The Oswegatchie Hills

Natural Resource Inventory

East Lyme, Connecticut

Eastern Connecticut
Environmental Review Team Report

The Eastern Connecticut Resource Conservation & Development Area, Inc.

The Oswegatchie Hills Natural Resource Inventory
East Lyme, Connecticut

Environmental Review Team Report

Prepared by the
Eastern Connecticut
Environmental Review Team
of the
Eastern Connecticut Resource Conservation and Development Area, Inc.

For the
First Selectman
and Conservation Commission
East Lyme, Connecticut

Report #606

May 2007

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Acknowledgments

This report is an outgrowth of a request from the East Lyme First Selectman and the East Lyme Conservation Commission to the Eastern Conservation District (ECD) and the Eastern Connecticut Resource Conservation and Development Area (RC&D) Council for their consideration and approval. The request was approved and the measure reviewed by the Eastern Connecticut Environmental Review Team (ERT).

The Eastern Connecticut Environmental Review Team Coordinator, Elaine Sych, would like to thank and gratefully acknowledge the following Team members whose professionalism and expertise were invaluable to the completion of this report.

The field reviews took place on Wednesday, August 23, 2006 and October 4, 2006.

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**Report not yet received.*

I would also like to thank Meg Parulis, town planner, Ed Hafner, conservation commission, A. Carl Stamm and Marvin Schutt, Friends of Oswegatchie Hills Nature Preserve, and Dave Kozak, DEP-OLISP, for their cooperation and assistance during this environmental review.

Prior to the review day, each Team member received a summary of the proposed project with location and aerial photos. During the field reviews Team members received additional information, reports and maps. Following the reviews, reports from each Team member were submitted to the ERT coordinator for compilation and editing into this final report.

This report represents the Team's findings. It is not meant to compete with private consultants by providing site plans or detailed solutions to development problems. The Team does not recommend what final action should be taken on a proposed project - all final decisions rest with the town and landowners. This report identifies the existing resource base and evaluates its significance to the proposed use, and also suggests considerations that should be of concern to the town. The results of this Team action are oriented toward the development of better environmental quality and the long term economics of land use.

The Eastern Connecticut RC&D Executive Council hopes you will find this report of value and assistance in reviewing the Oswegatchie Hills area for preservation, conservation or development issues.

If you require additional information please contact:

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August 23, 2006 Field Review

Quarry area, field review, August 23, 2006

Boat trip on the Niantic River on October 4, 2006

View of the Hills from the Niantic River, October 4, 2006

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Introduction

Introduction

The East Lyme First Selectman and the East Lyme Conservation Commission have requested Environmental Review Team (ERT) assistance in reviewing an area known as the Oswegatchie Hills.

The +700 acre study site is an area bounded on the north by Route 1 (the Boston Post Road) at the interchange with I-95, bounded on the east by the Niantic River and Quarry Dock Road, on the south by Oswegatchie Hills Road, and on the west by various developments along Route 161 (Flanders Road). The area was broken down into 13 parcels by landowner for ease of study the ERT Team. At the time of the ERT field reviews the following parcels and landowners included:

Parcel #	Acres	Owner
1	86.71	Jarvis of Cheshire – Glenn Russo
2	113.51	Sergeant's Head Realty Co.
3	29.0	Sergeant's Head Realty Co.
4	34.08	Woodridge Condominiums
5	65.11	Town of East Lyme
6	10.91	East Lyme Land Conservation Trust
7	88.18	East Lyme Land Conservation Trust
8	52.85	William Wilson
9	41.34	Christian Bayreuther
10	94.92	Town of East Lyme
11	61.20	Town of East Lyme
12	8.85	Town of East Lyme
13	1.58	Town East Lyme

The ERT did not have permission to enter Parcels 1, 2 or 3 for the field review, but relied on previous reports, plans and publicly available data for review and comments concerning those parcels.

Please refer to the following Location Map and Parcel Map for approximate property locations.

Objectives of the ERT Study

The town has requested assistance in conducting a natural resource inventory and assessment of this undeveloped area. The Oswegatchie Hills have been a target of preservation efforts by the Town working with the non-profit Friends of Oswegatchie Hills, the East Lyme Conservation Trust and the Trust for Public Land. As of the field review date, 345 acres of the total have been acquired and/or permanently preserved through conservation easements. Three parcels totaling 230 acres in the northernmost area of the Hills, including 5000 feet of shoreline along the Niantic River, have been the subject of repeated applications for a zone change to allow affordable housing. There have been as many as +1700 units of housing proposed for these parcels. The remaining three parcels totaling 128 acres are privately owned.

The town plans to use the information gathered by the ERT review for the following purposes:

- To develop a comprehensive management plan for preserved land;
- To develop educational materials for public access trails;
- To develop land use guidelines for potential development on unprotected land;
- To apply for state and federal grants to preserve remaining unprotected land.

The ERT Process

Through the efforts of the First Selectman and the Conservation Commission this environmental review and report was prepared for the Town of East Lyme.

This report provides an information base and a series of recommendations and guidelines which cover the topics requested by the town. Team members were able to review maps, plans and supporting documentation provided by the town.

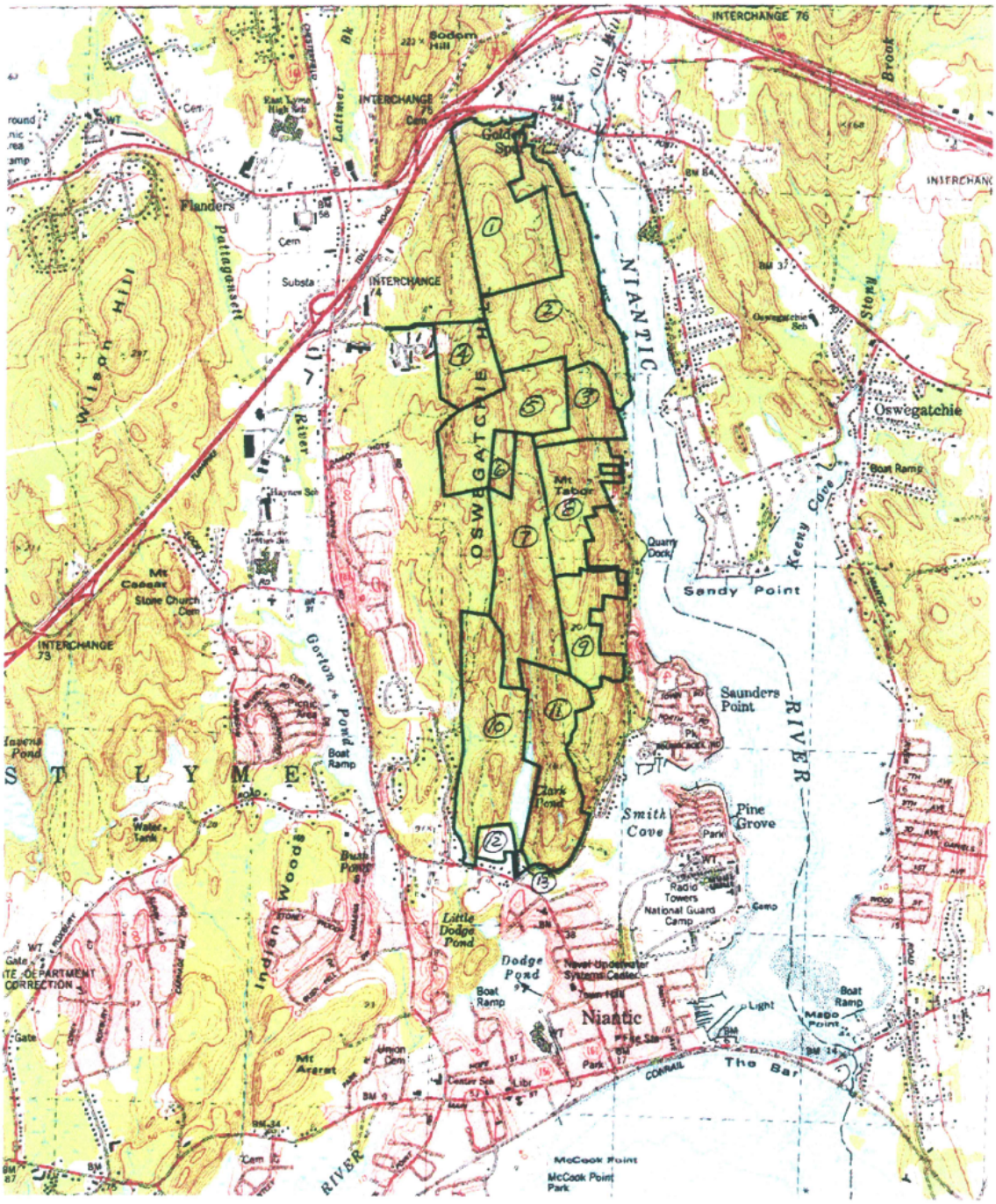
The review process consisted of four phases:

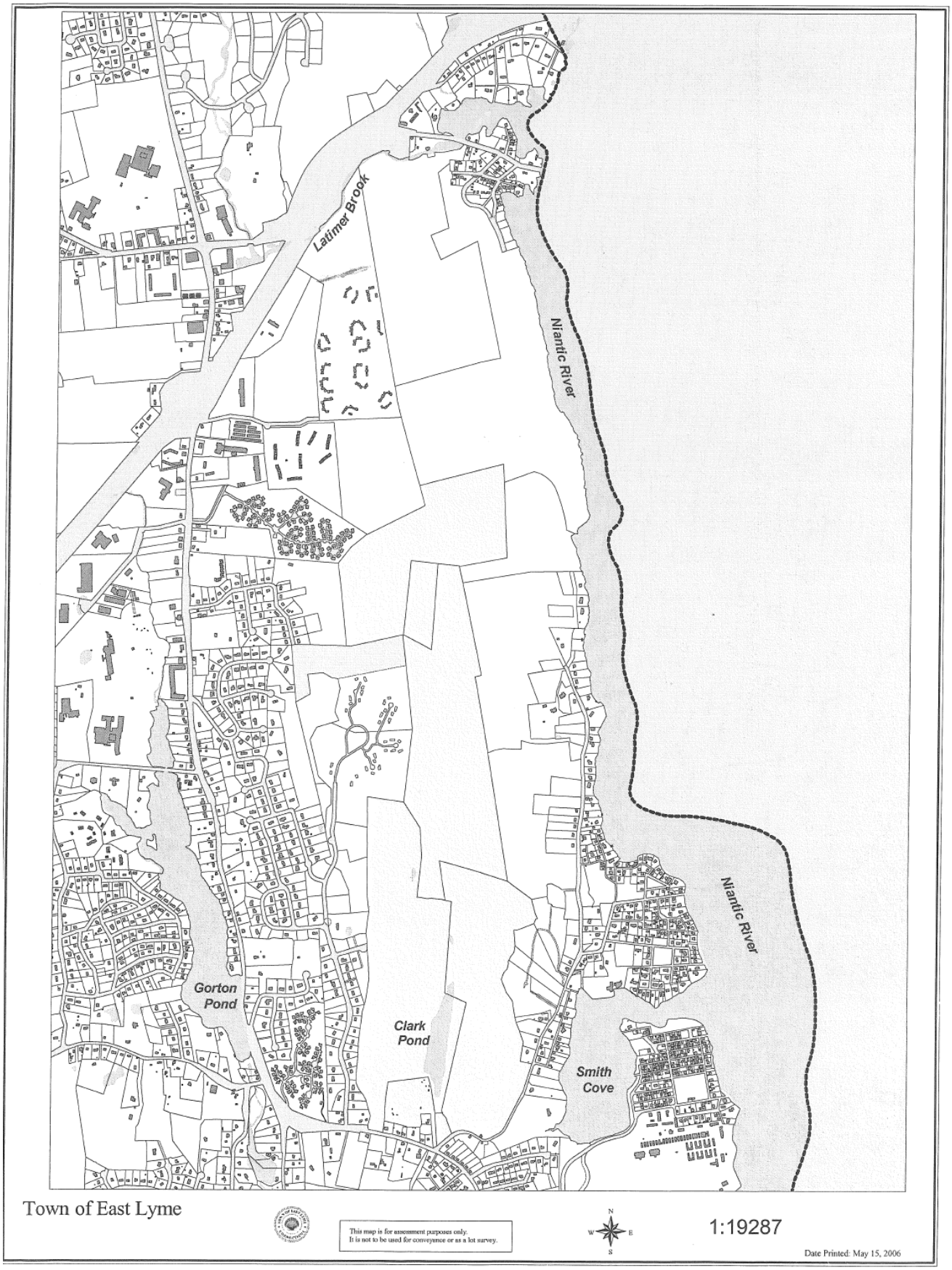
1. Inventory of the site's natural resources;
2. Assessment of these resources;
3. Identification of resource areas and review of plans; and
4. Presentation of education, management and land use guidelines.

The data collection phase involved both literature and field research. The field reviews were conducted on two days due to the size of the area to be studied. On Wednesday, August 23, 2006 the Team met and conducted a field walk of the southern portion of the study area. The Team met again on Wednesday, October 4, 2006 to walk the northern portions of the area in the morning and to view the Oswegatchie Hills by boat on the Niantic River in the afternoon. The emphasis of the field review was on the exchange of ideas, concerns and recommendations. Being on site allowed Team members to verify information and to identify other resources. Some Team members attended all the field reviews, while others attended only portions of the field/boat trips.

Once Team members had assimilated an adequate data base, they were able to analyze and interpret their findings. Individual Team members then prepared and submitted their reports to the ERT coordinator for compilation into this final ERT report.

Oswegatchie Hills Location Map




Latimer Brook
Niantic River
Niantic River
Gorton Pond
Clark Pond
Smith Cove
Town of East Lyme
This map is for assessment purposes only.
It is not to be used for conveyance or as a lot survey.
N
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E
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1:19287
Date Printed: May 15, 2006

Oswegatchie Hills Aerial Map

The Connecticut Environmental Review Team

This map was prepared by Amanda Fargo-Johnson for the Connecticut Environmental Review Team.
This map is for educational use only.
It contains no authoritative data.
May 2007.

East Lyme, CT

0 0.15 0.3 0.6 0.9 Miles

N

A Watershed Perspective

General Watershed Characterization

The review area is described as the Oswegatchie Hills within the community of East Lyme. The Town of East Lyme requested assistance in conducting a natural resources inventory and assessment of this largely undeveloped area. A decades-long preservation history was documented during the ERT site review and is described elsewhere in this document. Significant investments in time, planning, and funding priorities have been made by a state-local-non profit partnership in recent years, leading to a broader community awareness and priority focus on land preservation of at least 350 acres within this roughly 800 acre Hill area. The Town indicated three objectives:

- to develop a comprehensive management plan for the preserved lands;
- to develop educational materials for public access trails on preserved lands; and
- to develop land use guidelines for potential development in unprotected areas of the Hill.

The Town provided reviewers with a copy of the draft Oswegatchie Hills Natural Preserve Management Plan, with initial desire to extend such management planning to the unprotected parcels of the Hill. During this site review the portion of the Oswegatchie Hills with controlling interest by the Mr. Glenn Russo of Landmark Development, LLC was unavailable for an onsite tour and assessment. Mr. Russo provided no new information for this ERT review.

The major natural resources include a dry, hilltop woodland, granitic rock outcroppings (including local favorites known as High Rock and Turkey Point), a topographic prominence rising considerably above the adjacent Niantic River, a largely wooded river shoreline, and inland wetlands with associated small stream discharging to the Niantic River, and a smaller wetland draining toward Latimer Brook. The Oswegatchie Hills, formerly known as Sargeant's Head, is one of the few remaining large stretches of undeveloped coastal waterfront land in Connecticut.

The Hill area is a north-south oriented landscape feature with regional visual and topographic prominence, rising to 260 feet above seas level, in the lower Niantic River sub-regional drainage basin, or watershed. The term watershed can mean different things to different people. Here, one can envision a "watershed"

as the land area that drains to a common receiving water body such as a stream, lake or wetlands. It is an easily identifiable landscape unit that ties together terrestrial, aquatic, geologic, and atmospheric processes.

The Niantic drainage basin covers a land area of 31.3 square miles, or approximately 20,000 acres. The relatively small watershed encompasses portions of four municipalities: East Lyme, Montville, Salem and Waterford, and is entirely located within Connecticut. The Niantic basin's main freshwater watercourses are Latimer Brook, Oil Mill Brook, Stony Brook, and several unnamed tributaries. The longest freshwater stream is Latimer Brook, which originates at Fairy Lake in Salem, and ultimately discharges to the Niantic River at Golden Spur. The remaining significant watercourse in this basin is the tidally influenced Niantic River estuary. From Golden Spur south to Sandy Point, the Niantic River is ¼ mile wide. To the south of Sandy Point, the Niantic River widens to ½ to ¾ mile. The Niantic River receives the freshwater drainage from the upper watershed, mixes with the salt water of Long Island Sound, and discharges into Niantic Bay, in the towns of East Lyme and Waterford. This coastal embayment is nested with Long Island Sound. The freshwater input is only 3% of the total tidal prism in the River and Bay. The discharge of ground water, containing high levels of nitrogen and other nutrients, has been identified by the U.S. Geological Survey and the CT DEP as a suspected cause of water quality degradation. The Survey estimates about 50% of the freshwater discharged to the Niantic River originates as ground water.

The Niantic River estuary is a drowned valley, with nearly 800 acres separated from Long Island Sound by a sand bar and a small connecting inlet that is structurally engineered to support the Amtrak railroad crossing and State Highway 156. There is a tidal flood delta or flat, that has developed within the Niantic River estuary that extends from the narrow inlet to about 1 mile upstream. Upstream of this delta is a broader, shallow basin with average channel depths of 10-12 feet and maximum water depths of 22 feet. The bottom substrate composition mirrors the hydrologic regime of well-sorted sands in high-energy environments and finer grained silts and clays in slow energy regions. Organic material has deposited in the low energy environment that creates a muddy bottom.

The entire River, Bay and inlet are subject to the tidal dynamics of Long Island Sound, ranging in the Niantic River to 2.5 feet, a little less than in the Bay. There is a relatively high retention time within the Niantic River of 25 days, which is likely attributed to the semi-enclosed basin morphology. This high retention

attribute and limited flushing rate has benefited the fish nursery resources, including winter flounder. It can also result in reduced capacity to assimilate higher nutrient and sediment loads from the upper watershed, having increased in recent decades from documented land use changes.

The Niantic River watershed reflects a human settlement pattern found in many other coastal watersheds in much of the northeastern United States. This sub-regional basin contains a relatively rural human population across the upper reaches, transitioning downstream through a highway network and increasingly densely populated lower basin, especially along the tidal Niantic River. The upper East Lyme shoreline is lightly developed and includes the Oswegatchie Hills. The opposing shoreline in Waterford supports a moderate density of residential and commercial development. Near the mouth of the Niantic River, from Mago Point to the Amtrak railroad bridge, the shoreline is a highly developed commercial area. Based on U.S. Census 2000 data, the Niantic sub-regional basin contains an average of 521 people per square mile. Nearly 55% the regional watershed is classified as having deciduous forest cover, 12% in residential and commercial land use, nearly 5.5% of coniferous forest cover…

The CT DEP and the USDA-Natural Resources Conservation Service (NRCS) conducted a Unified Watershed Assessment (UWA) for all Connecticut regional basins or watersheds, as part of the 1998 federal Clean Water Action Plan. The assessments were the results of a compilation and review of available information on surface water conditions, land use conditions and known pollution sources. Local knowledge and critique was requested to reinforce the assessments. The Niantic Subregional basin is nested within the Southeast Coastal Basin – Western complex (from the Four Mile River in the west to Alewife Cove and Fenger Brook to the east). The Southeast Coastal regional watershed was classified as a Category 1 watershed – identifying the watershed priority need for restoration. This compares to Category 2 watersheds with priority for protection (e.g. the adjacent Eightmile River). The UWA Classification for the Southeast Coastal/Western Complex regional basin has assisted both DEP and NRCS with forming watershed management objectives to focus work towards protection of the relatively intact watershed processes and functions. These same agencies also use the UWA process to target watershed restoration funds made available under Section 319 of the federal Clean Water Act.

