table 4-2).

Table 4-2. Hockanum River Watershed Land Use Commissions

Town	Land Use Commissions
Manchester	• Planning and Zoning Commission (acts as Inland Wetlands and Watercourses Agency) • Zoning Board of Appeals
Vernon	• Planning and Zoning Commission • Inland Wetlands and Watercourses Agency • Conservation Commission
Ellington	• Planning and Zoning Commission • Inland Wetlands and Watercourses Agency • Conservation Commission • Zoning Board of Appeals • Economic Development Commission
Tolland	• Planning and Zoning Commission • Inland Wetlands and Watercourses Commission • Conservation Commission • Design Advisory Board
East Hartford	• Planning and Zoning Commission

	• Inland Wetlands/Environment Commission • Zoning Board of Appeals
South Windsor	• Planning and Zoning Commission • Inland Wetlands/Conservation Commission • Zoning Board of Appeals • Open Space Commission • Agricultural Land Preservation Commission
Bolton	• Planning and Zoning Commission • Inland Wetlands Commission • Conservation Commission • Open Space Preservation, Acquisition, and Conservation Committee

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

Table 4-3 summarizes the current plan of development, subdivision, inland wetlands, zoning, floodplain management, and stormwater regulations for the watershed towns. The table lists the last revision date for the applicable land use regulations.

Table 4-3. Municipal Land Use Regulations

Regulation	Manchester	Vernon	Ellington	Tolland	East Hartford	South Windsor	Bolton
Plan of Development	4/2004	6/2001	1997	8/1999	2003	7/2002	1990
Subdivision Regulations	10/2004	4/2003	8/1995	3/2005	8/2001	1/2002	2004
Wetlands Regulations	11/2004	4/2004	8/1996*	3/2005	11/2004	10/2002	2004
Zoning Regulations	4/2005	6/2005	4/2002	3/2005	4/2004	3/2005	2005
Floodplain Management	6/1994	In Zoning Regs.	None	None	1997	3/2005	2005
Stormwater Regulations	2004 Connecticut Stormwater Quality Manual	In Zoning Regs.	None	12/2004	11/1990	None	2004

*Currently under revision
Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

Inland Wetlands & Watercourses

Regulating activity with the potential to affect wetlands and watercourses is an essential component in preserving or improving the water quality and overall health of the Hockanum River. In Connecticut, the Inland Wetlands and Watercourses Act requires that each municipality establish an Inland Wetlands and Watercourses Agency or Commission and local

regulations regulating private and municipal work located in or affecting wetlands or watercourses. Each of the surveyed watershed towns has an inland wetlands agency, and each town has defined an upland review area, or distance from wetlands and watercourses that is subject to review. For example, Ellington has established an upland review area of 250 feet from Shenipsit Lake, which is considered to be a sensitive or critical water body. Approximately one half of the towns surveyed indicated that they have identified wetlands or watercourses that are impaired or that require restoration or require special protection. Table 4-4 summarizes the regulating agencies, upland review areas, and identified wetlands and watercourses of special significance for the surveyed watershed towns.

Table 4-4. Inland Wetlands and Watercourses Regulations

Town	Regulating Agency	Upland Review Area	Wetlands and Watercourses of Special Significance
Manchester	Planning & Zoning Commission	50' wetlands and watercourses	None identified
Vernon	Inland Wetlands & Watercourses Agency	100' wetlands 200' designated watercourses	Yes • Vernal pools on Box Mountain Road • Tankerhoosen River • Hockanum River • Belding Preserve and Wildlife Management Areas
Ellington	Inland Wetlands & Watercourses Agency	100'wetlands and watercourses 250' Shenipsit Lake	None identified
Tolland	Inland Wetlands & Watercourses Commission	50' wetlands 100' watercourses	Preliminary*
East Hartford	Inland Wetlands/Environment Commission	100' wetlands 200' watercourses	None identified
South Windsor	Inland Wetlands/Conservation Commission	80' wetlands and watercourses	Yes*
Bolton	Inland Wetlands Commission, Conservation Commission	100' wetlands and watercourses	Yes*

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

*Information available from the individual towns.