Water Quality Conditions

Surface and Ground Water Classification

The current State of Connecticut surface water quality classification for the Niantic River is SB/SA. The Niantic River may not be meeting one or more of the water quality criteria, which support designated uses. These surface waters have designated uses for: habitat for marine fish, other aquatic life and wildlife; recreational uses; and agricultural/industrial water supplies. The water quality goal (and the associated management actions) is the achievement of Class SA criteria and the attainment of these designated uses. All permitted wastewater discharges are limited in Class SA surface waters. The State of Connecticut Water Quality Standards, with associated Criteria for Surface Waters and Ground Waters, is available on-line at: www.ct.gov/dep.

The freshwater Latimer Brook (downstream to Latimer Brook Pond Dam) and most tributaries on this review area have a surface water classification of A, with designated uses of potential water supplies; fish and wildlife habitat; recreational uses; and agricultural/industrial water supplies. There are some upper basin tributaries that supply public water supply sources and have a Class AA surface water classification – none of these tributaries would be directly impacted with future development on the Oswegatchie Hills parcels.

The current Connecticut ground water classification for the associated development area is GA. The designated uses for GA waters are: existing private and potential public or private supplies of water suitable for drinking without treatment; baseflow of hydraulically connected surface water bodies. CT DEP presumes that ground water in such areas is, at a minimum, suitable for drinking or other domestic uses without treatment. The management goal is to protect these designated uses of the Niantic River and associated ground water resources.

Water Quality Assessment

Existing water quality issues have been documented for the Niantic River and Bay. The 2006 Connecticut Integrated Water Quality Report to Congress (formerly known as the biennial 305b report) indicates the Niantic Bay (defined as the Upper Bay and River from Sandy Point north to the Golden Spur area) segment associated with this resource inventory area is impaired for the designated use of "Habitat for Marine Fish, Other Aquatic Life and Wildlife". The listed causes include: dissolved oxygen saturation, nutrient/eutrophication

biological indicators, and dissolved oxygen. The potential sources include nonpoint source, atmospheric deposition – nitrogen, unspecified urban stormwater, on-site treatment systems (septic systems and similar decentralized systems), and residential districts.

Additionally, the designated use of "Shellfish Harvesting for Direct Consumption Where Authorized" is impaired, with the listed cause as fecal coliform. The potential sources include: on-site Treatment Systems (septic systems and similar decentralized systems), waterfowl, residential districts, unspecified urban stormwater, marina/boating sanitary on-vessel discharges, and non-point sources.

Similarly, the lower Niantic Bay and Offshore area north to Sandy Point area is listed for the impaired designated use of "Habitat for Marine Fish, Other Aquatic Life and Wildlife." The listed cause is unknown, and potential sources are unknown at this time. Additionally, the designated use of "Shellfish Harvesting for Direct Consumption Where Authorized" is listed as impaired. The listed cause is fecal coliform, and potential sources include marina/boating sanitary on-vessel discharges, waterfowl, unspecified urban stormwater, residential districts, and on-site treatment systems (septic systems and similar decentralized systems).

Connecticut DEP did not conduct a recent water quality assessment for Latimer Brook for the latest statewide reporting cycle.

Potential Water and Watershed Issues

Leachate and Wastewater Discharge Inventory

There are no known wastewater discharges or leachate sources included in the Connecticut DEP databases for area included within or adjacent to the Oswegatchie Hills parcels under this review. This database for the greater Thames River basin is being revised and will be brought forward for public comment later in 2007.

Contamination or Potential Contamination Sites

The Department maintains a database of "Hazardous Waste Facilities" as defined in Section 22a-134f of the Connecticut General Statutes. A review of the listings within the Town of East Lyme does not indicate any sites within or proximate to the parcels under this site review. For more information about this

statewide database, visit the CT DEP website at:
http://www.ct.gov/dep/cwp/view.asp?A=2715&Q=325018

Water Supply Wells

A cursory review of the CT DEP's database indicates there are no identified major public wells associated with these parcels under review. Public water service is currently provided in some areas adjacent to, but not within the Oswegatchie Hills parcels reviewed – up Quarry Dock Road, and along Flanders Road that includes Damon Heights Road, Stone Cliff Road, the Woodridge Condominiums area, and along Pennsylvania Avenue. There is no potable water infrastructure available to supply the undeveloped Oswegatchie Hills parcels under this review. The Town of East Lyme is under a DEP Consent Order that prevents extension of the East Lyme water service area. The Town's capacity to produce water is limited to its existing wells and maintaining a safe yield is important, especially during peak demand during the summer months. There is a small amount of potable water (approximately 50,000 gallons per day) from the City of New London that may be available to the Golden Spur area. This would require approval from the Towns of Waterford and New London, as well as East Lyme. Such potential amount of water must first serve the existing homes in the Golden Spur area.

Municipal Wastewater Service Areas

The existing East Lyme sanitary wastewater sewer service area does include some areas within the reviewed Oswegatchie Hills parcels. Sanitary wastewater from homes and businesses in these areas is conveyed into the municipal sewer system and piped to the Waterford sewer system via Route 156, where it is later treated at the New London Water Pollution Control Facility and discharged to the Thames River. The service area boundary encompasses the northern end of Parcel 1, nearly one half of Parcel 4 and of Parcel 5, possibly Parcel 6 and the southern end of Parcel 11. The existing service area does not include Parcel 2, 3, 7, 8, 9 or 10, and most of Parcel 11. The East Lyme Water Pollution Control Facilities Plan (June 1985), prepared by Consulting Environmental Engineering, Inc, defined the areas where sewers were projected to be built, based on engineering evaluations of the needs over the following 20 years. The facilities plan was submitted to CTDEP as a formal document of the Water Pollution Control Authority. Approximately 42 acres of an earlier proposed Riverview Heights development proposal would be located within the proposed sewer service area known as Golden Spur, based on CTDEP estimates. This area appears to be within Parcel 1 and possibly the northern end of Parcel 2. The

balance of the former development proposal would lie outside the sewer service area. The average daily flow (ADF) projected from the entire Golden Spur sewer service area was 20,000 gallons per day that would be conveyed to the Waterford sewer system via Boston Post Road. Based on residential property allocation units, known as Equivalent Dwelling Units, or EDUs, the proportional flow allocation from this service area would be 5,600 gallons per day. That translates to just under 24 residential units that would be projected to receive sewer service from within this proposed development. There are no areas outside of the approved sewer service district boundary that can be provided with sewer service until and unless the town of East Lyme adopts a revision to their WPCA report showing the area as falling within the sewer service area and files said report with DEP. Such changes must be consistent with the local Plan of Conservation and Development, as well as the State Policies Plan of Conservation and Development, the latter prepared by the Office of Policy and Management. The Town Sewer and Water Commission has been updating the Sewer Facilities Plan, and did contract with Fuss & O'Neill Inc. Consulting Engineers in 2005 to conduct a comparison of sewer service district boundaries. A report submitted to the Town delineated the town's sewer service district as amended by the Water and Sewer Commission in 2003, the applicant's sewer shed limit with the proposed Riverview Heights development, and the 1985 Town Facilities Plan (for Golden Spur) and it ultimate tributary area limits. The majority of the land area proposed for the affordable housing application by Landmark Development LLC was determined to be located within a sewer avoidance area, and thus lacks the ability to connect to the East Lyme sewer service system. The small area of the Oswegatchie Hills parcels within the Golden Spur sewer shed currently has no infrastructure in place to accommodate the flow from development proposals, and future development connections would have to share the limited flow with all the Golden Spur properties.

On-Site Wastewater Treatment

Development applicants have provided no recent information for an on-site subsurface wastewater absorption system, or whether one would be eventually proposed. CTDEP's Water Permitting and Enforcement Division did review a 2004 site development application by Landmark Development Corp for 352 units and raised issues of the conceptual subsurface design not meeting the Department's criteria. It is likely that any proposed on-site community system would require a wastewater treatment plant and lateral sand filter.

Stream Channel Encroachment Lines (SCEL)

SCELs are regulated areas within the State of Connecticut. They are a nonstructural element in Connecticut's ongoing effort to reduce the loss of life and property from flooding events. This program is administered to assure that floodplain development is compatible both structurally and hydraulically with the flood flows expected in 270 miles of the State's most flood prone rivers regulated under this program. The actual encroachment lines delineate the limits of State authority, and in general, roughly outline the limits of the national flood insurance program 100-year riverine floodplain. Town land use commissions reviewing site conservation and development proposals can assist State regulatory actions by alerting private and public landowners of designated SCELs. There are no SCELs designated for this or other segments of Latimer Brook or the Niantic River. Any questions regarding the SCEL program should be directed to the CT DEP Inland Water Resources Division at (860) 424-3019.

Aquifer Protection Areas (APAs)

Some of the parcels under review will likely be included within an approved Aquifer Protection Area (APA). The Town of East Lyme Water Department is responsible for delineating critical recharge areas to the aquifer that provides water to the Gorton's Pond 1 wellfield. There is a preliminary mapping (Level B) area identified along the western edge of Parcel 5 that may also include a portion of Parcel 4 and Parcel 6. The Level B mapping delineates a preliminary aquifer protection area, providing an estimate of the land area from which the wells draws its water. The Level A mapping will delineate the final Aquifer Protection Area, which becomes the regulatory boundary for land use controls designed to protect the well from contamination. Land use regulations will be established in those areas to minimize the potential for contamination of the well field. The regulations restrict development of certain new land use activities that use, store, handle or dispose of hazardous materials and require existing regulated land uses to register and follow best management practices. Residential development, including densely populated affordable housing units, is not a regulated land use activity under the APA program. The Town of East Lyme Zoning Commission is the designated Aquifer Protection Agency, and Zoning Commission official Bill Mulholland is the local contact. Additional information about the Connecticut APA Program, including guidance to East Lyme on ground water resource protection and with areas not included in the current designation areas, can be found at the CT DEP website at:
http://www.ct.gov/dep/cwp/view.asp?a=2685&q=322252&depNav_GID=1654

Clark's Pond Dam

During the initial ERT site visit, comments were made about a possible repair order from CTDEP to the owner of this dam. Upon checking on the Department's files, a January 2006 letter was sent to Mr. Martin Gottesdiener of Waterford. The letter indicated that the dam, identified as #4517 with a Hazard Class A, does fall within the regulatory powers of the Department. Following the flood event of October 14 and 15, 2005, DEP staff visually inspected the dam and found it to have been significantly damaged. The letter indicated the dam needed to be restored to ensure the safety of the dam and minimize future sedimentation and erosion discharges. Dam repair and improvement items were listed, a submission of plans and timetable were required for DEP approval prior to any repair or demolition work, and a suggestion that the local inland wetlands agency be contacted to determine if local permitting would be required. The file does not reflect whether the repair and improvement plans were subsequently submitted and approved by the Department.

Watershed Planning Considerations

Historic and Recent Cultural Water Uses

The Niantic River has provided humans with important economic assets for centuries. Information is provided in earlier documents and resource assessments of this review area and the larger Niantic River and Bay. It is worth mentioning in this review section how prominent and diverse were the human uses of the water resources in and around the Niantic River (including Oswegatchie Hills) and Niantic Bay.

The shores of the Niantic River were the long time homeland for the Nehantic people. Historic records and archaeological assessments have determined that this river area was used extensively for human transportation, for fish and shellfish, while the woodlands and the river shoreline were used for shelter, food and fuel. In more modern times the upper Niantic River area had two known areas - the Golden Spur and Keeney Cove – that were frequented by boat transportation before bridges were built. A granite rock quarry and loading dock were developed in the early to mid 1800s along the Niantic River in the vicinity of Quarry Dock Road. The Niantic River and Bay became well known for the desired, high quality scallops found in many restaurants in the area and beyond. There was a sizeable fishing fleet associated with this river and bay in the 1880s and early 1900s.

In recent decades, recreational uses of the Niantic River have largely overtaken the once dominant commercial uses. Current recreational uses include clamming, crabbing, scalloping, sport fishing, pleasure boating, sailing, waterskiing, wake boarding, tubing, kayaking, canoeing, swimming, and shoreline picnicking. To state that the Niantic River is active with a diverse boating user group is an understatement. There are 10 commercial marinas in the Niantic River, two anchorage areas, one State Boat Launch, and increasing demand for non-motorized vessel access areas along the river. A canoe/kayak trail guide for the Niantic River Estuary was published a few years back (see Appendix) to broaden community awareness and enjoyment of both historic and natural resource assets of the river and bay, as well as appropriate public access sites and additional local resources to pursue further information.

Both the Niantic River and Bay, along with Latimer and Oil Mill Brooks are productive and popular recreational fishing areas. One of Connecticut's best runs of sea-run brown trout fishery can be found at the confluence of Latimer and Oil Mill Brook, and upstream to Silver Falls.

The Niantic River shellfishery historically has been one of the most productive in Long Island Sound, noted for the bay scallops in particular. Other important shellfish include hard clams, soft shell clams, blue mussels, and oysters. Recreational shell fishermen seek after blue crabs.

Recent studies by the Long Island Sound Study and others have recently found that along Connecticut's coastline, urban development is occurring at a much faster rate than population growth and is not dictated by population growth. This trend appears the results of the real estate rise for second or seasonal homes near the coastline. The Connecticut coastline is becoming densely populated with densities exceeding, on average, 125 persons per square mile. In the Niantic River watershed, urbanization is occurring with moderate increases in population. The urbanization and population growth in this watershed are major driving forces for environmental changes, especially with nonpoint source pollution and water quality impairments.

The Oswegatchie Hills has been designated for resource protection in the East Lyme Plan of Conservation and Development. At the time of the 2006 ERT site review, this area was a municipally zoned RU-120 Rural District (minimum 1 single family on a nearly 3 acre parcel) for residential development. A combination of advancements in site development technologies and changes in Connecticut coastal real estate marketing pressures have yielded recent

development proposals considered "undoable" only a decade or two ago. The current land ownership pattern includes a developer-controlled interest in the northeastern portion of the Hills, including approximately 5300 linear feet of the Niantic River. Several different proposals that include a zone change have been discussed with East Lyme for intensive residential development that could yield 1700 housing units serving over 5,000 people. In 2005 the East Lyme Zoning Commission did approve a zone change from RU-120 Rural District to an Affordable Housing District for an area in the northernmost Oswegatchie Hills parcels that includes a triangle that overlaps a portion of the Niantic River Gateway Commission's Conservation Zone (as more fully defined in Section 25-109d of the Connecticut General Statutes). The Gateway Commission in February 2006 reviewed the East Lyme approval application for consistency with the Gateway Commission Conservation Zone standards, adopted March 1, 2002. A decision was not confirmed at the time of this report.

Oswegatchie Hill is a relatively intact landscape continuum from Latimer Brook, Oil Mill Brook and the Golden Spur to the north, through the Hill's ridge-forested slope-wetland-stream complex – river estuary ecological gradient and linkage with the downstream coastal embayment that is essentially unique in southeastern Connecticut and perhaps in most of the Connecticut coastline. With the Hills patchwork of protected and unprotected lands, the community of East Lyme has a rather unique opportunity for managed public recreation, diverse natural history and ecological studies, and even limited conservation development at a significant landscape scale along this portion of coastal Connecticut.

There were no detailed development plans currently submitted by the developing interest, Landmark Development LLC, which prevented a technical analysis by ERT members for better site design recommendations, site grading, erosion and sediment control measures and mitigation measures, effective stormwater quality management, and related potable water and wastewater infrastructure alternatives and potential impacts to local and regional resources. Landmark Development representatives have not incorporated CT DEP land use and conservation recommendations over the last 4-5 years of development proposal revisions.

This review section did not analyze the site development history or the Connecticut State Statutes regarding previous zone change applications allowing for development of affordable housing. If the developer's zone change application is approved in a future Town action, no site plan review may be

required since local zoning regulations would not apply. Due to the potential large scale of a future development proposal on the physical constraints of this area of Oswegatchie Hills, the East Lyme Inland Wetlands Commission would likely trigger a limited jurisdictional review.

The town of East Lyme has expressed an option beyond a full no-build alternative for this ERT review to consider limited development proposals that fit the carrying capacity of this unique near-coastal Connecticut landscape.

Coastal Site Plan Review

The Connecticut Coastal Management Act requires that coastal site plan review be conducted (per sections 22a-105 through 109 of the C.G.S.) for significant development projects in areas within the town's coastal boundary area (as legally defined, approximately 1000 feet from the Niantic River or Long Island Sound) with a similar purpose. The coastal site plan review process has been well established across the state and implemented in East Lyme, providing for a comprehensive review in scope and with a sound legal basis.

Recommended Action: The CT DEP's Office of Long Island Sound Programs has a considerable investment of site review comments for conservation and development proposals within the Oswegatchie Hills area. Coastal planning staff is available for a detailed review of past correspondence and additional technical assistance for the Town to address long-term coastal resource conservation and protection strategies and actions. Contact Marcia Balint at CT DEP's Office of Long Island Sound Programs at (860) 424-3034.

Watershed Vulnerability Assessment

The Niantic River Watershed Protection Plan (2006) included an assessment of the broad watershed to determine specific areas that demand the most priority for management. Areas ideal for protection against future water quality degradation scored high in a GIS-based assessment for the Conservation Priority Index (CPI), which highlighted areas such as riparian corridors and forests. Areas susceptible to erosion or increased agricultural impacts scored high for the Restoration Priority Index (RPI). Urbanized areas, including transportation corridors, were included in the Stormwater Management Priority Index (SMPI). Through GIS analysis of land use and cover data input, assigned priority rankings were mapped out for further study and possible mitigative actions. Specific to the town of East Lyme, and the Oswegatchie Hills area, conservation priority areas around Clark's Pond shoreline ranked high. Additional areas for conservation surround wetland areas and form riparian buffers along Latimer Brook and the wetland and watercourses within the Oswegatchie Hills. The

local basin area including the Oswegatchie Hills parcels was analyzed for current and projected impervious cover, in preparation of the Niantic River Watershed Protection Plan. The local basin, delineated by CT DEP as 2204-00-3-R2, has a current impervious surface (IS) cover of 5.1% and a projected buildout analysis amount of impervious surface cover, under current land use regulations (includes the RU120 Rural District and land use data for most of the Oswegatchie Hills parcels), at 6.7%. These impervious surface percentages are generally considered within the protected threshold of stream/water quality conditions. **Recommended Action**: These priority areas require added consideration by land use decision makers from the town, from developers, and from resource managers. They highlight the need for careful site plan review and field verification with regard to valuable watershed land characteristics. As stated earlier, streamside vegetated zones are the highest conservation priority in the Niantic River watershed.

Stormwater Management and Planning Considerations

The USDA Natural Resources Conservation Service - CT Office (NRCS) produced a publication in 2005 of value to Town of East Lyme. Entitled, *Soil Based Recommendations for Storm Water Management Practices* CT-TP-2005-3, this report includes four soil survey interpretations that evaluate the suitability of Connecticut soils for four widely used post-construction stormwater runoff management systems. The purpose of these interpretations is to help people use soil survey information as a screening tool for successful selection and implementation of best management practices (BMPs) for stormwater runoff. The majority of the soils classifications within the Oswegatchie Hills parcels would be considered generally "poor" for infiltration trench, retention or detention basin and underground gallery type BMPs. Such treatment practices have been proposed in earlier development applications. NRCS personnel are available to provide information about these interpretations and provide guidance on additional site evaluations necessary to determine if some BMP types can be utilized in some areas of the Oswegatchie Hills parcels. Contact Lisa Krall, Soil Interpretation Specialist, at the NRCS State office in Tolland at (860) 870-4942 X 110.

Another notable guidance document is the *2004 Connecticut Stormwater Quality Manual*. Information about urban stormwater characteristics can be found in Volume 2 of that manual. The Town Hall should have at least one copy of the manual. An online, downloadable version is also available on the Connecticut DEP website, at: http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325704&depNav_GID=1654.

The DEP promotes this manual for use as a planning tool and design guidance document. The manual assists local (and state) land use commissions and government officials to design and review projects in a technically sound and consistent manner. A strong emphasis of the Manual is dedicated to site planning and design. This consists of preventative measures that address core causes of stormwater problems by maintaining the pre-development hydrologic functions and pollutant renovation mechanisms to the extent practical. Elements of such site design and planning include concepts raised in this review: alternative site design for transportation infrastructure and lot layout, watershed planning, and LID management practices. The manual recommends downstream resource selection criteria for several categories affecting estuary and coastal waterbodies. These categories include: stormwater ponds, stormwater wetlands, infiltration practice, filtering practices, and water quality swales. The Niantic River and Bay are more sensitive to nitrogen loadings than for most fresh water systems. In addition, bacteria loading are also a concern for impacting the designated use of recreation and shellfishing. Both nitrogen and bacteria loading must be analyzed and managed for with all site developments and redevelopment proposals within the Oswegatchie Hills area.
Recommended Action: In general consideration, the Town should consider stormwater wetland treatments to encourage long detention times to promote pollutant loadings; filtering practices (including sand filters and bioretention areas) to promote medium to high bacteria removal; and water quality swales to provide pretreatment of stormwater runoff and some minimal bacteria removal.

Stormwater Modeling Results

The Niantic River Watershed Protection Plan (2006) showed areas of concern highlighted from this analysis that included the dense developments abutting the Niantic River. Modeling showed that future development would contribute to already existing high levels of pollutant contributions. Additional results of the model showed that areas of the watershed are susceptible to large increases in developed areas.
Recommended Action: Results of the modeling studies can be used by East Lyme and the other watershed communities to use zoning strategies to hinder the expansion of impervious surfaces and work with developers to minimize the impact of impervious surfaces and mitigate any new impervious coverage

Niantic River Gateway Commission

The Connecticut legislation established the Niantic River Gateway Commission, through Connecticut General Statute 25-109d, to cover a specific political boundary that includes some, but not all, of the Niantic River. There have been

some conservation and development standards developed, following the proposed East Lyme Greenway Gateway District. Any zone change approval made by either the Town of East Lyme or neighboring Waterford in this defined area must be followed with a referral to the Gateway Commission. It is noted here that Latimer Brook, tributary to the Niantic River on the northern end of Oswegatchie Hills, is regulated by the State-defined Coastal Area Management regulations, and not by the Niantic River Gateway Commission.

Riparian/Wetland Areas

When developing watershed management efforts, riparian/wetland areas are often the first place to look. This is true in part because a functioning riparian area (the interface between water and adjoining lands) can be an indication of a functioning watershed. Although riparian/wetland areas occupy a rather small footprint on most landscapes, their highly variable and complex combinations of physical and biological characteristics create tremendously productive ecosystems. The physical functions of healthy riparian systems include:

- sediment and pollutant filtering,
- bank stabilization, and
- surface/ground water storage and release.

When these physical features are working they are able to sustain a range of benefits or values such as fish and wildlife habitat, flood control, erosion and sediment control, recreational opportunities, and more. In brief, these areas serve as places of great ecological, social, cultural, historic and aesthetic importance.

An important aspect of an East Lyme Conservation Commission or Inland Wetland Commission site plan review should go towards the protection of myriad resources within the shoreline of the unnamed streams within the Hills, along the Niantic River shoreline, and along Latimer Brook. These natural shorelines do produce a variety of benefit to landowners, and the natural world, in significant ways.

With water quality, shorelines can effectively trap and filter sediments and debris from rain events and snow melt. On average, wider shorelines are more effective than narrow shorelines. Further, vegetated shorelines comprised of trees, shrubs and grasses are more effective in this function than with just grass cover.

With flood control, shoreline vegetation will slow the flow of runoff and provide for infiltration into soil. This in turn will aid in subsurface, or ground water, recharge. That ongoing process, if left undisturbed, can supply benefits to the Hills stream/wetland complex by extending water flow during the drier seasons. Building within or adjacent to delineated floodplains can increase the risk for property damage on–site and to downstream portions of the community. It should be noted that there are mapped floodplain areas that extend beyond the delineated inland wetland areas of this subdivision proposal. Full and complete floodplain resource protection should be a priority consideration by the East Lyme land use commissions.

Another value to protect is that of shoreline stability. Native vegetation or well-designed naturalized plantings can stabilize these zones and reduce erosion potential. Within the stream channel, aquatic plants can help protect the abutting shoreline by deflecting and absorbing wave action and boat wakes.

Additional benefits of protecting intact shorelines are aquatic habitat, upland wildlife habitat, recreation, aesthetics, and even property values. Prospective buyers to an approved residential development within this site will likely be attracted in part to the current and future potential high quality condition along both Latimer Brook and the Niantic River shorelines.

The Niantic River and Bay contain a plethora of important coastal resources, some of which are sensitive to in-water and upland contributions of excessive sediments, nutrients, competing invasive plant and animal species, and other pollutants. The upper Niantic River in the area of Parcels 2 and 3 has recorded observations of submerged aquatic vegetation (SAV) beds, including eelgrass beds. Eelgrass (*Zostera marina*) is a rooted, vascular, flowering plant that live permanently submerged below the water in coastal, tidal and navigable waters. SAVs are particularly sensitive to in-water and contributing watershed pollutant loadings. Beds of eelgrass once occurred throughout Long Island Sound but today are only found in the Niantic River and Bay and a few other eastern Sound bays and coves. Eelgrass provides critical habitat for juvenile scallops and other shellfish and finfish species, as well as stabilizing underwater sediments. SAV beds are also an important food source for many waterfowl species.

Recommended Actions:

1. The Town of East Lyme should strongly promote community support and action for federal, state, and local government coastal management and

clean water efforts that protect such SAV beds and other imperiled coastal habitats. The East Lyme Harbor Management/Shellfish Commission is an invaluable resource that should participate in eelgrass monitoring and outreach efforts in this northern reach of the Niantic River.

2. The Town should update the POCD, zoning regulations and subdivision regulations to better protect sensitive resources by increasing protective buffers between development and the Niantic River coastal waters. The Town's Engineering Department has been informally using the 2004 Connecticut Stormwater Quality Manual to guide new development but it has not been codified in the local ordinances and regulations. The Town's ordinance revisions should require an effective impervious surface reduction of development density impacts through better site design and stormwater runoff designs (including upland retention of runoff associated with the first one inch of rainfall and to direct additional runoff, after appropriate treatment, away from the coastal waters of the Niantic River), implementation and long-term maintenance of stormwater treatment practices that are consistent with the Connecticut Stormwater Quality Manual.

The Niantic River Watershed Protection Plan identifies riparian (streamside vegetated) corridors as the highest conservation priority within the watershed. The protection and enhancement of these shoreline resources can be realized through several land use planning, management and education options available to the Town of East Lyme. Some options are provided in the following discussion points and recommendations.

Vernal Pool Wetlands

The Oswegatchie Hills site visits and review of past reports indicated a number of significant vernal pool wetlands within these parcels. The ERT request seeks input on land use and/or management plan guidelines for natural and cultural features, including these ephemeral and sensitive resources. The East Lyme Conservation Commission can take advantage of a new program that enhances local understanding and supports integrated land use planning for natural resources within the region. The Connecticut Association of Wetlands Scientists (CAWS) began in 1997 is an organization of wetland professionals, land use commissioners and their staff involved with wetlands regulations and conservation. CAWS recently announced their Vernal Pooling Monitoring Program and are seeking assistance from conservation and local inland wetland commissions to identify applications that contain a verified or potential vernal pool. Commissions can then ask a landowner applicant to include the vernal

pool(s) in an open space or conservation easement to allow for long term monitoring of the pool(s) by CAWS volunteers. Town commissions would be asked to submit project maps and plans to CAWS. The program is based on volunteers, requires no cost, excludes landowner liability through a waiver release, and provides baseline data prior to developments within the vernal pool areas of Oswegatchie Hills. This is an opportunity for the East Lyme Conservation Commission to promote better watershed-based conservation planning that considers resource connectivity than are generally available through state or federal governments. For more information on this new CAWS program, contact Ed Pawlak at (860) 561-8598 or at ecosys@comcast.net.
Recommended Action: The Town should develop a vernal pool conservation plan for the Oswegatchie Hills parcels that can be integrated with other natural resource planning efforts described in this report. For instance, a conservation area, or greenway conservation overlay district proposal can be supported with overlay maps of significant biodiversity areas developed in conjunction with other Niantic basin communities of Montville, Salem and Waterford and other neighboring towns.

Thinking About the Watershed Picture

It may help the Town of East Lyme to step back from this lengthy site inventory and think about the big picture. Everyone lives in a watershed. Everyone lives downstream. Everyone has an impact, and everyone can make a difference.

In 2006 a watershed-based plan was developed for the Niantic River subregional watershed. The Connecticut DEP Water Protection and Land Reuse Bureau contracted with a consulting team lead by Kleinschmidt Associates of Essex, Connecticut for the communities and advised by a Steering Committee with the vision to improve water quality throughout the watershed, eliminate shellfish bed closures, support fish and wildlife habitat and provide safe and healthy recreational areas. This plan takes a watershed approach to addressing the problems of nonpoint source pollution associated with the Niantic River. Examination of the watershed was facilitated by the use of aerial photography, geographic information systems and stormwater models. Existing land use and water quality reports for the watershed were consulted. Key findings about the Niantic River watershed and nonpoint source pollution were identified. Watershed management really is all about land use management. Within Connecticut, most land use planning and regulation occurs at the municipal level. It is central to this plan that polluted runoff be considered the greatest

water quality management challenge to the Niantic River, primarily because it is considered the most manageable of all potential sources of pollution to the river.

Several key management strategies have direct relevance to the Town's ability to protect and manage the Oswegatchie Hills parcels. For the focus of water quality protection, the Plan's recommended measures concentrate on developable land; areas that will be not be preserved through acquisition or preservation. These include the following:

- Mitigating the impacts of increased/increasing impervious surfaces from development
- Enforcing state-of-the-art stormwater management practices for all development (both during and post-construction)
- Implementing municipal stormwater management program plans according to the Connecticut General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4), including retrofits for existing stormwater drainages and outfalls on the river.
- Requiring developers to incorporate low-impact site preparation and development techniques.
- Elevating the importance of homeowners' and business' "housekeeping" responsibilities.
- Protecting existing and restoring degraded vegetative and riparian buffers where needed.

In addition, these strategies should be supplemented with an early focus on better site design for development proposals, which are then followed by required construction and post-construction practices.

LID Site Planning and Design Considerations

Low Impact Development (LID) is a combination of techniques designed to lessen our human impact on the broader environment. There are many well-documented ways, from nature-based site design to best management practices (BMPs) used across the region and beyond to accomplish this, and include open space residential design, rain garden/bioretention areas, permeable pavers and other "hard" surfaces, green roofs, water quality swales, and use of native or naturalized plantings. A major goal of LID is to mimic or restore the pre-development hydrology and natural processes of the site, or a similar undeveloped site nearby, by recognizing water on the site as an asset. This is accomplished, in part, by managing the resulting site runoff through

evapotranspiration through vegetation and natural retention and infiltration to the ground to replenish nearby wetlands and streams and the regional groundwater resources, rather than a more traditional pipe and conveyance stormwater system. Successful LID projects will reduce land development and infrastructure costs as they protect a property's natural resources and diverse functions.

In recent years, the Town of East Lyme has made and acted upon a commitment to protect the multiple high quality resource values of the Oswegatchie Hills landscape. The Town is in a strong position to manage future development proposals by working with designers, developers, and reviewing agencies to identify solutions that integrate the following concepts:

- Preserve open space and minimize land disturbance;
- Protect and incorporate natural systems as design elements;
- Utilize neo-traditional street and lot layouts and designs; and
- Decentralize and micromanage stormwater at its source using LID stormwater management practices.

The Town will recognize benefits including the protection of regional flora and fauna, balancing growth needs with environmental protection, reduce municipal infrastructure and utility maintenance costs, and increase collaborative public/private partnerships – all objectives reflected in the Town's Plan of Conservation and Development.

Because non-point source pollution comes from almost everywhere, it cannot be regulated in the same way as point source discharges (those areas having a limited number of specific places where the pollutants originate). Conventional municipal zoning can actually contribute to the problem of nonpoint source pollution by not including the impacts of nearby development.
Recommended Action: The Town of East Lyme should consider requesting practical and feasible alternative site plan design(s) to accommodate flexible subdivision, protection of priority natural resources, and lot layout and configuration to protect the integrity of the Niantic River and Latimer Brook shoreline and associated riparian/wetland area. This recommendation is supported at the local level through resource inventory, analyses, and conclusions published in the *Town of East Lyme Conservation and Open Space Plan*, 1999.

An Overlay District Protection Strategy

In 2001 the Town of Killingly adopted a Five Mile River Protection Overlay District for a segment of this river. The publicly recognized purposes of the regulations include:

- contribution to the regional conservation of the river corridor;
- prevention of any alterations to the natural flow of the river, in order to maintain its ecological, recreational, aesthetic and other qualities;
- prevention of water pollution caused by erosion, sedimentation, nutrient or pesticide runoff and waste disposal facilities and to encourage retention and enhancement of shore vegetation cover;
- conservation of the ecological, water supply and flood storage functions of the river's floodplain and related groundwater table and aquifer recharge areas;;
- protection of valuable fisheries and wildlife habitat within and along the Five Mile River;
- conservation and enhance the natural scenic and topographic conditions of the river corridor; and
- carrying out the recommendations of the Town Plan of Conservation and Development and the State Plan of Conservation and Development.

Recommended Action: The Town of East Lyme should consult with the Town of Killingly, Director of Planning and Development, to better understand that Town's adoption of the overlay protection district, and to determine if portions of the Niantic River may be better protected within East Lyme with such overlay protection regulatory review. A river resource protection vision could include the combination of:

a) site-specific conservation easements and/or dedicated open space provisions to the Town of East Lyme (or agreed-upon third party land trust) to protect critical river corridor resources within the Oswegatchie Hills; and
b) b) long-term coordination with the Town of Waterford (and in the future with the Towns of Montville and Salem) to plan, design, and effect a river corridor protection and commensurate conservation development system for the Niantic River and its significant tributaries.

Recommended Action: The Town of East Lyme can look to the successful, 10-year old Farmington River Overlay Protection Districts that were researched, adopted and regulated by five (5) towns sharing borders along the Farmington River in north-central Connecticut. For more information, contact the

Farmington River Coordinating Committee, on the web at: www.farmingtonriver.org.

Better Site Design

Better site design (BSD) is a set of techniques established by a national planning roundtable 10 years ago that offers to municipalities, designers, and developers guidance to employ a variety of methods to a) reduce total paved areas, b) distribute and diffuse stormwater; and c) conserve natural habitats. To meet the goals associated with the nearly two dozen BSD techniques, designers need to carefully review every aspect of a specific site plan – its streets, parking spaces, setbacks, lot sizes driveways and sidewalks – to see if any elements can be reduced in scale, while incorporating innovative site grading and drainage techniques to reduce stormwater runoff and promote infiltration.

The following residential streets and parking lots techniques are relevant for Town consideration with future development proposals within the Oswegatchie Hills parcels.

- Design residential streets for the minimum required pavement width needed to support travel lanes, on-street parking, and emergency, maintenance, and service vehicle access. Street widths should be based on traffic volumes.
- Whenever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.
- Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.
- Wherever possible, provide stormwater treatment for parking lot runoff bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

The following lot development techniques are relevant for Town consideration with future development proposals within the Oswegatchie Hills parcels:

- Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space. This is being proposed for the Oswegatchie Hills parcel, in part, by the proposed management plan agreement between the Town of East Lyme and the Friends of Oswegatchie Hill Preserve. (See copy in Appendix)

- Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing runoff to the roadway and the stormwater conveyance system. Sending runoff over a pervious surface has been demonstrated to reduce annual runoff volume from residential development sites by 50% or more. A recently completed 10-year urban water quality investigation in Waterford concluded that runoff volume and peak did not increase over predevelopment levels from the residential BMP watershed area. This was demonstrated with the effective design and use of water quality swales, pervious pavers and bioretention. This post-construction project result is the primary goal of low impact development and meets the objectives of better site design. More project information can be found on the Jordan Cove Urban Watershed Project website at www.canr.uconn.edu/jordancove.

Conservation of natural areas techniques was a repeated issue in this ERT request. Such agreed-upon techniques include stream buffers, clearing and grading, tree conservation and stormwater treatment. The town may realize the most success of employing these techniques by offering developers both flexibility and incentives.

- Create a three-zone, naturally vegetated buffer system along all perennial streams that also encompass critical environmental features such as 100 – year floodplains, steep slopes and freshwater wetlands. Buffers are noted for their water quality value and enhancing the quality of life of area residents. Buffers area also noted for their economic benefits, including those associated with increased property values, reduced flood damages, and sediment removal costs. A model stream buffer ordinance and regional examples can be downloaded from the Center for Watershed Protection at www.cwp.org.
- The riparian stream buffer should be preserved or restored with native vegetation. It is critical that the buffer system be maintained through the plan review delineation, construction and cost-construction phases.
- Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide for fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.
- Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and conserving native vegetation. Wherever practical, incorporate trees into community open space, streets rights-of-way, and other landscaped areas.

- Incentives and flexibility should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation should be encouraged where it is encouraged with locally adopted watershed plans. This technique can be locally tied to the developing implementation strategies evolving from the Niantic River Watershed Protection Plan.
- New stormwater outfalls should not discharge unmanaged stormwater into jurisdictional wetlands, sole-source aquifers, or sensitive areas. As stated earlier in this review, the Town is strongly encouraged to codify its currently informal use of the Connecticut Stormwater Water Quality Manual for requirements associated with on-site design criteria of stormwater treatment practices.

BSD is an especially useful strategy in watersheds such as the local Niantic River basin where future development is projected to approach or slightly exceed impervious cover thresholds.

Protection of Priority Sensitive Watershed Resources

Recommended Action:

- The relevant Better Site Design techniques highlighted in this review should be considered for incorporation in a Conservation Greenway or similar zoning district for the Oswegatchie Hills area.
- BSD techniques need to be combined and integrated with other watershed protection tools, such as the Niantic River Watershed Protection Plan, municipal soil and erosion control and also stormwater management measures, targeted open space and conservation land acquisitions and more. The incorporation of these techniques should be promoted as beneficial to municipal land use commissions and staff, watershed advocates, developers, and the community at large.
- It should be a Town resource protection strategy to maintain and enhance this protected waters relationship between watershed imperviousness and stream degradation within the Oswegatchie Hills. Future zone changes that allow for increased development density will require a reassessment of this project buildout analysis for an updated percentage of impervious coverage.
- The Town should apply for active assistance from the University of Connecticut's Cooperative Extension System's Nonpoint Education for Municipal Officials (NEMO) program towards revisions of the town

regulations for effective stormwater quality management. An additional local stormwater planning resource is the Eastern Connecticut Conservation District. Contact Scott Gravatt, ECCD Director, at (860) 887-4163, x3001.

- The Town of East Lyme should request the consideration of either conservation (restriction) easements to the Town (or agreed upon third party land trust), or provide for fee simple open space transfer to the Town to encompass a 100-foot vegetated riparian and upland buffer along the two watercourses within this development site. The initial preference is for this area to be placed in common ownership, rather than scatted amongst a dozen or more future landowners, which can make long-term management of said resources very difficult.
    - The agreement(s) should require a visible boundary marker program, complete with marker locations, allowable signage, delineation of boundaries on filed approved site plans, a schedule of marker installation prior to on-site construction phases and maintenance responsibilities through the post-construction period.
    - Further, specific language should be included in said agreements, whether this area is held in private or public ownership, which clearly describes permitted clearing limits for pedestrian paths, water views and other forecasted interests to access or otherwise use this resource area. Guidance may be offered in agreement language by area towns or land trusts that coordinate their own land conservation and stewardship programs.
- The Town is encouraged to consult with the CT DEP Land Acquisition and Management Division and other programs for preserve management guidelines. Contact Assistant Director Elizabeth Brothers at (860) 424-3086. Another valuable resource is the Connecticut Land Conservation Council, formed in 2006 by the merger of two existing programs of The CT Chapter of Nature Conservancy: the Land Trust Service Bureau (LTSB) and the Land Conservation Coalition for Connecticut (LCCC). The Council provides the state's conservation community with technical assistance and referrals for land trusts and other organizations on Connecticut-specific conservation topic. For more information contact Sara Pellegrino at (860) 344-0716 x320 or spellegrino@tnc.org .
- There is a model local law document of interest to the Town for consideration of a Greenway Conservation District proposal. The conservation areas do not replace existing zoning districts, but instead overlay a new set of standards and incentives within those districts to better achieve natural resource protection goals. The technical paper was

produced by the Metropolitan Conservation Alliance, and promoted at a recent Land Use Leadership Alliance training workshop attended by the East Lyme First Selectwoman and the Town Planner.