Stormwater Management and Soil Erosion and Sediment Control

Development of the landscape with impervious surfaces can alter the hydrology of a watershed and has the potential to adversely affect water quality and aquatic habitat. As a result of development, vegetated and forested land that consists of pervious surfaces is largely replaced by land uses with impervious surfaces. This transformation increases the amount of stormwater runoff from a site, decreases infiltration and groundwater recharge, and alters natural drainage patterns. Natural pollutant removal mechanisms provided by on-site vegetation and soils have less opportunity to remove pollutants from stormwater runoff. During construction, soils are also exposed to rainfall, which increases the potential for erosion and sedimentation. Development can also introduce new sources of pollutants from everyday activities associated with residential, commercial, and industrial land uses (DEP, 2004b).

Stormwater runoff both during construction and following completion of construction for new development and redevelopment projects is regulated at the local and state levels. As shown in Table 4-5, all of the watershed towns have erosion and sediment control regulations as mandated by the Soil Erosion and Sediment Control Act. Most Connecticut municipalities have adopted regulations requiring that a soil erosion and sediment control plan be submitted with any application for development within the municipality when the disturbed area of such development is more than one-half acre. Projects that disturb greater than 5 acres of land are subject to regulation under the DEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities. This permit applies to discharges of stormwater and dewatering wastewaters from construction activities including, but not limited to, clearing, grading, and excavation that result in the disturbance of 5 or more acres of total land area on a site. Pursuant to Phase II of the NPDES Stormwater Program, construction activities disturbing between 1 and 5 acres have been delegated by DEP to the municipalities provided that the erosion and sediment control plan is reviewed and receives approval from the town, under the Soil Erosion and Sedimentation Control Act.

Post-construction stormwater quantity and quality are also regulated by the watershed municipalities through municipal planning and zoning and inland wetlands and watercourses regulations. All of the watershed towns are subject to the requirements of the NPDES Phase II stormwater program, which is regulated under the DEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit). The MS4 General Permit regulates the quality of municipal stormwater discharges and requires the creation of a Stormwater Management Plan that addresses the following six minimum control measures:

1. Public education and outreach on storm water impacts required throughout the entire municipality;
2. Public involvement/participation required throughout the entire municipality;
3. Illicit discharge detection and elimination required throughout the entire municipality including mapping all storm water discharges from a pipe or conduit with a diameter of 15 inches or greater (or equivalent cross-sectional area) owned or operated by the municipality;
4. Construction site storm water runoff control required throughout the entire municipality;

5. Post-construction storm water management in new development and redevelopment; and
6. Pollution prevention/good housekeeping for municipal operations.

The DEP and Fuss & O'Neill recently developed the 2004 Connecticut Stormwater Quality Manual. The manual provides guidance on the measures necessary to protect the waters of the State of Connecticut from the adverse impacts of post-construction stormwater runoff. It is intended for use as a planning tool and design guidance document by the regulated and regulatory communities involved in stormwater quality management in Connecticut. The manual provides uniform guidance for developers, engineers, and review agencies on the selection, design, and application of stormwater control measures. All of the watershed towns in the Hockanum River watershed have indicated that they use the stormwater manual in reviewing development proposals for stormwater management issues.

Table 4-5. Stormwater and Erosion and Sediment Control Regulations

Town	Erosion and Sediment Control Regulations	NPDES Phase II Stormwater Program		Use 2004 CT Stormwater Quality Manual
		Subject to Phase II	In Compliance with Phase II	
Manchester	Yes	Yes	Yes	Yes
Vernon	Yes	Yes	Yes	Yes
Ellington	Yes	Yes	No*	Yes
Tolland	Yes	Yes	No**	Yes
East Hartford	Yes	Yes	Yes	Yes
South Windsor	Yes	Yes	Yes	Yes
Bolton	Yes	Yes	No***	Yes

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005; Stormwater Phase II Program compliance status provided by DEP Stormwater Program records as of December 2005.
*Has not submitted the 2004 Annual Report.
**Has not submitted the Part B permit registration or the 2004 Annual Report.
***Has not submitted the Part B permit registration or the 2004 Annual Report.

Open Space

Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious coverage, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as farmland preservation, community preservation, and passive recreation. Open space includes preserved natural areas as

well as lightly developed parks and playgrounds. While up to 40 percent of the Hockanum River watershed consists of undeveloped land uses, much of this land is not considered open space because it may be privately owned and ultimately developed. Protected open space areas include deeded open space that is privately owned, parcels owned by land trusts, state and federally-owned land, land owned by water companies, and municipal park land. Such land is protected against future development.

A current estimate of protected open space land in the Hockanum River watershed was not available as of the publication date of this report. Each of the watershed towns has recently prepared or is in the process of preparing an open space plan for their respective communities (Table 4-6). Inventories and mapping of protected open space land are available from the individual towns.

Table 4-6. Status of Municipal Open Space Plans in the Hockanum River Watershed

Town	Open Space Plan
Manchester	4/2004
Vernon	1/2002
Ellington	In progress
Tolland	In progress
East Hartford	2003
South Windsor	2/2005
Bolton	2004

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

In addition to the designation of protected open space through donation, purchase of land by a town, conservation or land trusts, or other private and/or public agencies, towns also require that some land be dedicated as open space with the development of new subdivisions. The subdivision regulations of all of the towns in the Hockanum River watershed require the set aside of a percentage of new subdivisions as open space, and all but Manchester have provisions for fee-in-lieu-of open space. Table 4-7 summarizes responses from the surveyed watershed communities regarding their current open space regulations.

A majority of the surveyed watershed towns also allow "cluster development" and "open space subdivisions" in their subdivision regulations. These are compact forms of development that concentrate density in one portion of the site in exchange for reduced density elsewhere, thereby

reducing overall site imperviousness and associated stormwater impacts and potentially avoiding development in sensitive areas of a site.

Table 4-7. Open Space Regulations

Town	Allow 'Cluster' Development	Allow 'Open Space' Subdivisions	Subdivision Open Space	
			Required	Fee in lieu of
Manchester	Yes	No	Yes, 6%	No
Vernon	No	No	Yes	Yes
Ellington	No	No	Yes	Yes
Tolland	Yes	Yes	Yes, 10%	Yes
East Hartford	-	Yes	Yes	Yes
South Windsor	Yes	Yes	Yes	Yes
Bolton	Yes	Yes	Yes	Yes

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

4.3.2 Regional Planning

All of the towns within the Hockanum River watershed lie within the Capitol Region Council of Governments (CRCOG), which is guided by the chief elected officials of the 29 Greater Hartford municipalities. CRCOG serves as a regional planning organization by:

- Helping members improve governmental efficiency and save tax dollars through shared services and other direct service initiatives;
- Promoting efficient transportation systems, responsible land use and preservation of land and natural resources and effective economic development;
- Advocating for the region and its towns with the State and Federal governments;
- Strengthening the regional community by helping coordinate regional agencies and programs; and
- Assisting local governments and citizens in articulating, advocating and implementing the vision, needs and values of their regional community.

4.3.3 Conservation District

All of the towns within the Hockanum River Watershed are served by the North Central Conservation District. This is a nonprofit organization dedicated to assisting private landowners and municipalities with environmental information, including:

- Comprehensive review of development plans
- Wetland Boundary review
- Erosion control and stormwater plan review
- Workshops on natural resource topics
- Soil information, erosion control inspection and compliance (by special arrangement)
- Pond Inspections and trouble-shooting
- Native landscaping assistance
- Agricultural services
- Funding assistance to municipalities for special projects.

4.3.4 Non-Profit Groups

Several non-profit groups that are actively involved in land use issues in the Hockanum River watershed were identified through the 2005 land use questionnaire. These groups include:

- South Windsor Land Trust
- Tolland Land Acquisition Committee
- Conserving Tolland
- Willimantic River Alliance
- Manchester Land Trust
- Hockanum River Watershed Association
- Friends of the Hockanum River Linear Park
- Northern Connecticut Land Trust
- Bolton Land Trust
- Mohegan Land Trust.