Groundwater Resources Protection

The CT DEP has developed a useful guide for municipalities to promote locally based groundwater resource protection. This guide and local town maps were provided during outreach presentations across the State – check with your Town Hall staff. Since a number of East Lyme residents, and potential residents of this resource area, if developed, rely on individual private water wells for drinking and other consumptive uses, it is the Town's best interest to proactively plan for and develop action steps to protect ground water resources for current and future East Lyme residents. The Department's Water Quality Planning program can provide a copy of this municipal handbook and other guidance for site plan review to address concerns raised during the ERT request for development impacts to groundwater resources and eventual discharges to surface waters of Latimer Brook and the Niantic River. Contact the CT DEP Water Quality Planning program at (860) 424-3020.

Connecticut State Policies and Plan 2005-2010

The State Policies Plan serves as a statement of the development, resource management and public investment policies for the State. The Plan is used as a framework for evaluating plans and proposals submitted to OPM for review through mandated review processes. The latest revision of this five year Plan introduced six Growth Management Principles and associated policy recommendations intended to better integrate state planning functions across agency lines and to provide a more prescriptive advisory tool for municipalities and Regional Planning Organizations when they revise their own plans. The current State Plan designates this area of the Niantic River sub-regional watershed as a combination of Neighborhood Conservation Area, Conservation Area, Rural Land Area, Existing Preserved Open Space, and Preservation Area. The State Plan has an essential visual component known as the Locational Guide Map that depicts these areas and provides explanation for each category. The Town of East Lyme did request a change in the draft Locational Guide Map for the roughly southern portion of the Oswegatchie Hills area from the proposed Rural Lands area to a Conservation Area. CT Office of Policy and Management denied the proposed change, referencing the legislatively delineated boundaries of the roughly upper portion of the Oswegatchie Hills area under the Niantic River Gateway Commission and designated Conservation Area.

Recommended Action: The East Lyme First Selectman and the Conservation Commission should consider this State Polices Plan for background review. This is especially relevant when evaluating site conservation and/or development proposals, within a regional or watershed context, as consistent with the local Plan of Conservation and Development. The East Lyme Town Hall should have an accessible State Plan copy to review. The Plan can also be viewed and downloaded off the Connecticut Office of Policy and Management website at: http://www.opm.state.ct.us/igp/cdplan/cdplan2.htm

The following are current State Policies Plan components of Conservation Area Policies as identified on the Locational Guide Map (in order of priority):

1) Existing Preserved Open Space – Support the permanent protection of public and quasi-public land dedicated for open space purposes (e.g. Veteran's Memorial Field).

2) Preservation Areas – Protect significant resource, heritage, recreation, and hazard-prone areas by avoiding structural development, except as directly consistent with the preservation value (e.g. Niantic River and floodway, inland wetlands and Clarks' Pond).

3) Conservation Areas – Plan for the long-term management of lands that contribute to the state's need for food, water and other resources and environmental quality by ensuring that any changes in use are compatible with the identified conservation value (e.g. most of Parcels 1, 2, 3 and portions of 5 and 8 and the Quarry area).

4) Rural Lands – Protect the rural character of these areas by avoiding development forms and intensities that exceed on-site carrying capacity for water supply and sewage disposal, except where necessary to resolve localized public health concerns. The policy is to discourage development that exceeds on-site carrying capacity for water supply and sewage disposal and inconsistent with adjoining rural community character (e.g. most of parcels 7, 8, 9, 10 and 11.)

The Town's current Plan of Conservation and Development (1999) does recommend a municipal focus on open space acquisitions over the next decade within Oswegatchie Hills. Progress has been made in conjunction with CT DEP's Open Space and Watershed Lands grant program with parcels in the southern end of Oswegatchie Hills. In addition, recommendations were made to

reevaluate the development potential of the Hills parcels to reflect the environmental and natural resource sensitivity and carrying capacity. The Town did propose a Greenway Conservation District to reflect limited development and protection and wise conservation uses of the area's resources. The final zoning approval was not made due to a technical public notice error. **Recommended Action**: the Town is encouraged to utilize the information contained in this report to further strengthen the Greenway Conservation district proposal and submit again for regulatory approval. This should be reflected in the Town's current POCD (2009) update process.

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DEP Long Island Sound Program Review

The following report s based on OLISP in-house coastal management information and field investigations conducted previously for Parcel's 1-3 on March 4, 2002 and Parcel's 4-13 on August 23, 2006. While the details of the following evaluation apply to Parcel's 1-3 primarily, the resource impact and development concerns would apply to all parcels in as much as very similar resource inventory conditions exist on those parcels.

Coastal Resource and Water Quality

Coastal Resources observed or documented at or adjacent to subject parcels include shorelands; bluffs/escarpments; inland wetlands and watercourses, shellfish concentration areas, two small sandy beaches, fringe tidal wetlands, rocky shorefront and estuarine embayments. There are also Submerged Aquatic Vegetation (SAVs) in the Niantic River (see map attached) and vernal pools were observed on site at parcels 1-3 as well.

The Oswegatchie Hills parcels are located on the northeastern banks of the Niantic River and are characterized largely by steep slopes, shallow depth to bedrock and high erosion potential. The major soil type found extensively along the river frontage itself contains Charlton-chatfield complex of soils with slopes of 15 to 45 percent. Well drained to excessively well-drained glacial outwash and till soils are present as well as very shallow depths to bedrock. Exposed bedrock and steep slopes are evident throughout the site.

Potential Development

OLISP has been involved in reviewing several zone change and/or development proposals for parcels 1-3 pursuant to the Connecticut Coastal Management Act. Given these analyses, OLISP offers the following evaluation of potential development impacts that could potentially occur if development is again proposed for the hills. The last zone change regulation and map change proposed and then withdrawn in April of this year included plans for 1720 units on approximately 230 acres of land on parcels 1-3.

Our coastal management evaluation concluded that if the zone changes were approved and the site eventually developed, Parcels 1-3 are constrained for development. Natural features such as the exposed bedrock, shallow soils and topographic constraints would require extensive blasting, filling and grading to

accommodate development (proposals have ranged over time from 352 units as a phase 1 to 1720 units in the most recent development).

Even with the best stormwater management practices, such alterations as those previously proposed in the Hills are likely to cause substantial sedimentation and erosion and water quality degradation given site conditions. Based on OLISP's experience with similar constrained sites, conventionally accepted sedimentation and erosion controls are extremely unlikely to control sediment and erosion impacts as well.

Specific Connecticut Coastal Management Act (CCMA) policies that would apply to any future development proposed along the Oswegatchie Hills area include:
To insure that the development, preservation or use of the land and water resources of the coastal area proceeds in a manner consistent with the capability of the land and water resources to support development, preservation or use without significantly disrupting either the natural environment or sound economic growth (C.G.S. Section 22a-92(a)(1)).

> The applicable CCMA adverse impact policy regarding water quality is: It is found and declared that the pollution of the waters of the state is inimical to the public health, safety and welfare of the inhabitants *of the state,* is a public nuisance and is harmful to wildlife, fish and aquatic life. [CGS section 22a-422, as referenced by OGS section 22a-92(a)(2) emphasis added];

The CCMA policies state that adverse impacts must be avoided or, if avoidance is not possible, must be minimized in order for a project to be lawfully approvable.

> Degrading water quality through the significant introduction into either coastal waters or ground water supplies of suspended solids, nutrients, toxics, heavy metals, or pathogens, or through the significant alteration of temperature, pH, dissolved oxygen, or salinity [CGS section 22a-93(15)(A)];

The effects of significant development along the Niantic River as has been proposed since 2002 (clearing, blasting, filling, grading) would likely impact water quality through sedimentation and erosion. Also, studies involving impervious surfaces suggest a direct relationship between the intensity of

development in an area (indicated by the amount of impervious surfaces), and the degree of water quality degradation. Studies suggest that aquatic biological systems begin to degrade at impervious levels as low as 12 to 15 percent (according to NEMO's Fact Sheet, http://nemo.uconn.edu, also the article "Impervious Surface Coverage: *The Emergence of a Key Environmental Indicator*" may be found in the Appendix) and it is anticipated that proposed development, such as previously applied for, would allow for significantly greater impervious coverage. In addition to the concerns of overall site modifications and impervious coverage associated with development the need to properly manage stormwater in order to protect coastal water quality would be very difficult to achieve given the site constraints, limited ability to percolate into shallow on-site soils or install technologies on such a rocky and steep site. (See DEP Stormwater Management Fact Sheet found at the end of this section).

The level of intensive development that has previously been proposed since 2002 would likely have an adverse impact on SAVs in the river as well. This is due to the fact that overall water quality, nutrient inputs and SAV health are closely linked. There have been fairly extensive SAV beds in the Niantic River adjacent to the site (see map). SAV beds include plants that live permanently submerged below the water in coastal, tidal and navigable waters. They are valuable because they provide critical shelter for finfish and essential habitat for shellfish, especially scallops, and improve water quality. Additionally, they are an important food source for several species of birds. Thus, recreational and commercial fishing activities in Connecticut are critically dependent upon the preservation of SAV resources. Nutrient enrichment and sedimentation into coastal waters with SAV beds associated with large scale development proposals have been linked to altering coastal ecosystem and have led to a decline and degradation of estuarine seagrass ecosystems world wide.

Anadromous and marine fish resources in this area of the Niantic River are considered of premiere importance. According to Stephen Gephard, a fisheries biologist with the DEP's Inland Fisheries Division, many marine and anadromous fish ascend the Niantic River. Of those, alewife and sea-run brown trout continue up to Latimer Brook and pass through a DEP-owned fishway near Flanders. This is considered the most productive sea-run brown trout stream in the state and the Inland Fisheries Division received a grant to build a trap in that fishway to support research aimed at better understanding and ultimately expanding trout runs statewide. The alewife run has been experiencing a strong recovery in this stream as well. These fish require adequate volumes of cool water, unobstructed migratory paths and clean stream substrate that includes

occasional deep pools. Any development activity that occurs adjacent to these habitat areas should be planned carefully and include best management practices and suitable controls to protect riparian zones and instream habitat. Of concern, the most recent zone change in 2006 on parcels 1-3 would have allowed development much closer to Latimer Brook than previously proposed. ***Zone change and site plan approvals as OLISP has seen could easily adversely impact both Latimer Brook and Niantic River fisheries resources, especially without adequate vegetated buffer areas.***

The vernal pools observed on-site on Parcels 1-3 as well other subject parcels provide habitat for obligate species, including amphibians, which depend upon both the pools for breeding and significant areas of undisturbed upland adjacent to the vernal pools during non-breeding times. Species typically associated with such pools include the wood frog, *R. sylvatica*, and spotted salamander, among others. Glenn Miller, the District Manager for the Windham County Soil and Water Conservation District, has provided detailed comments on previous development applications regarding on-site resources including the vernal pools.

In addition, the state statutes pertaining to planning and zoning contain specific requirements for zoning regulations and plans of development that relate to the restoration and protection of coastal resources and water quality. These are:

> In any municipality that is contiguous to Long Island Sound the ***regulations adopted under this section shall be made with reasonable consideration for restoration and protection of the ecosystem and habitat of Long Island Sound and shall be designed to reduce hypoxia, pathogens, toxic contaminants and floatable debris In Long Island Sound.*** Such regulations provide that the land use commissions shall consider the environmental impact on Long Island Sound of any proposal for development [005 section 8-2(b) emphasis added]; and
>
> The plan adopted under this section for any municipality that is contiguous to Long Island Sound shall be made with reasonable consideration for restoration and protection of the ecosystem and habitat of Long Island Sound and shall be designed to reduce hypoxia, pathogens, toxic contaminants and floatable debris in Long Island Sound [excerpt from CGS section 8-23].

Sewer and Water

With any future proposals on Parcels 1-3, extension of sewer and water service to this site may be sought. Information provided by Dennis J. Greci of DEP's Water Management Bureau dated March 28, 2006 outlines additional information regarding sewer and water service. There are still many unresolved issues regarding the feasibility of providing sewer and water service to support large scale development as has been proposed since 2002 including the fact that the majority of Oswegatchie Hills parcels are outside the identified sewer service area (see attached 3/28/06 memo).

This area is designated "Rural Land" in the State's C&D Plan. Accordingly, it would be contrary to the C&D plan to approve a sewer extension into parcels 1-3 as well as other parcels potentially.

The above environmental and policy issues are compounded by the fact that, if sewer and water line extension service cannot be secured for any future development proposals that are approved, the only alternative would be to pursue a community septic system. The bedrock soils of the Oswegatchie hills parcels 1-3 are not well suited to on-site sewage disposal. The soil conditions would also likely inhibit the proper percolation of septic fields and pose potential threats to groundwater quality through seepage of wastes into the water table.

Town Plans

Any future proposals similar to those that we have reviewed since 2002 for any Oswegatchie Hills parcels which contain similar constraints to parcels 1-3, would likely be inconsistent with the Coastal Area Development Plan (CADP), the Town Plan of Conservation and Development (POCD), and the Town's Harbor Management Plan (HMP) in their goals to preserve, protect, and minimize development impacts to the subject area and nearby resources.

The Coastal Area Development Plan (CADP) was developed as part of East Lyme's Municipal Coastal Program (MCP), undertaken to promote the wise management, preservation, and use of the town's coastal resources and to provide more specific planning and zoning guidance to property owners and developers. The CADP includes proposed amendments to both the Plan of Conservation and Development (POCD) and the zoning regulations to fulfill the goals of the coastal plan.
One recommendation of East Lyme's 1982 CADP as updated by the 1987, and 1999 Plan of Development, was that the Oswegatchie Hills area be rezoned from

one acre residential to a more restrictive residential zone (low intensity or specially designed low-density residential use because it possesses one or more natural limitations for development, such as wetland soils or steep slopes) in order to preserve it to the extent possible from development. Consistent with this policy, the town adopted a RU-200 Greenway Conservation District for subject areas (minimum size of five acres, cluster and 500 foot river setback for all construction and clearing with restrictions on height) but it was overturned in court on a technicality. This type of zone should again be revisited and adopted to protect the Hills and include a significant river non-disturbance setback.

The CADP also recommended the area for acquisition by the Town as open space.

In addition, the 1999 POCD includes goals contrary to the approval of the any similarly proposed regulation/development proposals OLISP received since 2002; namely:

> To manage East Lyme's natural resources wisely. Thus the Town's land use controls must direct development according to the capability of the land to support the use. Sensitive lands, including. . .coastal areas must be protected. The town should continue to consider purchase of open space land, such as Oswegatchie Hills (paragraph #2 on p.7 and 8 Section Two: Goals and Objectives); and
>
> To promote wise use of land in the coastal area, which recognizes the importance of the Town's coastal resources and existing water-dependent uses. To achieve this objective, the Town adopted a Coastal Area Development Plan in 1982 and a Harbor Management Plan in 1992. The Town should continue to take the steps necessary to carry out these (paragraph #7 on p.7 and 8 Section Two: Goals and Objectives); and
>
> The future land use map under Figure 2-1 of the 1999 POD designates the hills as "proposed open space;" and
>
> Also, the Coastal Resources Map under Figure 12-1 shows portions of the Hills area as "Special Resources Protection Area."

The importance of the Niantic River and the Oswegatchie Hills entire area and its preservation is also documented in East Lyme's Harbor Management Plan (HMP). In particular, the plan includes specific guidelines for the protection of

the Niantic River and other coastal resources, and the Oswegatchie Hill waterfront as follows:

> The Town should implement (through appropriate zoning and other regulations) the policies of the East Lyme Coastal Area Development Plan to protect the natural resource values of the Oswegatchie Hill area (page 5-4);
>
> Any future development in the Oswegatchie Hill area should be of a density and type consistent with the capability of coastal land and water resources in the area to accommodate this development without significant impacts on natural resource values occurring (page 5-4); and
>
> The Town should also encourage the use of private initiatives, including the use of conservation easements, to protect undeveloped lands in the Oswegatchie Hill area
> (pages-4); and
>
> Town efforts to reduce water pollution in the Niantic River should include measures to reduce runoff, septic waste, and the disposal of litter and all other wastes in the upper Niantic River (page 5-37.

Future development proposals of the magnitude OLISP has reviewed since 2002 would be inconsistent with the Coastal Area Development Plan (CADP), the Plan of Conservation and Development (POCD), and the Town's Harbor Management Plan (HMP) in their goals to preserve, protect and minimize development impacts to the subject area and nearby resources. Through the town's significant planning efforts, the town has repeatedly tried to ensure that this land is used as a low intensity use with the recognition of the very limited capability of the land and water resources in the area to accommodate intensive development. In fact, the site and area has been identified for open space and acquisition for over 25 years as noted in the 1978,1987 and 1999 Plans of Development and 1982 Coastal Area Development plan. Other worthy efforts include the town adopting a RU-200 Greenway Conservation District for subject areas (minimum size of five acres, cluster and 500 foot river setback for a construction and clearing with restrictions on height) but it was overturned in court on a technicality.

It should also be recognized that the Town's POD states "with the exception of the Pattagansett River marshes, **Oswegatchie Hill is the last extensive undeveloped waterfront area in East Lyme and is considered unique among**

East Lyme's waterfront areas. OLISP would like to add that these parcels are unique as a significant tract of remaining undeveloped coastal waterfront with a significant established trail system on a statewide basis as well. Many are aware of the recent goals and successes in acquiring parcels for open space protection in recent months in parcels south of Parcels 1-3 in the Oswegatchie Hills. Not only has the state designated the Oswegatchie Hill area, which includes the subject site, as a conservation zone through legislation establishing the Niantic River Gateway Commission in 1987 (pursuant to CGS. 251O9d), the area has also been identified by DEP's Bureau of Outdoor Recreation as a natural area worthy of preservation.

CCMA Water-dependent Use Policies

Portions of the Oswegatchie Hills parcels are located adjacent to the Niantic River. The parcels, if proposed for development in the future, would be considered a waterfront site and as such, is subject to the water-dependent use standards of the CCMA. The relevant statutory standard is:

> to manage uses in the coastal boundary through existing municipal planning, zoning and other local regulatory authorities. . giving ***highest priority and preference to water-dependent uses*** and facilities in shorefront areas (CGS Sec. 22a92(b)(1)(A), emphasis added).

The CCMA defines water-dependent uses as:

those uses and facilities which require direct access to, or location in, marine or tidal waters and which therefore, cannot be located inland including but not limited to:
marinas, recreational and commercial fishing and boating facilities. . and uses which ***provide general public access*** to marine or tidal waters (CGS Sec. 22a93(16), emphasis added).

Any future proposals for development that do not meet the definition of water-dependent use would need to incorporate water-dependent use components. Previous proposals OLISP has reviewed since 2002 have not satisfied this statutory requirement, in particular, no provisions for public access and recreation have been included in any of the zone change proposals.

The demand for public access at this site has long been recognized. The parcels have long been targeted for future open space and recreational use and many of

the parcels have a long history of informal use by the general public. Evidence of existing public use at various parcels includes an extensive network of trails, beaches, views, ponds and wetlands to attract wildlife for birders and hikers to enjoy.

Any future intensity of the development similar to that proposed since 2002 on parcels 1-3 would likely make it difficult to meet the water-dependent use criteria and provide any meaningful public access. The level of housing development would necessitate blasting, clearing and building upon natural features of the site. This type of development would impair the sensitive resource features that make Oswegatchie Hills appealing as a potential public recreational access site.
Further, the OCMA requires the land use boards to ensure potential zone change and development proposals minimize statutorily defined adverse impacts to future water- dependent development opportunities to include:

> ... (A) locating a non-water-dependent use at a site that is (1) is physically suited for a water-dependent use for which there is a reasonable demand...(CGS Sec. 22a- 93(17)).

Any future proposals to allow intensive housing, similar to those proposed since 2002, on these parcels, where they are both physically suited for a water-dependent use and in demand by virtue of its own on-site use, would represent an adverse impact to future water- dependent development opportunities at this location and would be inconsistent with the above water-dependent use policies.