5.0 FISH AND WILDLIFE RESOURCES

Despite its developed nature, portions of the Hockanum River watershed, including the watershed of its major tributary, the Tankerhoosen River, have abundant habitats supportive of a variety of fish and wildlife. Various waterbodies, wetlands, and upland areas provide habitat to fish, mammals, amphibians, and birds.

Particularly notable is the 300-acre Belding Wildlife Management Area located in the upstream portion of the Tankerhoosen River watershed. The Belding Wildlife Management Area is a significant natural resource of undeveloped land owned by the State of Connecticut and managed by the DEP. A 1.4-mile section of the Tankerhoosen River within the Belding Wildlife Management Area is managed as a Class 1 Wild Trout Management Area and is one of only two such areas in eastern Connecticut. This section of stream is characterized by natural reproduction sufficient to produce robust populations of native brook trout (up to 8-10 inches) and wild brown trout (up to 10-11 inches) exhibiting above average growth rates (DEP correspondence, 2003).

The Belding Wildlife Management Area also supports a wide range bird of species. Surveys performed in 2003 and 2004 reported evidence of wood duck, willow flycatcher, hermit thrush, black-throated blue warbler, broad-winged hawk, hairy woodpecker, pileated woodpecker, olive-sided flycatcher, yellow-throated vireo, red-breasted nuthatch, blue-gray gnatcatcher, Nashville warbler, pine warbler, blackpoll warbler, blackburnian warbler, cerulean warbler, worm-eating warbler, and Canada warbler. European starling and house sparrow, two introduced invasive species, were also identified (Seymour, 2004).

Other natural resources in the Hockanum River watershed that provide significant habitat are summarized in Table 5-1. These natural resources were identified by the surveyed watershed towns as the most valuable or unique natural resources or ecosystems in their respective communities.

Table 5-1. Unique Natural Resources

Town	Natural Resource
Manchester	• Laurel Marsh • Case Mountain
Vernon	• Vernal Pools on Box Mountain Road • Tankanhoosen LLC Parcel • Talcotville Gorge • Belding Wildlife Management Area • Belding Wild Trout Management Area • Valley Falls Park
Ellington	• Shenipsit Lake watershed
Tolland	• Skungamaug River system • Tolland and Charter Marshes

	• Shenipsit Lake watershed
East Hartford	• Hockanum and Connecticut Rivers
South Windsor	• Central lowlands • Podunk River corridor • Lower Plum Gully Brook corridor
Bolton	• Blackledge River • Rose Farm • Herrick Park

Source: Hockanum River – State of the Watershed Land Use Questionnaire, North Central Conservation District, 2005

The following sections summarize the various fish and wildlife species that have been documented to exist in the Hockanum and Tankerhoosen River watersheds, as well as endangered, threatened, and special concern species.

5.1 Identified Species

5.1.1 Fisheries

The Hockanum River historically hosted large runs of many anadromous fish species. Development of the river with dams from 1700 to the 1920s created barriers to fish migration, which extirpated the salmon run and severely limited the upstream habitat for shad and river herring. Enough habitat remains below the dams in East Hartford to allow a small remnant shad and river herring run to persist. The DEP Inland Fisheries Division has been involved with past efforts to restore shad and river herring from East Hartford to the Union Pond Dam in Manchester (DEP correspondence, 2001) although efforts have stalled due to lack of funding for necessary fishways (DEP correspondence, 2005).

Despite these obstacles, the Hockanum River supports shiners, darters, suckers, and transient pond fish including bluegills, red breast sunfish, pumpkinseed sunfish, pickerels, largemouth and smallmouth bass, and wild brown trout weighing up to eight pounds. The Tankerhoosen River also contains gizzard shad and large carp. Additional anadromous species are likely present in the Hockanum River near the confluence with the Connecticut River (DEP correspondence, 2006).

However, while high species diversity is preferable in warm water fisheries, lower diversity is characteristic of healthy cold water systems. Although dams, ponds, and marshes along the Hockanum River cause generally warm water temperatures, several factors contribute to coldwater species habitat. The cold hypolimnetic release from Shenipsit Lake into the headwaters of the river results in wild brown trout populations between Rockville to Union Pond. Additionally, improvements to the Vernon wastewater treatment facility have resulted in improvements in the number and age class of trout in this reach. Although Union Pond warms the river substantially, the Town of Manchester has agreed to release hypolimnetic waters from the pond to cool the river below the dam. Evapotranspiration and groundwater inflows also contribute to cooling in the reach above New State Road, such that trout are present each year.

The river currently warms in Laurel Marsh, but natural infilling and reforestation of the marsh may reduce warming in the future. It is likely that the chain of dams and ponds downstream of the marsh results in warmer temperatures that are not favored by cold water species (DEP correspondence, 2006).

As indicated previously, the Belding Wild Trout Management Area in the upper portions of the Tankerhoosen River watershed is a Class 1 Wild Trout Management Area with self-sustaining native trout populations that rank among the best of their kind in the state. The remainder of the Tankerhoosen River is stocked annually by the DEP Inland Fisheries Division with over 1,100 adult size brook, brown, and rainbow trout. Walker Reservoir, upstream of the Belding Wildlife Management Area, is stocked each spring with over 1,800 adult brown and rainbow trout (DEP correspondence, 2003).

There are several other significant recreational fishing areas within the river system. Upstream of I-84, the Hockanum River is stocked with 2,600 trout annually. Daily angling is reported between New State Road and Middle Turnpike in all seasons but winter. DEP estimates that stocking there, as well as 2,600 trout downstream in East Hartford, can support approximately 10,000 angler hours of spring fishing annually. Trout are also stocked in Shenipsit Lake (1,500 trout) and Walkers Reservoir (2,000 trout). A new trout park at Valley Falls Park Pond will be stocked every 7 to 10 days with a total of 3,000 to 5,000 trout. This fishery is expected to generate between 3,000 and 6,000 angler hours of fishing annually. In addition to these cold water fisheries, there is regular fishing for warm water species on the Tankerhoosen Lakes, the pond near East Hartford Town Hall, and Union Pond, although a fish consumption advisory is in effect for Union Pond (DEP correspondence, 2006).

5.1.2 Amphibians & Reptiles

Amphibian and reptile surveys were conducted in 2004 within the Tankerhoosen River watershed, including the Belding Wildlife Management Area, Barrows Brook, and Railroad Brook. The species identified included Northern redback salamander, Northern two-lined salamander, Spotted salamander, American toad, Northern spring peeper, Gray treefrog, Wood frog, Green frog, Pickerel frog, Painted turtle, and Garter snake. The most abundant amphibian species detected during this study was the northern redback salamander. A previously undocumented vernal pool was discovered between Reservoir Road and Walker Reservoir West. Additional vernal pools were identified on Bolton Road and above Valley Falls Park (Seymour, 2004).

5.2 Threatened and Endangered Species

The DEP Natural Diversity Data Base (NDDB) maintains information on the location and status of endangered, threatened, and special concern species in Connecticut. Figure 5-1 displays the areas of endangered, threatened, and special concern species in the Hockanum River watershed. Shenipsit Lake and its surrounding area are identified on the NDDB mapping, as well as approximately 13 other areas of concern throughout the watershed. Table 5-2 provides a listing of plant and animal species identified within these areas, according to the NDDB (DEP correspondence, 2005).