Summary

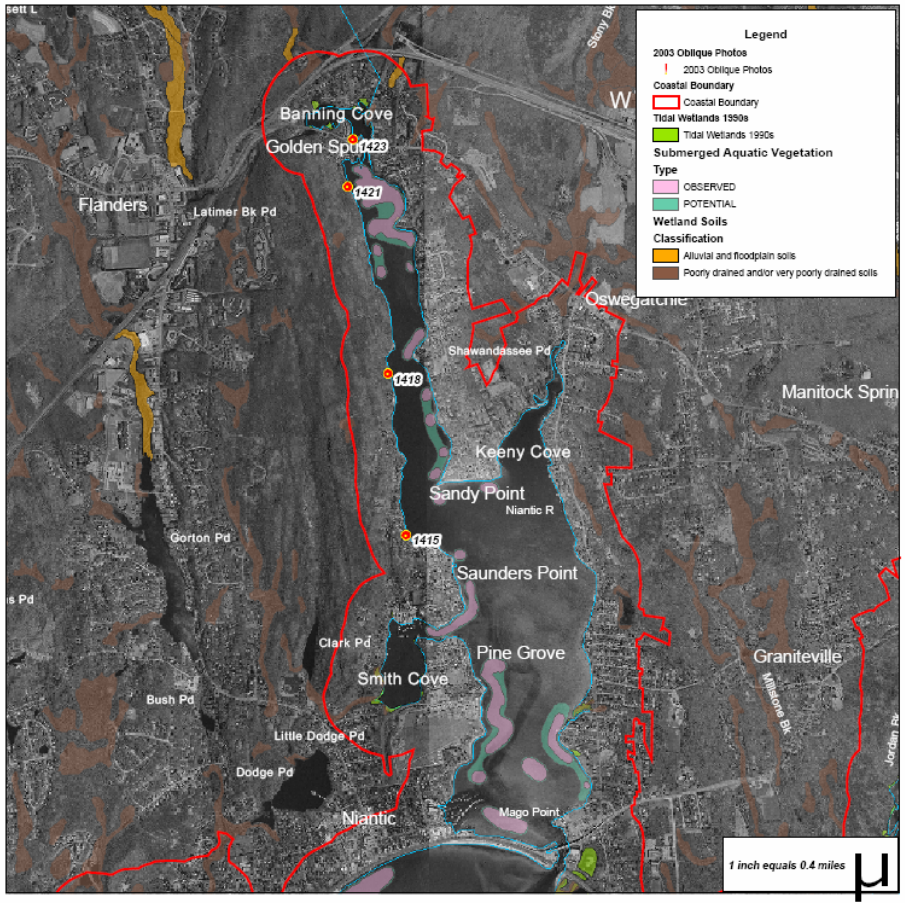
Any future development to the magnitude OLISP has actively reviewed since 2002, on such parcels such as these, with severe development constraints, could potentially adversely impact resources and water quality, and represent inconsistency with the Connecticut Coastal Management Act including water-dependent use policies, the Town's Plan of Development, Municipal Coastal Program and Harbor Management Plan.

OLISP also believes that the intensity of any future proposals to the magnitude OLISP has reviewed previously would be contrary to the state's policy that declares "that the pollution of waters of the stats is inimical to the public health, safety and welfare of the inhabitants of the state, is a public nuisance and is harmful to wildlife, fish and aquatic life and impairs domestic, agricultural,

industrial, recreational and other legitimate beneficial uses of water" as well as CGS Sec. 8-2(b).

Any future proposals to the magnitude OLISP has reviewed previously would allow for inappropriately intensive development to be proposed in the Oswegatchie Hills region of East Lyme in an area incapable of supporting intensive development without significant environmental consequences. The parcels are characterized by both shallow depth-to-bedrock and steep slopes which, as noted previously, would mandate significant alterations of the site to provide suitable land for road access, septic systems or water and sewer service, and inhabited structures. Such alteration of this natural area and associated runoff would significantly impact coastal resources and water quality along the river. Such a development would also cause sedimentation and erosion, nitrogen loading, and impacts on SAVs, finfish, shellfish and wildlife on the site and in the Niantic River and Latimer Brook.

OLISP believes a new zoning designation, similar to that previously adopted (the Greenway Conservation District) is needed which would include a significant river and wetland vegetated non-disturbance setback which would reduce adverse impacts to the environment and allow only limited development that is sensitive and appropriate to the resource constraints identified above. A minimum 500 foot river vegetated buffer should be included as part of any zone redesignation for the parcels. Adequate vegetated buffer setbacks from vernal and inland wetland resources should be included as well. Adequate water-dependent or public trail plans should be included and maintained. Given the considerable environmental and physical challenges the Oswegatchie Hills parcels represent a stormwater Ordinance which adequately addresses and includes Low Impact Development (LID) measures and BMPs to treat and remove pollutants should be adopted. The specific measures should be tailored to the unique constraints of the site. The Town and Niantic River Gateway Commission should evaluate and adopt additional land use regulations as necessary to further protect the Hills.



Oswegatchie Hills & Vicinity [53]

Photo 1423: View from the north looking south

Photo 1421: View from the north looking north

Photo 1418: View looking west, middle area.

Photo 1415: View looking west, southern area.

Oblique photos courtesy of CT DEP OLISP, 2003.
Map Produced By CT DEP OLISP, September, 2006.
For planning purposes only.

Dennis J. Greci, P.E.
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Municipal Facilities Section
DEP Water Management Bureau
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Connecticut Department of Environmental Protection

Memo

To: Marcy Balint, OLISP

From: Dennis J. Greci, Supervising Sanitary Engineer, Municipal Facilities

CC:

Date: March 28, 2006

Re: Oswegatchie Hills, Dec 2005 proposal

My previous comments regarding this site (November 1, 2004 letter to William Mulholland), are still valid, and apply to the current documents supplied to our office for review and comment. To highlight some of the previous salient issues, and expand as necessary to reflect the changes shown in the current submission, I offer the following:

1. The majority of the site is (still) outside the currently identified sewer service area.

2. The approximate flow which might be allocated to the area within the sewer service area is insufficient to support the density of development being proposed.

3. Extensions of sanitary sewers to the portion currently outside the sewer service area, in the absence of an existing wastewater disposal problem, would be contrary to the state's Conservation and Development Policies Plan, which shows the area as Conservation land, and it would be incumbent on this Department to disapprove such a proposal.

4. The density of development shown on the overall site plan as prepared by ASW Consulting Group and dated December 1, 2005 appears to be in the range of 8-12 units per acre, far in excess of the capacity of the land in terms of individual subsurface disposal systems (septic systems).

5. The area shown on the site plans for a community system is transected by wetlands. The likelihood of developing this area for large-scale wastewater disposal is limited, at best. Given the general soil conditions associated with wetlands and areas adjoining wetlands, the chance of using this site successfully as a community sewerage system with onsite disposal is very low.

6. In summary, it does not appear that there is any way to adequately provide wastewater treatment to this site for the volume of wastewater which can be reasonably expected to be generated based on the overall site plan by ASW.

Finally, while it is outside our regulatory responsibility, we also note that there are some continuing issues with adequate water supply which would need to be addressed before such a project could proceed.

Office of Long Island Sound Programs
Fact Sheet
for
STORMWATER MANAGEMENT

What is Stormwater Management?

Stormwater management is a comprehensive process to minimize potential adverse impacts to natural resources and water quality from stormwater runoff. The traditional approach to handling stormwater runoff has been to collect it from the developed area and shunt it as quickly as possible to the nearest water body to prevent flooding in upland areas. In the past, little attention had been paid to the impacts of the associated increases in both the volumes and rates discharged and the pollutants carried in the runoff. The result has been severe erosion of streams, the loss and degradation of habitat, increased flooding and associated damage, increased siltation resulting in more frequent dredging to maintain navigation, and tremendous capital expenditures to address these problems.

Proper state-of-the-art stormwater management involves many techniques including pollution prevention, minimization of impervious surfaces, on-site retention of a portion of the runoff, where appropriate, and treatment of non-retained runoff to remove contaminants such as oils, greases, suspended solids and floatable debris. One general goal is to design development in such a manner that the changes in runoff rates and volumes are minimized. This is initially accomplished through the proper siting and design of proposed structures and infrastructure.

Why is stormwater management important?

Pollution of our surface and ground waters has been a recognized problem for many years. While great strides have been made in controlling point sources of pollution, primarily through the National Pollution Discharge Elimination System (NPDES) permitting program and corresponding state regulatory programs, there is a new awareness of the importance of controlling nonpoint sources of pollution (pollution generated by many diffuse sources). Stormwater runoff is a major contributor of nonpoint source pollution.

The amount of stormwater runoff from a given site is dictated by site-specific conditions, such as the soil's infiltration capacity, the type and extent of site cover (e.g., vegetation or pavement), the slope, and the duration and intensity of each rainfall event. Stormwater that penetrates the soil is slowed, filtered, cooled, and renovated. Renovation is a process by which bacteria and minerals in the soil treat and bind contaminants, removing them from the stormwater.

Impervious surfaces, such as pavement and buildings, reduce the area of soil into which rainfall can infiltrate, thus increasing the volume of runoff that flows over the land. As this runoff flows over impervious and pervious surfaces, it can pick up and transport floating, suspended, and

dissolved constituents such as pathogens, toxic materials (heavy metals, oils, antifreeze, pesticides, etc.), high levels of nutrients (fertilizers and organic matter), eroded sediments (topsoil and road sand), and trash. This runoff flows down gradient over the land to the nearest water body or depression where it not only deposits the contaminants it carries, but it alters the temperature, pH, and/or salinity of receiving waters. It should be noted that even clean, potable freshwater can be a pollutant when introduced to a brackish or saline environment in the coastal area. Freshwater dilutes the salt concentrations in the receiving area, adversely impacting the flora and fauna that are uniquely suited to such salty environs. Over the long-term, sediment settles out of the water column and can degrade habitat in stream bottoms, tidal wetlands, and shellfish beds.

Poorly planned new development and redevelopment can result in increased stormwater discharges, and ultimately more polluted runoff reaching watercourses and wetlands. Unlike conditions in the soil, there are few natural processes available in the receiving waters to treat, reduce, or control many of the harmful constituents in the runoff; they can only be diluted by the volume of water that they reach. With constant inputs after each rainfall, concentrations of many harmful constituents have been increasing in the sediments and the water column. Additionally, increasing stormwater discharges can lead to increased risks of flooding and flood damage and to increased siltation in coastal waters which often results in habitat degradation and an increased need to dredge to maintain navigation.

Design issues relate to the topography, soil conditions, existing drainage, and natural resources on and adjacent to the site. The implementation of structural and/or non-structural best management practices (BMPs) can also be used to provide both effective erosion and sedimentation control and minimization of other pollutants including oils, greases, toxics, pathogens and floatable debris. Please refer to the manual titled *Coastal Water Protection: A Guide for Local Officials*, (DEP, 1996) for additional detailed information. A copy of the guide has been provided to the planning and zoning department in each coastal municipality.

What are the statutory policies that apply?

The Connecticut Coastal Management Act (CCMA) contains several policies that highlight the need to incorporate stormwater management into individual project reviews and long-range planning. These include the following:

> To manage estuarine embayments so as to insure that coastal uses proceed in a manner that assures sustained biological productivity, the maintenance of healthy marine populations and the maintenance of essential patterns of circulation, drainage and basin configuration; to protect, enhance and allow natural restoration of eelgrass flats except in special limited cases, notably shellfish management, where the benefits accrued through alteration of the flat may outweigh the long-term benefits to marine biota, waterfowl, and commercial and recreational finfisheries [Connecticut General Statutes (CGS) section 22a-92(c)(2)(A)].

> It is found and declared that the pollution of the waters of the state is inimical to the public health, safety and welfare of the inhabitants of the state, is a public nuisance and is

> harmful to wildlife, fish and aquatic life and impairs domestic, agricultural, industrial, recreational and other legitimate beneficial uses of water and that the use of public funds and the granting of tax exemptions for the purpose of controlling and eliminating such pollution is a public use and purpose for which moneys may be expended and tax exemptions granted, and the necessity and public interest for the enactment of this chapter and the elimination of pollution is hereby declared as a matter of legislative determination [CGS section 22a-422, as referenced by CGS section 22a-92(a)(2)].

The CCMA defines adverse impacts which must be avoided or, if avoidance is not possible, must be minimized in order for a project to be lawfully approvable. The following potential adverse impacts must be considered during the coastal site plan review process and when evaluating proposed zoning regulation and map amendments.

> Degrading water quality through the significant introduction into either coastal waters or ground water supplies of suspended solids, nutrients, toxics, heavy metals, or pathogens, or through the significant alteration of temperature, pH, dissolved oxygen, or salinity [CGS section 22a-93(15)(A)];
>
> Degrading existing circulation patterns of coastal waters through the significant patterns of tidal exchange or flushing rates, freshwater input, or existing basin characteristics and channel contours [CGS section 22a-93(15)(B)];
>
> Degrading natural or existing drainage patterns through the significant alteration of groundwater flow and recharge and volume of runoff [CGS section 22a-93(15)(D)];
>
> Degrading or destroying essential wildlife, finfish or shellfish habitat through significant alteration of the composition, migration patterns, distribution, breeding or other population characteristics of the natural species or significant alteration of the natural components of the habitat [CGS section 22a-93(15)(G)]; and
>
> Degrading tidal wetlands, beaches and dunes, rocky shorefronts, and bluffs and escarpments through significant alteration of their natural characteristics and functions [CGS section 22a-93(15)(H)].

In addition, the state statutes pertaining to planning and zoning contain specific requirements for zoning regulations and plans of development that relate to the restoration and protection of coastal resources. These are:

> In any municipality that is contiguous to Long Island Sound the regulations adopted under this section shall be made with reasonable consideration for restoration and protection of the ecosystem and habitat of Long Island Sound and shall be designed to reduce hypoxia, pathogens, toxic contaminants and floatable debris in Long Island Sound. Such regulations shall provide that the commission consider the environmental impact on Long Island Sound of any proposal for development [CGS section 8-2(b)].
>
> The plan adopted under this section for any municipality that is contiguous to Long Island Sound shall be made with reasonable consideration for restoration and protection of the

ecosystem and habitat of Long Island Sound and shall be designed to reduce hypoxia, pathogens, toxic contaminants and floatable debris in Long Island Sound [excerpt from CGS section 8-23].

Proper management of stormwater will address these statutory requirements.

Are stormwater discharges regulated by the Department of Environmental Protection?

Yes. Technically, most discharges to the waters of the State Of Connecticut are regulated by the Department of Environmental Protection through either a general permit or individual permit requirement. There are several types of stormwater discharges that are covered by the issuance of a general permit. If the stormwater discharge does not qualify for coverage by the general permit because adverse impacts to the waters of the state would result, an individual permit may be required prior to discharge.

Registration is required to be submitted in order for stormwater discharges to be authorized by the following general permits issued by the Connecticut Department of Environmental Protection:

Stormwater and Dewatering Wastewaters from Construction Activities: This general permit applies to all discharges of stormwater and dewatering wastewaters from construction activities which include, but are not limited to, clearing, grading, and excavation and which result in the disturbance of *five or more acres* of total land area on a site.

Stormwater Associated with Commercial Activities: This general permit applies to all discharges from any conveyance which is used for collecting and conveying stormwater and which is directly related to retail, commercial, and/or office services whose facilities occupy *five acres or more* of contiguous impervious surface.

Stormwater Associated with Industrial Activities: This general permit applies to all discharges from any conveyance which is used for collecting and conveying stormwater and which is directly related to manufacturing, processing or material storage areas at an industrial activity site.

What can a municipality do to minimize impacts from stormwater runoff?

- Maintain, enhance or restore the quality of coastal waters and submerged lands through the adoption and implementation of a stormwater management ordinance, either as an amendment to the municipal zoning regulations or as a "stand-alone" ordinance. In either case, it should require 1) that new development projects be designed to minimize clearing, cutting and filling in undisturbed areas to ensure that new development is consistent with the capabilities of the land to support such development; 2) soil erosion and sediment control plans for all development projects near sensitive coastal resources, even those projects with less than one-half acre land disturbance proposed, and strictly enforce appropriate

sedimentation and erosion control measures during construction; and 3) that site plan and special permit/exception applications include appropriate best management practices to retain and treat on-site the runoff generated by the first inch of rainfall, remove 80% of the total suspended solids on an annual basis, and, where site conditions allow, prohibit post-development increases in the pre-development rates and volumes of stormwater discharge.

- Review zoning regulations to determine the maximum impervious cover allowed in each district and carefully consider reducing these maximums wherever possible, particularly in areas abutting coastal waters and other sensitive coastal resources, but also for areas serviced by municipal stormwater systems that discharge to coastal waters. Include buildings, paved areas, sidewalks, terraces, patios and other non-porous surfaces when calculating impervious cover.

- Update subdivision regulations to encourage cluster developments that incorporate features such as curbless roads, narrow roads, grass swales, retention ponds, and other features that reduce impervious cover, disperse and treat stormwater, and minimize the collection and transport of stormwater to surface waters.

- Update the municipality's Plan of Conservation and Development and Municipal Coastal Program, if applicable, to encourage best management practices for stormwater for all new or substantially improved development, including improvements to municipal roads, bridges and other facilities, and for currently developed areas. Consider including the following:

  An inventory of existing storm drain outfalls to identify opportunities to retrofit roads and other municipal facilities for stormwater retention and pollutant reduction;

  Identification of illicit connections to municipal storm sewer system (anything that is not stormwater that is being discharged to the stormwater system without a permit) and recommendations to correct or mitigate adverse impacts associated with these connections;

  Adoption of a municipal ordinance that prohibits illicit connections to municipal stormwater systems;

  Consideration of (and preparation for) the use of alternatives to winter sanding and salting on roadways and parking areas;

  Planning for and implementation of appropriate snow disposal practices;

  Initiation of a storm drain stenciling program to help identify direct links to coastal waters and other waterbodies;

  Adoption of an ordinance that limits the application of fertilizers and broad-based pesticides, particularly in months with historically high or low average precipitation such as April and August; and

Recommendations for regularly scheduled street sweeping and catch basin clean-outs to minimize the amount of sediment, contaminants, and floatable debris entering coastal waters and other waterbodies through the municipal stormwater management system, and recommendations to amend the zoning regulations to require similar maintenance of private parking lots and streets.

- Develop a watershed management plan with neighboring municipalities that share your watershed boundaries, and implement a coordinated stormwater management plan.

- Develop an educational handout that: addresses the importance of stormwater management; identifies actions that individuals can take to minimize potential stormwater impacts (including, for example, the proper use of fertilizer, disposal of used motor oil and composting of lawn clippings, etc.); and includes the municipality's standards for development. Include it in every application package for land use and/or building permits and authorization.

- Develop an open space/greenways plan to create recreational opportunities and buffer sensitive and important resources, particularly streams, tributaries, and coastal resources from stormwater impacts.

- During the review process for new or redeveloping marinas, require coastal site plan conditions that incorporate the practices identified in *Best Management Practices for Coastal Marinas* (DEP-OLISP, August 1992).

- Coordinate with the Department of Environmental Protection's Stormwater Management Unit to make sure that all eligible stormwater discharges from industrial, commercial, or construction activities are covered by the appropriate general permit and to ensure compliance with Stormwater Pollution Prevention Plans.

- Refer coastal site plan review applications for waterfront sites or significant development proposals within the coastal boundary to the DEP's Office of Long Island Sound Programs for comment and technical assistance.

Planning Considerations

Oswegatchie Hills is a unique area of East Lyme with a variety of flora, fauna, streams, wetlands, ponds, geologic conditions, scenic vistas, and unique habitats. In terms of southeastern Connecticut, Oswegatchie Hills and the Bluff Point Reserve in Groton, are the only large contiguous areas remaining in an undeveloped state adjacent to tidal rivers. Earnest efforts should continue to conserve and preserve this natural area of East Lyme for the use and enjoyment of current and future generations.

The East Lyme Plan of Conservation and Development recommends this area of town for existing and proposed open space.

The Regional Plan of Conservation and Development recommends this area for proposed conservation areas, and existing and proposed low density uses. This plan is currently in the process of being updated for completion during 2007.

The Connecticut State Plan of Conservation and Development recommends this area for conservation areas and rural lands.

The area is currently zoned for residential single-family homes at three acres per unit as specified by the RU-120 Rural District. A greenway conservation-zoning district was previously proposed for this area and will be reintroduced. In addition, some of this area falls within the defined Connecticut coastal zone and within the jurisdiction of the Niantic River Gateway Commission. The greenway conservation-zoning district should be reintroduced by East Lyme and expanded in content to include the Niantic River Gateway standards. These standards are specifically enumerated in Section IV of the approved standards adopted by the Niantic River Gateway Commission on March 1, 2002.

In general, the existing road network is poor for additional intensive development in this area of town. The existence of more than one way in and out

is critical for emergency access for natural and person made emergencies. Damon Heights, King Arthur Drive, Oswegatchie Hills Road, Quarry Dock Road, River Road, Hill Road and Calkins Road are narrow town roads serving existing residential development and were not intended to be widened to serve any intensive new development. In many instances this is physically impossible with residences located very close to the travel way.

Archaeological and Historical Review

The Office of State Archaeology (OSA) and the State Historic Preservation Office (SHPO) believes that the ERT project area possesses a high sensitivity for archaeological resources. This review is based on known prehistoric Native American sites in the State of Connecticut's archaeological site files and maps, and, topographic and environmental characteristics of the land. Five prehistoric Native American sites have been located on the project area, or immediately adjacent to the project area. These sites include a hunting and gathering camp (ca. 4,000 years ago), a village (ca. 1,000 years ago), and associated burials. In addition, historic sites, including a quarry are registered in their site files. Proximity to the wetlands to the east and the soil types and slope associated with the project area also suggests a high probability for undiscovered archaeological resources.

In particular, the OSA and SHPO are concerned with the possible unearthing of Native American burials. Both banks of the Niantic River and Smith Cove have yielded a number of Indian burial sites. Due to the heightened sensitivity associated with burials, their offices make the following recommendations:

They concur in the need for a professional reconnaissance survey that should be undertaken in order to locate, identify and evaluate all archaeological resources that may exist within the developable areas of the study site. A reconnaissance survey would provide the Town of East Lyme, OSA and SHPO with important cultural resource information for assisting in the local land use decision-making processes. All archaeological investigations should be carried out pursuant to SHPO's *Environmental Review Primer for Connecticut's Archaeological Resources.*

The OSA and SHPO are available to provide technical assistance to applicants and the Town of East Lyme in conducting the recommended survey.

Topography and Geology

Topography

The Oswegatchie Hills (Fig. 1) form a prominent north-south oriented ridge sandwiched between the Niantic River estuary on the east and the Pattagansett River on the west. Thus, the hills have a relief that extends from sea level to the height of Mt. Tabor, about 275 feet. The hills are cut by a deep valley that begins at Clark Pond and extends northward to just west of Mt. Tabor. The valley, at its deepest, is greater than 150 feet. The valley is steep-sided and to hikers on the trail going up, it seems much deeper. The valley owes its existence to a rock formation (schist of the Plainfield Formation) that is more easy to erode than adjacent rocks that form the ridge lines.

The ridge-top hills are rather streamlined with gentle slopes on their north and south sides, but generally moderate to steep eastern and western flanks. They were sculpted by Ice Age glaciers that moved in a general north-south direction in this area. The underlying rocks, of course, influenced the shapes of the hills also. Most of the rocks that crop out in the Hills are composed of varieties of granite-gneiss that are not well fractured. They resist erosion by glacial action. Where fractures or fracture zones do exist, glacial erosion is enhanced and aligned valleys form, as can be seen on several spurs on the proposed Riverview Heights parcels.

Very little glacial till remains on top of the Hills (Goldsmith, 1964) and hence soils are thin to non-existent. This leaves a lot of bald hill-tops and large expanses of bare rock (Fig. 2). Glacial erratics (Fig.3) are scattered across the area and is likely that till of some thickness was initially deposited. Water from the melting glaciers may have washed away any veneer of till that may have existed.

Geology

The Hills are plagued by very thin or no soils and the underlying bedrock (ledge) crops out abundantly, especially on the steeper easterly and westerly facing slopes. Thus the rock lithologies are well exposed.

The area is very complex on a regional scale, but is quite straight forward in the Hills. Rock formations are arrayed in north-south bands (Goldsmith, 1967; Rodgers, 1985). The rocks are all quite old, one billion years or more, and are part of the Avalonian Terrane (see Bell, 1985, and Rodgers, 1985). The Avalonian

Terrane is a small older continent that, through plate tectonic processes, bumped into and became welded onto the ancestral North American Continent about 350 million years ago. The edge of the Avalon Continent slid under the ancestral North American Continent. The boundary between the two different continents, located in the northern part of Montville and Ledyard, is a major fault, long since inactive. The rocks were subjected to very high pressures and temperatures during this process.

The rocks consist of three basic assemblages: layered rocks of the Waterford Group and Plainfield Formation (Rodgers, 1985) form the eastern slopes of Oswegatchie Hills. They are the oldest rocks. They were probably sedimentary and possibly volcanic in origin. They have been metamorphosed to gneiss and schist. These were intruded by molten igneous rocks that congealed to varieties of granite when they cooled. They comprise the Sterling Group (Rodgers, 1985) and underlie most of the higher parts of the Hills. The third assemblage is the Tatnic Hill formation (Rodgers, 1985) that is generally regarded (Wintsch, 1979) as a ductile fault zone that resulted from intense shearing as different blocks of rock moved past one another in a hot pressurized environment, maybe 10 or more kilometers beneath the surface.

The older rocks consist of schist and gneiss belonging to the Plainfield Formation, the Marmacoke Formation and the Rope Ferry Formation. The Plainfield Formation, the oldest rocks in the area, consist of biotite-quartz-plagioclase feldspar schist and gneiss. It underlies the deep valley that runs through the center of the Oswegatchie Hills. More of the Plainfield Formation is exposed to the west of the Oswegatchie Hills. The Marmacoke and Rope Ferry Formations belong to the Waterford Group and are similar in lithology. They consist of granitic gneiss (biotite-quartz, plagioclase feldspar), amphibolite, and minor calc-silicate gneiss. The Rope Ferry Formation consists primarily of gneiss whereas the Marmacoke tends to contain a greater variety of interlayered gneisses. Also, the Rope Ferry contains hornblende in addition to biotite. All of the older formations are metamorphosed sedimentary and volcanic rocks that are Proterozoic in age (roughly 1-1.3 billion years in age). The formations require patience and practice to be distinguished in the field.

Slightly younger, but still Proterozoic in age, igneous rocks intruded into the older layered rocks. The igneous rocks have since been metamorphosed into gneiss. The younger rocks consist of two formations, the Hope Valley alaskite gneiss and the Potter Hill granite gneiss, both of which are part of the Sterling Group. Both are composed of quartz, potassium feldspar, plagioclase feldspar

and mica. The Potter Hill gneiss tends to be greyer and in places contains biotite mica, and rod-like concentrations of quartz. The Hope valley has equigranular quartz and may be pinkish to orange and gray colored. These two formations are not easy to distinguish in the field.

The formations are on the east flank of a large dome that extends from the Niantic River westward to the Connecticut River and northward to about Salem-Four Corners. The foliation of the layers dips steeply toward the east in the Oswegatchie hills.

Devil's Den

An interesting set of caves (Fig. 4), formed by collapsed boulders, are located on the eastern flank of the Hills near their southern end. House-sized boulders are piled up at the base of steep east-facing cliff-like bedrock ledges. The rock consists of the Hope Valley alaskite gneiss. Near the base of the ledge in a couple of areas is smoothed rock (Fig. 5) suggestive of water-working. To the east are sand and gravel deposits which suggests the possibility of melt water streams coursing through the area for a brief time. The streams may have undercut the ledge leading to failure and the falling of large blocks to the base of the cliff. The blocks leaning against the cliff provided shelter caves that are locally referred to as the Devil's Den.

Conclusion

Steep slopes and thin soils are a hindrance to development. Off-site sewage treatment will be necessary because of a lack of soils into which the effluent may be discharged. Off site water supply will probably be necessary because the rocks are poorly fractured and developing a sufficient water supply will be difficult. All phases of construction will likely require extensive blasting of the bedrock to achieve sufficient depths and grades required by the development.

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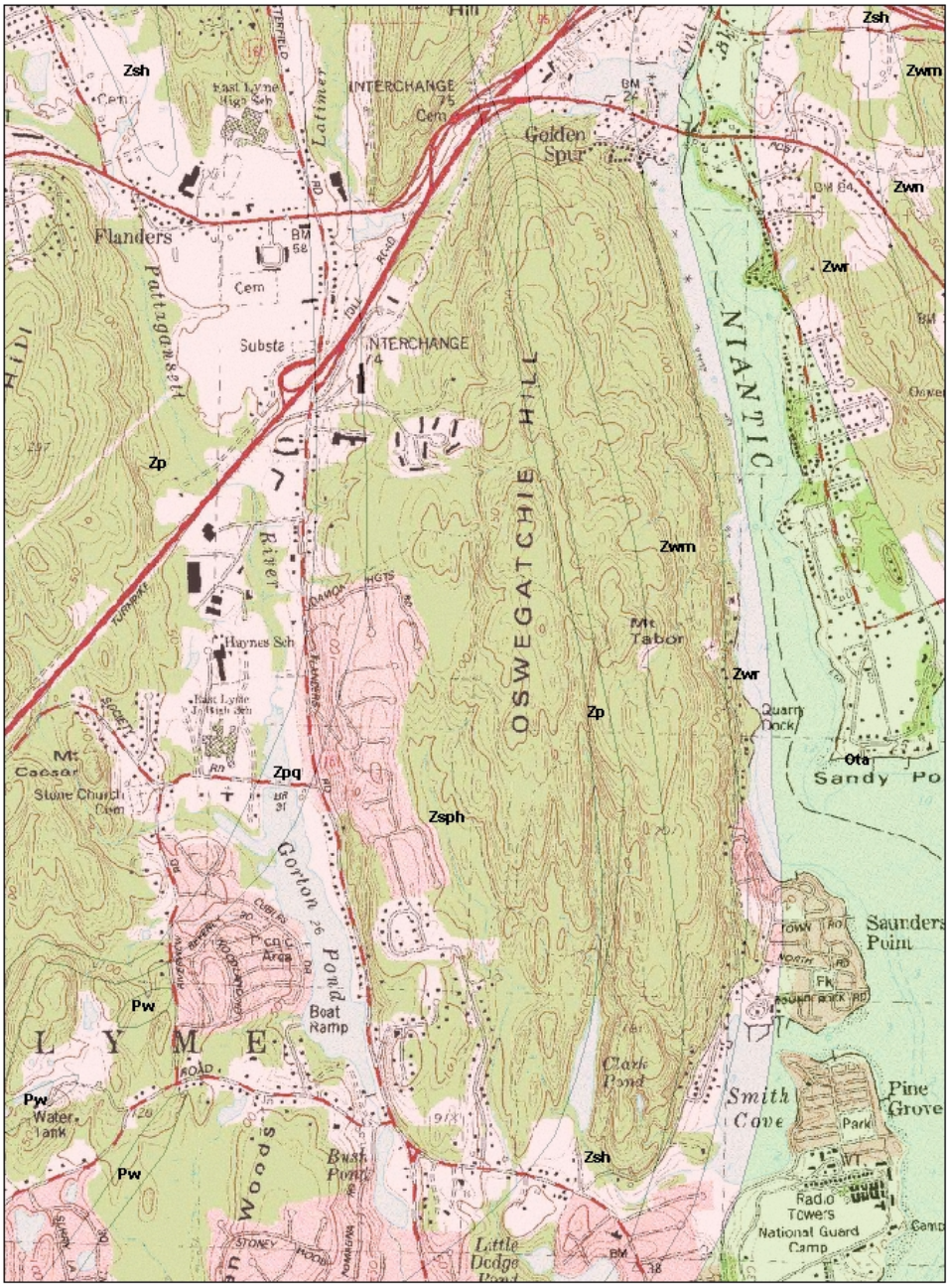


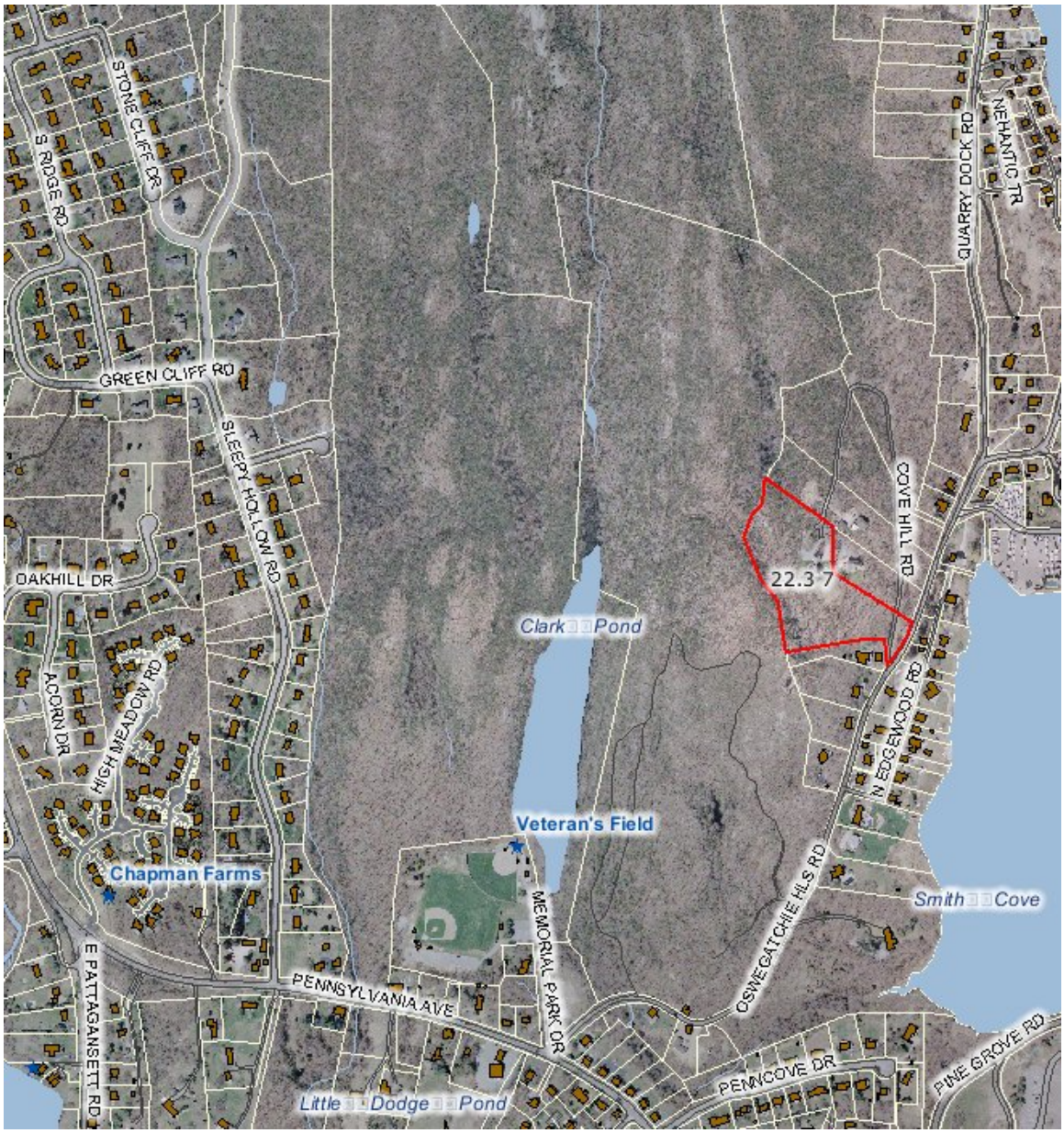
Figure 1. Geologic Map of Oswegatchie Hills (from Rodgers, 1985). The formations, listed from youngest to oldest are: Ota (now thought to be Devonian in age) – Tatnic Hill Formation (ductile fault zone), Zsh – Hope Valley alaskite gneiss, Zsph – Potter Hill granite gneiss, Zwr – Rope Ferry Formation, Zwm – Marmacoke Formation, Zp – Plainfield Formation. Also shown: Zpq – quartzite in Plainfield Formation.

Figure 2A (top) and 2B. Thin soils or no soils are typical of upland surfaces. Local pockets of soil persist where weathering has enhanced the width of high angle fractures Fig. 2A). Notice on the left side of the picture that the outcrop looks slabby. In addition to the high angle fractures, surface parallel fractures are locally common. These are referred to as exfoliation fractures and developed as a response to unloading of the rock by weathering and erosion and possible by melting of the Ice Age glacier. Where the rock is poorly fractured, large unbroken outcrops are seen. Note in both photos that the rock surface is smooth and rather streamlined, giving the hill a drumlin like shape.

Figure 3. Glacial erratic composed of locally derived granite gneiss.

Figure 4A and B. Devil's Den. Notice large boulders of rock that are piled up against the cliffs of Hope Valley alaskite gneiss. Caves are shelters beneath the boulders and were not formed by dissolution of rock as are caves in limestone and marble.

Figure 5. Water worked surface at base of cliffs at Devil's Den.



Devil's Den Property Location (in red).

Eastern Connecticut Conservation District Review

The Eastern Connecticut Conservation District (ECCD) attended the East Lyme Oswegatchie Hills ERT review and site walk on August 23, 2006. ECCD reviewed the various materials provided, and is submitting comments on the following topics:

1. Overview
2. Maintenance of the property around Clark Pond
3. Forest Management
4. Signage and other trail system enhancements
5. Future development of Parcels #'s 1, 2, and 3
6. Additional property purchase or protection
7. Soils Map

Overview

The area referred to Oswegatchie Hills in East Lyme contains a group of undeveloped parcels totaling roughly 700 acres. Approximately half of the land has been acquired by the Town of East Lyme (the "Town") and the East Lyme Land Conservation Trust. Their plan is to preserve the land in its natural state. The remaining half of the "Hills" is in private ownership and could possibly be developed. The Town requested an Environmental Review Team (ERT) assessment of the area to assist them in making future decisions.

Large tracts of undeveloped land along the Connecticut coast are not common. By purchasing several parcels, the Town and the East Lyme Land Conservation Trust have seized a rare opportunity to conserve a considerable portion of this ecologically and historically important area. To protect the remaining undeveloped portions of the Hills, obtaining ownership, conservation easements, or some other form of legally binding protection will likely be necessary.

Maintenance of the Property Around Clark Pond

The Town has valuable recreational and ecological resources in its ownership of Clark Pond. During the site inspection there was discussion around the possibility work being done to increase the stability of the pond's outfall located at the southern end of the pond. The ECCD recommends that this work be done,

however, it is suggested that the scope be limited so as to cause as little disturbance as possible to the area.

In addition to improving the stability of the outfall area, it is recommended that the appropriate action be taken to manage the invasive species Japanese knotweed (*Polygonum cuspidatum*) located in the same area. At this time it appears that there is a single small stand present.

Japanese knotweed, a rhizomatous perennial, grows to a height of 2-3 meters. The woody, dead stems remain standing throughout the winter (which can create a fire hazard) and new shoots, produced from the extensive rhizome system, grow up amongst these the following spring to form dense thickets. The dead stems and leaf litter decompose very slowly and form a deep organic layer, which prevents native seeds from germinating. Once present at a site, Japanese knotweed increases in area very rapidly and soon forms monoculture stands. If left unchecked, high water flows from Clark Pond can disperse fragments of the plant downstream where new colonies will form.

The work to control this weed could be performed by the Town, or alternatively the work could be performed by volunteers. Now is the time to manage this plant as it is highly likely to spread in the future and become unmanageable.

Forest Management

The Oswegatchie Hills area is typical of many Connecticut forests. The overwhelming majority of the property is mixed upland hardwoods with the

most mature trees being less than 100 years old. This is due to changes in land use that took place in Connecticut 50 to 100 years ago, allowing trees to take over what were formerly agricultural fields. In general, the forest is healthy and includes a variety of species. There is ample understory to provide replacement trees when openings occur, and the danger of fire is low.

The ERT was informed that the Town's plan for the property is passive recreation. That being the case, it is suggested that a formal forest management plan is not critical, and that the forest can simply be monitored.

The only issues currently noted were: 1) Certain sections of the trails appeared susceptible to erosion. Trails will need to be monitored for erosion, and maintained or relocated as needed.
2) Evidence of travel by All Terrain Vehicles (ATV's) was present, but fortunately, no damage was observed. ATV's can cause serious soil erosion in a very short period of time, and the damage is usually costly to repair. It is recommended that ATVs not be permitted on the property.