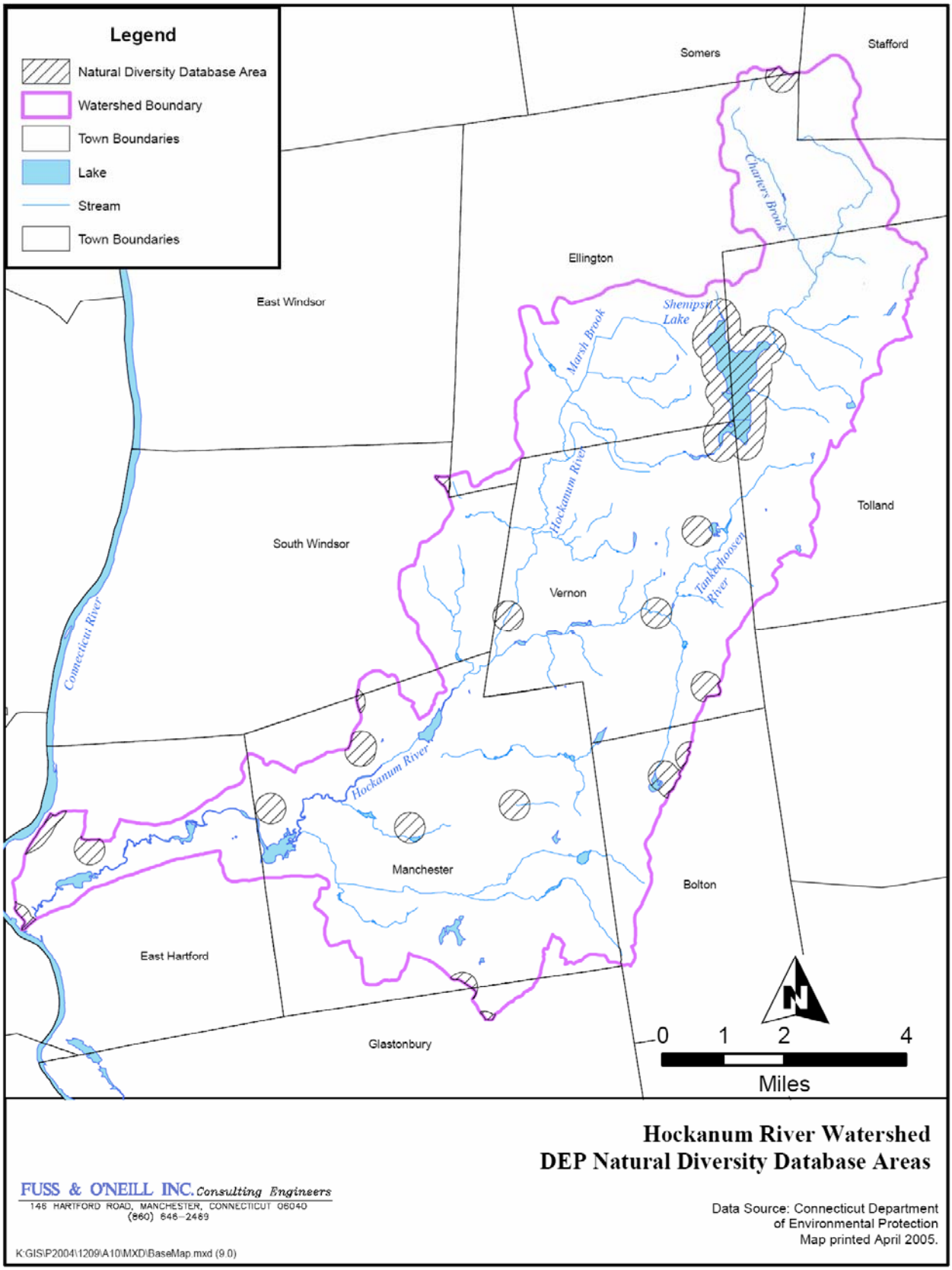
Table 5-2. Endangered, Threatened, and Special Concern Species