Signage

As part of its designated use as passive recreational land, the ECCD sees an excellent opportunity for citizen education. Specifically they recommend signage that is educational in nature. For example, tree species could be identified along frequently used trails, and Clark Pond could have information regarding wetland ecology. With regard to trash, they recommend signs designating the area as a "carry in, carry out". They also recommend signage regarding pets and pet waste. Small trash containers designed for pet waste could be considered.

Future Development of Parcel #'s 1, 2, and 3

The Town has received several applications for development of the parcels identified as #1, 2 and 3 over the past few years. ECCD notes that much of the property surrounding the Oswegatchie Hills has already been developed. The proximity of the Hills to the Niantic River and other wetlands and watercourses raises the concern of the cumulative effects of development in this relatively confined area. Considering cumulative effects and the steepness of the slopes on portions of parcels 1, 2 and 3, ECCD recommends that any development of those parcels be limited in scope. For example, single-family homes selectively placed so as to limit changes in the existing topography, could be constructed and occupied without causing serious environmental damage. In addition, roads

should be engineered to use the existing terrain, such that only minor grading is needed to install them.

If a high-density development is considered, degradation of water quality is greatest natural resource threat. If such a development is pursued, the ECCD recommends that the Town require pre- and post-development stormwater quality monitoring, and that the post-development quality be equal to the pre-development quality. It is also recommended that the Town require a bond or some other type of financial protection to cover the cost of corrective action in the likelihood that the high-density development results in a degradation of water quality. Any plans for development should comply fully with Connecticut's Erosion and Sediment Control Guidelines.

Future Purchase of Additional Property

ECCD recommends that the Town purchase or otherwise protect the parcel shown as #8, around Mt. Tabor. This property contains a series of sphagnum vernal pools as well as historic value in its quarry.

Soils Map

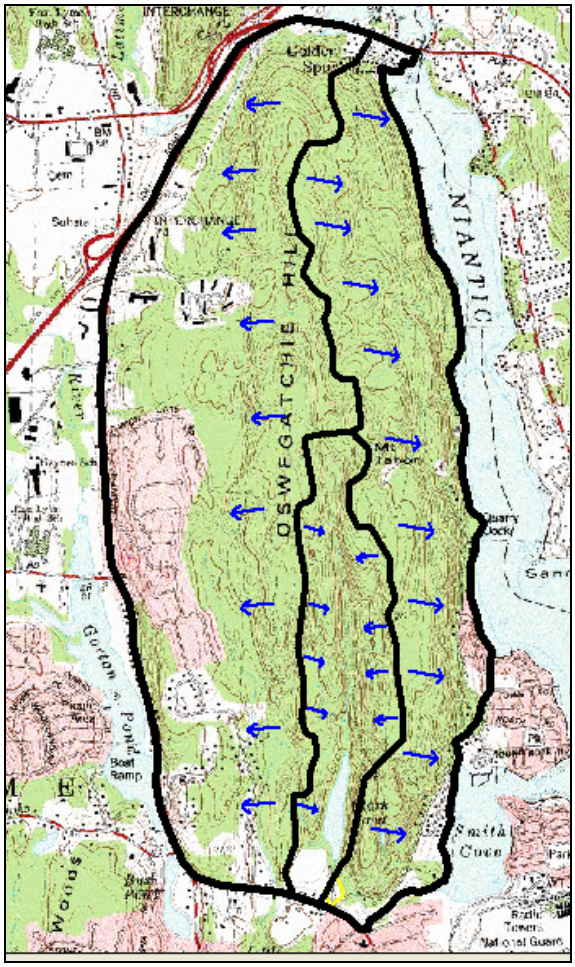
ECCD has developed a soils map of this area and can furnish the map and accompanying soils descriptions if requested.

Wetland Review

The Team reviewed the parcels that make up Oswegatchie Hills on two different field days. The first was August 23, 2006; the second was October 4, 2006. The charge to the Team was two fold: to assess the resource base on the protected holdings that make up the preserved portions of the area, and to assess the northern end of the area for development, parcels one, two and three on the maps provided to the team.

Study Area Description

The Oswegatchie Hills borders the Niantic River in the southeast part of East Lyme. Loosely defined, the Oswegatchie Hills encompass an area of approximately 1,426 acres. This area is bounded to the west by Route 161/Flanders Road, to the north by Route 1, to the east by the Niantic River, and to the south by Pennsylvania Avenue and Smiths Cove. This area is ~2.6 mile north to south and about one mile wide.



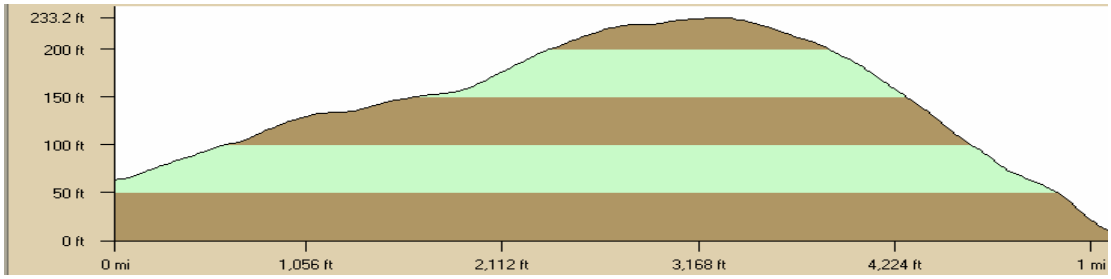
Within these bounds there is a series of north-south ridges that form the crests of the hills for which the area is named. The highest of these is Mount Tabor at approximately 285 feet above sea level. Thus, the crest-of-the-hills give rise to the headwaters of streams that drain downslope.

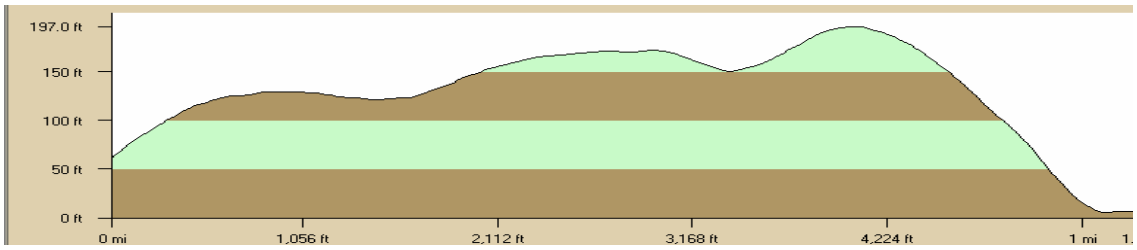
The southern half of the study area is split east and west by the Clarks Pond Brook drainage area (shown) and the Dodge Pond Brook drainage.

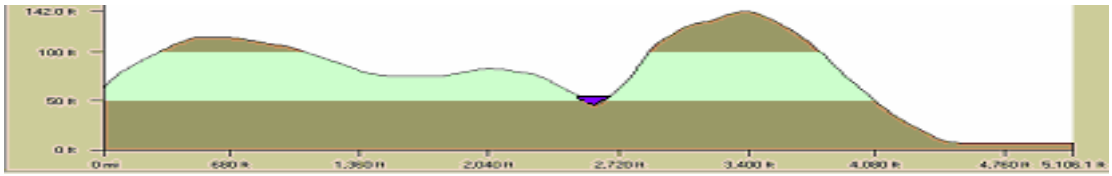
This graphic depicts the Oswegatchie Hills study area and a simplified drainage pattern. Generally the drainage is east-west from the ridge tops except where Clarks Pond Brook has created its own drainage area.

Wetland headwaters ultimately give rise to a stream that increases its flow quantity as it works its way downslope.

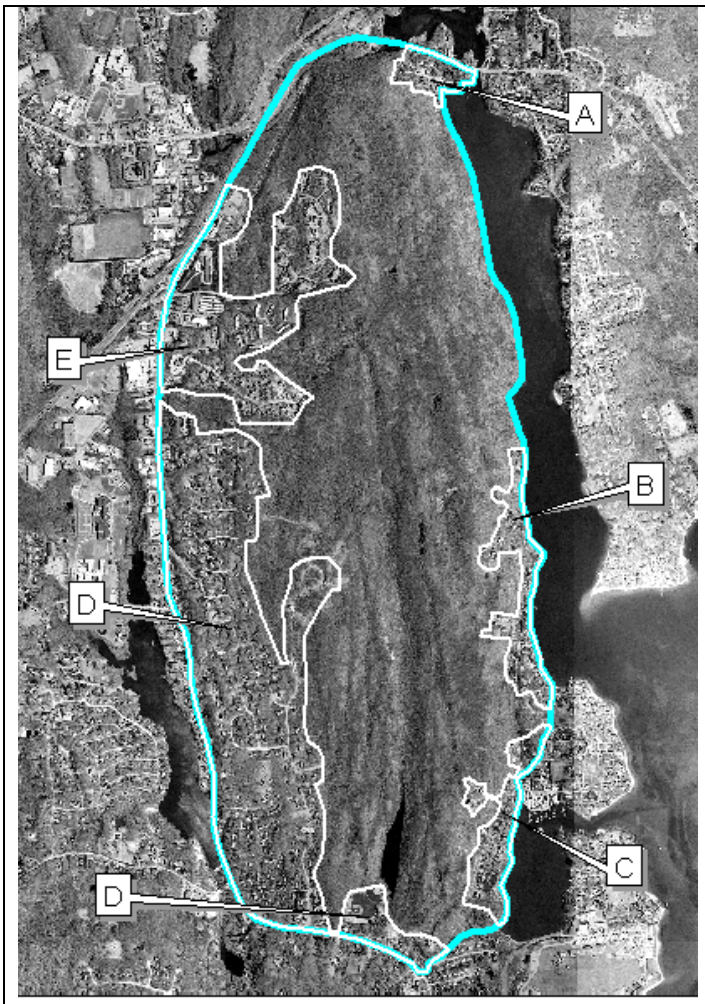
East-west cross sections show the profiles of the hills and valleys that make up the study area. Below are three cross sections of the Oswegatchie Hills. The top one depicts an east-west line about one third of the way down from the north (between the "E" and the "H" of the words Oswegatchie Hills on the map above). The second image shows a line at about two thirds of the way down, between the "O" and the "S" of the word Oswegatchie. The bottom image shows the cross section as it passes through Clark Pond, and the way the Clark Pond Brook has cut into the hillside.







Within the study area of 1,426 acres approximately 501 acres are developed. This represents 35 percent of the whole. The development is broken down into five sections and, while it is subjective, does provide a base for discussion. Within the five sections development is concentrated along the foot of the hills on both the east and the west sides but is increasingly working its way upslope as can be seen in the graphic on the next page:



The five general areas of development total 501 of the study area's 1,426 acres. The individual areas measure as follows:

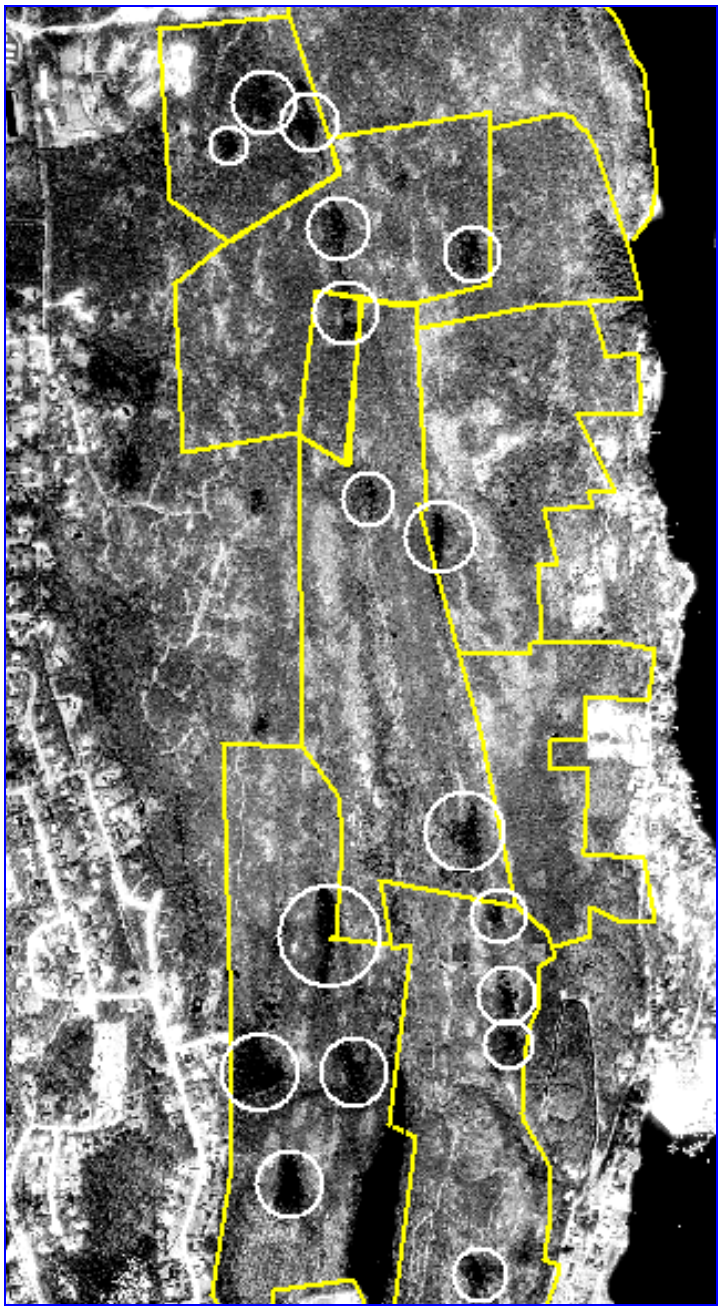
A is ~13.6 acres
B is ~35.9 acres
C is ~30.7 acres
D is ~291.3 acres
E is ~129.7 acres

These delineations are drawn on a photographic base which dates from the spring of 2004, with reference to undated MapQuest aerial views subsequent to that. The 2004 aerial imagery may be reviewed at http://clear.uconn.edu/data.html

The greatest amount of development is along the west side of the study area where Flanders Road provides ready access. There residential areas are in the one half to one acre lot sizes.

Wetlands

During the course of our two walks the Team encountered many wetlands. Some were open water, some were composed of bog-like organic accumulations, some were watercourses leading into wetlands, and some were floodplain. For a variety of reasons, it was difficult at times to relate our field position to the map. But it was clear that on the two days we viewed the properties there were many and diverse wetland areas on the preserved parcels.



The easiest way to observe these wet areas is often with an aerial photograph. The wettest areas occur darker on the imagery, while the high dry areas appear very light in color, and roadways and manipulated areas appear almost white. This photograph was taken in the spring of 1990 and shows the potential wet areas exceedingly well. (Later photographs, like those from 2004, do not have sufficient contrast for the wet areas to be distinguished quite so easily.)

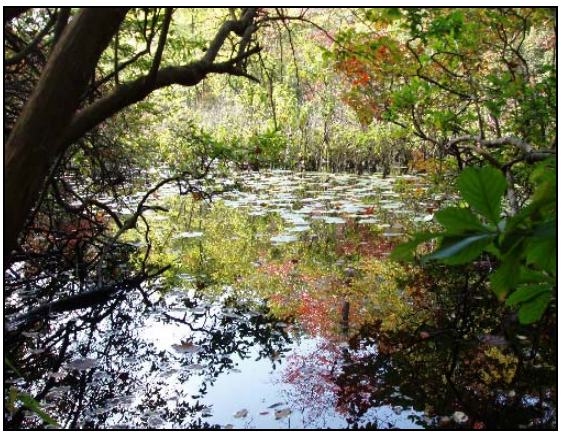
Included here are 17 circles which outline possible wetland locations. The angular lines in the image represent the approximate boundaries of the protected parcels.

The wetlands that are the easiest to see are those with open water. They appear almost black on the photos. Clarks Pond, which measures ±six acres in size, is a good example of this in the bottom center of the photograph above. It drains an area of 169 acres, or about 12 per cent of the study area. It is an exciting, unimpacted drainage basin that has excellent potential for educational use.

These six photographs show the diversity of the wetlands on the protected properties.





The top right and bottom left show headwaters areas - the very beginning, rocky starts to watercourses. Top left and bottom right show two different open water areas. In the center a Team member samples the depth of the organics in this

sphagnum covered wetland. The depth above the mineral soils at this location totaled 15 to 16 inches.

The Team encountered potential vernal pools and a few intermittent streams. These latter speak to wetter periods of the year when they that provide flow for downstream reaches. The hills of the protected lands are almost completely dominated by woodland. The woodlands provide shade protection from the sun/evaporation so that the water that falls on any given watershed has and excellent opportunity to move towards the brook, by both surface or subsurface flow. It would be very beneficial when planning any trail work to leave wooded buffers for the wetlands and watercourses. These buffers serve as prime filters of surface runoff before it enters the wetlands.

The Oswegatchie Hills wetland systems that the Team visited were found to be in an extremely healthy ecological state. In open water the emergent and near shore vegetation were both vigorous and in balance – no single vegetative species dominated, no extremes of monoculture, few, if any, invasives, and the water proved to be free of both odor and visible pollution. Similar observations of quality were made for all non open water wetlands where frequently three tiers of vegetation flourish. The herb level which leads to scrub shrub, and follows slightly up gradient with vigorous deciduous woodland. The successful herb and shrub level are indicative of a lack of over grazing by the deer population and general ecological balance of the area.

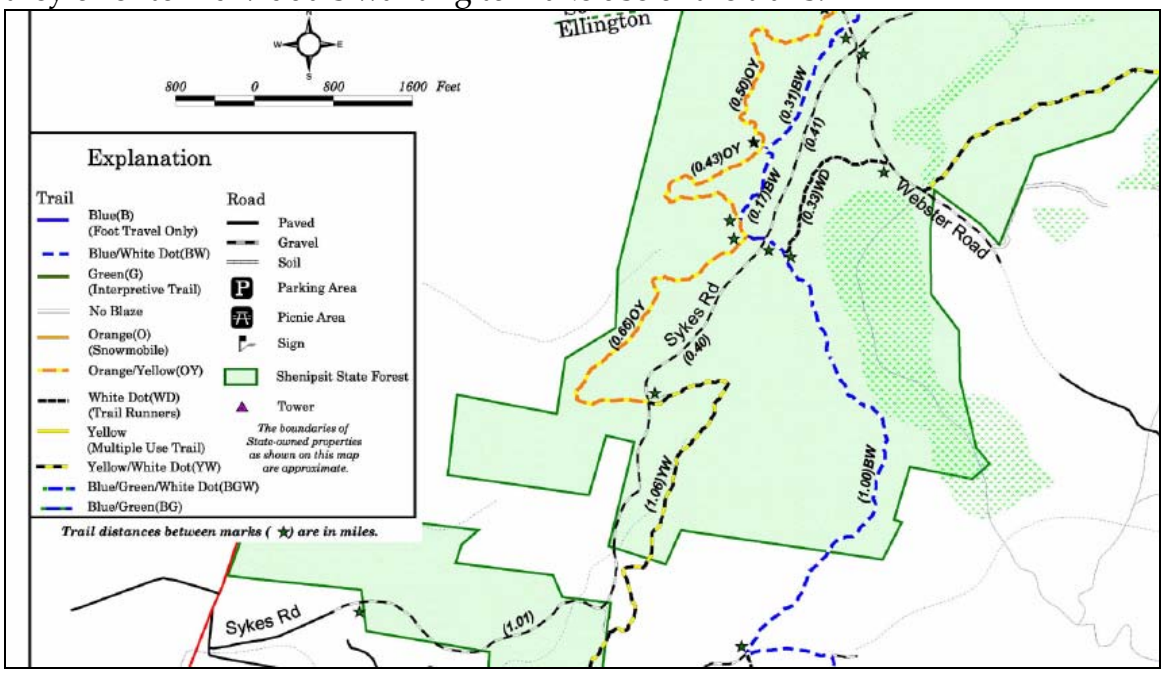
All soils, wetland and upland, are till based in this study area. The Ridgebury Leicester Whitman complex dominates the study area with about 51 acres, followed by Timakwa-Natchaug at about 20 acres. The three acres of Raypol Silt loam bring the total wetland soils, as mapped by USDA, Natural Resources Conservation Service (NRCS), to 73 acres. That acreage, combined with the 28 acres of open water, totals 101 acres, or 7 per cent of the study area. However, there is undoubtedly more wetland acreage than this. Since the smallest NRCS mapping unit is three acres there are many wetland locations of less than three acres which need to be documented.