Common Name	Scientific Name	Status
Plants		
Eastern pearlshell	*Margaritifera margaritifera*	Special Concern
Sedge	*Carex typhina*	Special Concern
Yellow lady's-slipper	*Cypripedium parviflorum*	Special Concern
Dwarf bulrush	*Hemicarpha micrantha*	Endangered
Climbing fern	*Lygodium palmatum*	Special Concern
Hooker orchid	*Platanthera hookeri*	Special Concern*
One-sided pyrola	*Pyrola secunda*	Special Concern*
Birds and Reptiles		
Sharp-shinned hawk	*Accipiter striatus*	Endangered
Whip-poor-will	*Caprimulgus vociferous*	Special Concern
Wood turtle	*Clemmys insculpta*	Special Concern
Bald eagle	*Haliaeetus leucocephalus*	Endangered
Savannah sparrow	*Passerculus sandwichensis*	Special Concern
Purple martin	*Progne subis*	Threatened
Eastern spadefoot	*Scaphiopus holbrookii*	Endangered
Eastern meadowlark	*Sturnella magna*	Special Concern
Barn owl	*Tyto alba*	Endangered
Eastern box turtle	*Terrapene carolina*	Special Concern

Source: DEP Natural Diversity Data Base, 2005. *Believed locally extinct.

- "Endangered Species" means any native species documented by biological research and inventory to be in danger of extirpation (local extinction) throughout all or a significant portion of its range within Connecticut and to have no more than five occurrences in the state.
- "Threatened Species" means any native species documented by biological research and inventory to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range within Connecticut and to have no more than nine occurrences in the state.
- "Species of Special Concern" means any native plant or any native nonharvested wildlife species documented to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high demand by man that its unregulated taking would be detrimental to the conservation of its population, or has become locally extinct in Connecticut.

Figure 5-1. Areas of Endangered, Threatened and Special Concern Species



6.0 CONCLUSIONS

As documented in this State of the Watershed report, the Hockanum River has seen dramatic changes in land use and water quality over the past 100 years. Intensification of land use within the watershed has degraded the river's water quality, and the numerous impoundments within the watershed act as barriers to fish passage along the Hockanum River and its tributaries. Water quality along reaches of the Hockanum River and its major tributary, the Tankerhoosen River, does not meet state standards to fully support aquatic life and primary contact recreation as a result of various point and nonpoint sources of pollution. Historical monitoring data and recent surveys of benthic macroinvertebrates in the Hockanum and Tankerhoosen Rivers indicate degraded water quality throughout the developed portions of the watershed, with a general upstream-downstream decline in water quality that follows the watershed development and impervious cover. Future watershed planning efforts should emphasize restoration and protection from further degradation in these impacted areas.

Significant portions of the watershed are also relatively undeveloped and remain in pristine condition. Large areas of protected open space have historically sustained these conditions. Charters Brook and the tributaries that feed Shenipsit Lake, as well as the upper reaches of the Tankerhoosen River, are noted significant natural resources. These and other high-quality watercourses in the less developed portions of the watershed are under significant pressure from ongoing development in the watershed. Protection of these resources is critical to maintain their current high quality into the future.

Development of a watershed management plan is recommended to identify the causes of impairment in the Hockanum River watershed and strategies for addressing the issues identified in this report. The watershed management plan would augment the ongoing preservation and restoration efforts in the watershed, integrate all phases of the watershed planning process, and outline recommendations that can be implemented by the appropriate watershed stakeholders. The plan should include the following nine elements consistent with DEP's and EPA's recommended watershed management planning process:

- Definition and characterization of the watershed
- Description of the partnership who participated in developing the plan
- Identification of the problems, indicators, and measures
- Identification of goals and objectives
- Summary of pollutant loading evaluation and target pollutant reductions
- Description of implementation approach and management practices
- Implementation schedule (including interim and long-term goals and milestones), roles, responsibilities, budget, and potential funding sources
- Description of monitoring plan and evaluation process (adaptive management)
- Description of public outreach component implemented during the project.

The watershed management plan should be tailored to the specific problems and issues in the Hockanum River watershed. Some of the strategies that should be considered in the plan include:

- Open space preservation/acquisition
- Protection of vegetated and riparian buffers
- Stormwater management planning and implementation
- Following stormwater quality guidelines
- Public awareness and education
- Sustainable development
- Protecting wetlands from development
- Restoring aquatic habitat and fish runs, including fish passage at dams
- Restoring and maintaining wildlife habitat.

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