Mapping

One of the greatest assets of the Oswegatchie Hills properties the Team visited was their value as undeveloped land in an area of the state that maintains a constant growth rate. Recreation from the Hill's trail system will be the most

dominant public use. Passive activities in the form of hiking, birding and photography will have users needing excellent mapping so that they may enjoy it with confidence. And having a consistent user base is like building a custom constituency or advocacy group for the preservation of the entire preserve.

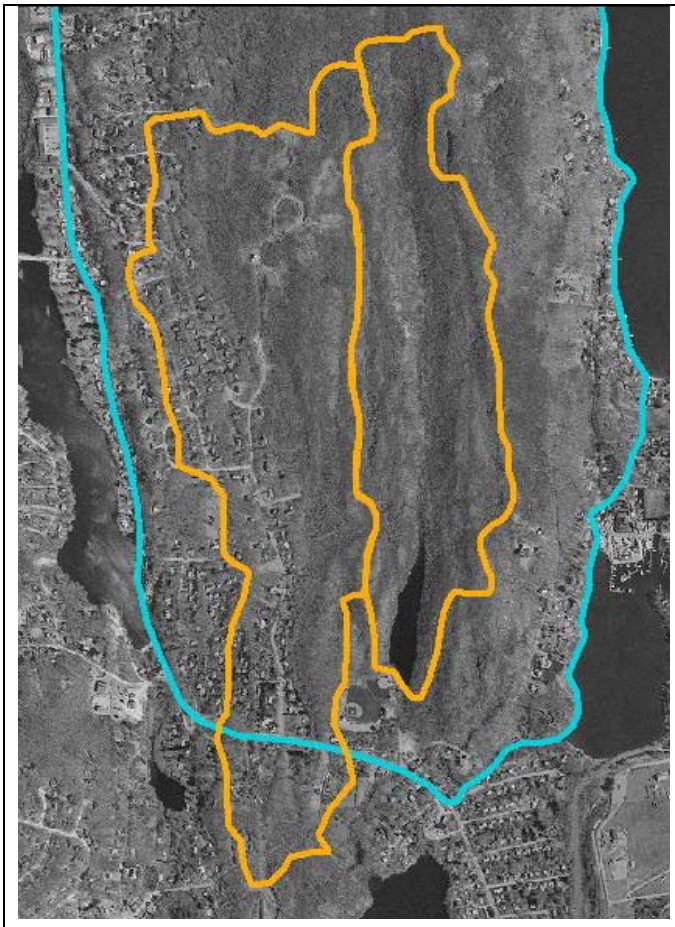
Earlier in this decade the DEP mapped several of its state park and forest trails. This was done with the use of a GPS unit to provide exact trail locations and distances. The following section of a DEP trail map (below) shows a product of the mapping project. Each trail is assigned a dedicated color. Sections of the trail, as separated by the five pointed stars, show specific distances from point to point. These maps have been a success because of their clarity and the confidence they offer to individuals wanting to make use of the trails.



Education

It is infrequent along the shore, and in many southern tier Connecticut towns, that an entire 169 acre watershed remains totally undeveloped. The Clark Pond Brook watershed provides a remarkable opportunity for environmental, ecological, and land use education. There is excellent access for buses at Veterans Memorial Field just south of the pond. And the location is three to four road miles from the nearest schools and close to Connecticut College as well. An untouched watershed that is open to the public, combined with good proximity to neighboring *developed* watersheds, can be an educational treasure.

Comparisons of wetland and upland ecology, water quality, water temperature and land use between the two drainages is a lesson plan already made.



Here is the southern portion of the study area. It shows the pristine condition of the 169 acre Clark Pond Brook drainage. Immediately to the west of that is the Dodge Pond Brook Drainage. It measures 351 acres in size of which 132 acres, or 38 per cent, is developed. The land use is dominated by road surface, roof tops, and grass, all of which can affect the quality of the runoff.

Concluding Comments

The following steps may aid in the ongoing preservation of the natural resources and the growth of recreational use of these properties.

Inventory wetlands by type and location - there is great diversity of wetland type and location on these lands. Before any planning for future use is done, it is necessary to understand where the resources are that need protection. That inventory, consisting of text and photography, will also serve as wetland baseline data, a sort of snap shot of their condition at a given time. This will allow caretakers to asses any impacts in later years.

Map and label all trails as thoroughly as possible – Trails should avoid wetland and sensitive areas such as steep slopes and soils prone to erosion. Headwaters areas are especially sensitive to impacts. Vernal pools will need to be monitored in the spring breeding season. Special care should be taken to protect the upland areas around breeding pools as those areas are the homes to amphibians for 90 per cent of their adult lives.

Continue to obtain as much land as possible – to date the efforts to preserve lands has seen remarkable success. Any additional acreage will serve as buffer to what is already in hand and continue to protect water quality and wildlife habitat.

* * * * * * * * * *

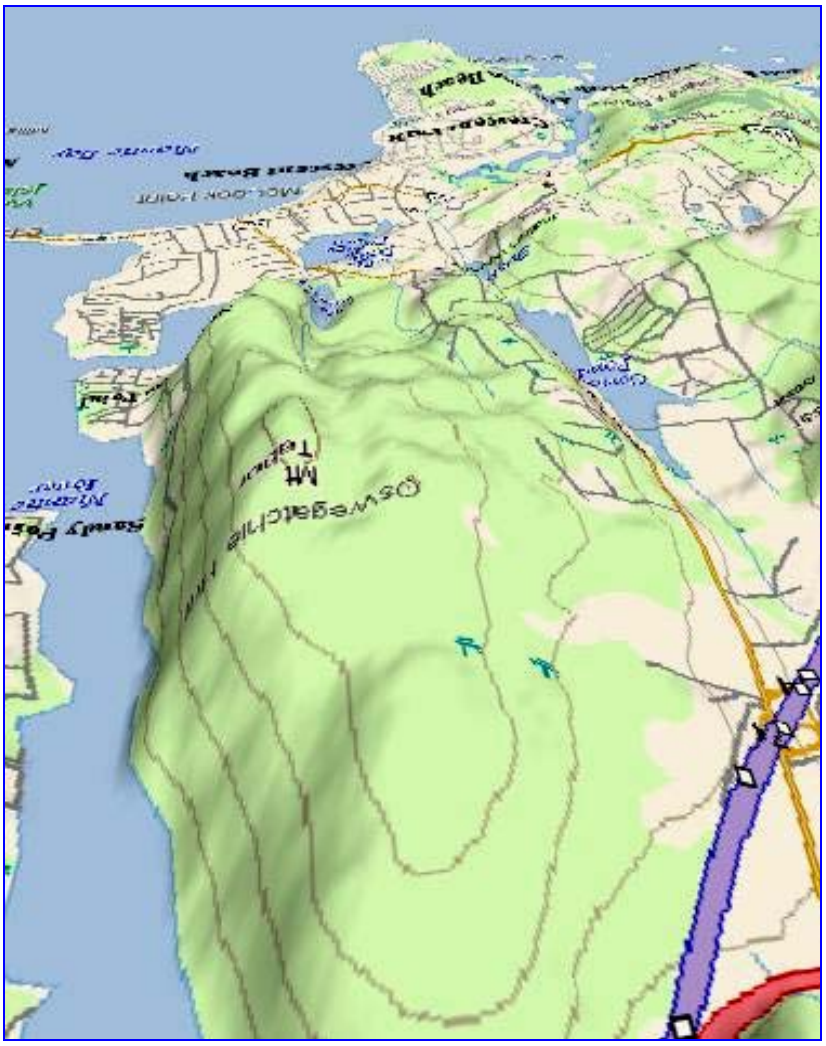
Development Prospects for the Northern Parcels

The three parcels that make up the northeast portion of the study area can potentially be developed. Slopes of 10 to 12 and even 15 per cent are common. Effective erosion and sediment control and close monitoring of total impervious surface percentage will be critical. There are some wet areas shown on the USDA mapping, but typically an applicant would have to show a detailed proposal complete with wetlands mapping. Buffers and/or setbacks will have to be carefully considered for size to account for steepness of slope.

Depth to bedrock could also be a challenge for a builder. The ERT team visited historic quarries on the protected properties less than a mile to the south indicating that bedrock is at, or just below, the surface in some locations. Depth to bedrock is difficult to predict in till-based locations. However, it is notable that the study area is *not* mapped as thick till as it is just three miles to the north on Pigeon Hill and northwest of Morgan Hill. The depth to bedrock will be a critical facto if well and septic will serve the structures.

Through artistic shading, the image below attempts to show the three dimensions of the landscape on the two dimensional piece of paper (or monitor). This view is from the north looking south over the Oswegatchie Hill study area, and beyond. Though there is some vertical exaggeration depicted, the slopiness of the landscape, and the construction challenges that will follow as a result, are readily apparent.

(Note the valley cut by Clark Pond Brook beginning at the upside down “W” in the upside down “Oswegatchie” and continuing downslope to the small blue Clark Pond.)



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The Natural Diversity Data Base

The Natural Diversity Data Base maps and files regarding the Oswegatchie Hills project area have been reviewed. According to our information there are records of State Special Concern *Caprimulgus vociferous* (whip-poor-will) in the general area of Oswegatchie Hills.

Whip-poor-wills favor open mixed hardwood forest, often second-growth or sapling stage areas. They are ground-nesting birds that are only found in Connecticut during the breeding season (late May through July) and spend the winter in South America.

If timber harvesting is an activity considered for these parcels, whip-poor-wills may ultimately benefit from earlier forest growth stages. Any forestry operation should be conducted outside of the breeding season so that the potential for destruction of nests, eggs or young is reduced.

This section of the Wildlife Division has not made an on-site inspection of the project area. Consultation with this office should not be substituted for site-specific surveys that may be required for environmental assessments. This is a preliminary site review and is not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to the DEP for the proposed site. Please be advised that should state permits be required or should state involvement occur in some other fashion, specific restrictions or conditions relating to the species discussed above may apply. In this situation, additional evaluation of the proposal by the DEP Wildlife Division should be requested and species-specific surveys may be required.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Natural Resources Center's Geological and Natural History Survey and cooperating units of DEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for

on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Also be advised that this is a preliminary review and not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to DEP for the proposed site.

Wildlife Resources

Site inspections were conducted on August 23 and October 4, 2006 to evaluate existing wildlife habitat on the property. The entire area encompasses approximately 700 acres in Oswegatchie Hills in East Lyme, bordered by residential neighborhoods to the west and south, and by the Niantic River to the east. There are 13 parcels under various ownerships. The inspections and review include parcels 5, 6, 7, 10, and 11 (approximately 320 acres). Applications for zoning changes to allow for affordable housing have been submitted for parcels 1, 2, and 3 (230 acres). Approximately 345 acres are owned by the town of East Lyme or the East Lyme Land Conservation Trust. The site is hilly, with abundant boulders, outcrops and ledges. Wetlands include ponds and intermittent streams and there is an old quarry within the area.

Existing Wildlife Habitats

The 320 acres reviewed contain mature hardwood forest including black oak, red oak, chestnut oak, red maple, and black birch. The understory is dominated by dense mountain laurel and includes typical ledge species such as highbush blueberry, lowbush blueberry, and Christmas fern. These forested areas are valuable to wildlife, providing cover, food, nesting and roosting places and denning sites. Mast or acorns produced by oaks provides excellent forage for a wide variety of mammals and birds including white-tailed deer, gray squirrel, southern flying squirrel, eastern chipmunk, white-footed mouse, eastern wild turkey and blue jay. Trees, both living and dead, also serve as a home for a variety of insects, which, in turn, are eaten by many species of birds, including woodpeckers, warblers and nuthatches. Other wildlife species found in this habitat type include white-breasted nuthatch, American redstart, barred owl, broad-winged hawk, redback salamander and northern ringneck snake.

According to a DEP memo from Dawn McKay, Environmental Analyst/ Biologist, dated March 18, 2002, the state Special Concern species whip-poor-will has been reported in the vicinity. This species prefers scrubby woodlands, often in areas with dry soil and a somewhat open canopy, and may potentially be using this site. They may be associated with pitch pine areas, as found in and around the rocky balds (areas of exposed rock) of the Hills.

The area also contains wetlands including intermittent streams and pools within the forested area. Wildlife likely utilizing wetland habitat for food and cover are

raccoons, star-nosed moles, pickerel frogs, spring peepers and eastern garter snakes. According to Glenn Miller's (District Manager, Windham County Soil and Water Conservation District) Oswegatchie Hill Review, multiple vernal pools (small, temporary bodies of standing fresh water that are typically filled in spring and dry out most years) are found in the area. Pools such as these are critical to the survival of many reptilian and amphibian species, including gray tree frogs and spotted salamanders, which utilize vernal pools for breeding and spend the balance of their time in forested uplands.

Habitat Management Recommendations

The most important recommendation for managing this area is to limit its use to the types of recreation compatible with wildlife. Development into ball fields or other intense-use activities would diminish the value to wildlife.

There is some opportunity to manage the forested habitat to benefit wildlife. Forestry management techniques could be considered for the more level, lower elevation portions of this site. Creating a variety of age-classes within a forested area is often beneficial to a wide variety of wildlife species. The location of any vernal pools or other wetlands should be carefully considered when planning any cutting. Forestry management should only be undertaken under the advisement of a certified professional forester.

Habitat management should also include non-native invasive species control. Invasive species such as Japanese barberry can become the dominant vegetation in the understory, significantly reducing plant diversity. They displace native vegetation that provides high-quality forage, thereby diminishing the value of an area to wildlife. Invasive species control can be accomplished through manual pulling (although very labor intensive) or through the use of herbicides such as Roundup®.

The sections containing rocky balds and pitch pines should not be altered through management techniques. These pitch pine areas should be assessed for their potential to provide habitat for the state-listed whip-poor-will.

Summary

The Oswegatchie Hills provides high-value habitat for wildlife because of its size, the habitats of which it is comprised, and its proximity to the Niantic River.

Large, unfragmented parcels of mature forest containing multiple habitat types are increasingly rare in Connecticut, as development creates small, isolated patches of habitat in the landscape. For wildlife, large blocks of habitat are always better, as they can provide a greater variety of food (different types of acorns, catkins, and a variety of berries), more nesting and roosting sites, and areas for cover. Areas of more stunted, scrubby growth provide both food and cover for species that utilize shrubland habitat, such as cottontails, hognose snake, and eastern towhee. These species in turn provide prey for other species, such as red-tailed hawk, fox, and barred owl.

The importance to many reptiles and amphibians of maintaining vernal pools and their connection to surrounding uplands cannot be overstated; they simply cannot reproduce successfully without access to both. Examples of species that make use of vernal pools and surrounding uplands include wood frog and spotted salamander.

Proximity to the Niantic River contributes to the value of this area, providing a large area with multiple resources (food, cover, shelter) for species that may be using the river as a migratory route.

Continued stewardship of the already protected area will conserve the inherent wildlife values. Purchase or protection through conservation easement or other land protection tool would protect the value of the Hills by providing a buffer from development and would increase the value by greatly adding to its size.

Vegetation and Forest Management

Report not yet received.

Vegetation and Forest Management

Vegetation

The vegetation of the subject parcels is best divided into three categories based upon its position on the slopes. These categories are base, mid-slope and ridgetop and are the end result of soil moisture and soil depth conditions.

Mid-slope

The mid-slope vegetation is the most common forest cover over the entire subject area. The soils found within this area are relatively moist throughout much of the growing season and have sufficient depth to be well suited for tree growth.

The overstory is comprised of mixed hardwood species including Black oak, Scarlet oak, White oak, Chestnut oak, American beech, Aspen, Red maple, Hickory, and Tulip poplar. The overstory trees are poles (5"-11" in diameter at breast height (d.b.h.)) and sawtimber size (10"-12" d.b.h.). Black birch, Hickory, American beech, Sassafras, and Red maple saplings (2" - 4" d.b.h.) and poles form the understory. A shrub layer of Mountain Laurel varies in density from moderately dense to very dense. This layer is nearly continuous. Tree quality is medium on the lower portions of the slopes and decreases in quality as one progresses upslope and onto the ridgetops. Tree stocking[1] falls within the range of full stocking across the non-harvested parcels but is variable across the properties. Harvested parcels of the subject area are at the low end of the fully stocked range and may be slightly understocked.

Desirable tree regeneration is nonexistent over much of this area due to the dense shading by the Mountain Laurel and continual browsing by deer.

Ridgetop

Included within the subject area are shallow to bedrock and exposed ledge ridgetops. The thin soils found here are droughty and therefore are poorly suited for tree growth.
These ridgetops have an overstory of Pitch pine and Chestnut oak, a shrub layer of Shadbush (also commonly known as Serviceberry or Shadblow), Black huckleberry, and Lowbush blueberry, and a ground cover of Little bluestem (a native grass) patches, club mosses and ferns. The sapling and pole-sized overstory is short in height and understocked due to the droughty soil conditions. Tree quality is poor to very poor.

Pitch pine is considered a fire species as fire is largely responsible for maintaining this forest cover type by eliminating competing vegetation. Fire is also responsible for the

[1] Stocking – the amount of live trees on a given area in relation to what is considered optimum.

sprout origin, relatively slow growth, and poor form that characterize Pitch pine. Cones can remain closed for many years, opening only after the heat of a fire or the tree is cut.

Evidence of past fires, including several severe enough to be stand replacing fires, were noted during site inspections. Late spring and summer fires, when dry soil conditions exist, consume what little organic matter is present in the soil and can cause widespread tree mortality. Species such as Pitch pine which have the ability to sprout following a fire will then populate the site.

Base

Narrow riparian zones are found at the bases of the slopes throughout the subject area. These zones have the deepest soils of the subject area. Since the soils contain adequate moisture during much of the growing season, these soils are ideally suited for tree growth.

Riparian zones within the drainages have an overstory of large pole and sawtimber-sized Tulip poplar, Red maple, Red oak, Black oak, Yellow birch, Aspen, Black birch, Black gum, American beech, and Sugar maple. The understory consists of sapling to pole-sized Red maple, Yellow birch, Black birch, Black gum, and Sugar maple. Tree stocking levels are within the range of full stocking in non-harvested parcels. Tree quality is medium to high. A light to moderately dense shrub layer of Mountain laurel and Witch hazel exists. Continuity of this shrub layer is variable but for the most part the layer is patchy and non-continuous. Skunk cabbage, Wood lily, ferns and other herbs form the ground cover.

Vernal pools are scattered through much of the subject area. The vegetation in and around these pools is quite variable. Red maple, Chestnut oak, and Black gum are common overstory and understory trees. Highbush blueberry, Spicebush, Sweet pepperbush, and Witch hazel are the most commonly noted shrubs.

Forest Management

Forest landowners may manage their property for a variety of objectives, including but not limited to: aesthetics, ecosystem enhancement, recreation, wildlife habitat, production of forest products for home use and/or income, fisheries habitat, watershed protection, and real estate investment.

A professional forester certified by the Connecticut Department of Environmental Protection should be consulted prior to undertaking the harvesting of forest products or other forest management activities on these properties. The Connecticut Forest Practices Act requires that anyone who advertises, solicits, contracts, or engages in commercial forest practices within the state at any time must be certified in accordance with the law. Additional information concerning the Forest Practices Act (CGS Sec. 23-65f – o) and the Directory of Certified Forest Practitioners is available on-line at www.ct.gov/dep/forestry .

Landowners should strive to maintain a healthy diverse forest containing a variety of tree, shrub, and ground cover species of several age classes. Diverse forestlands are best able

to survive possible insect and disease outbreaks and also to survive significant weather events. With the narrow drainages and the subject properties proximity to the Niantic River and Long Island Sound, landowners should also strive to protect water quality. Best Management Practices for water quality while harvesting forest products should be closely followed whenever forestry operations are undertaken on these properties. The newly published 2007 Connecticut Field Guide is available on the DEP website.

Access for management activities, property security and fire suppression is a critical need. Access to and through the various parcels by way of the old quarry and woods roads needs to be improved and maintained. Runoff from these roads can be a major source of stream and wetland degradation. Stabilization of the road surface and diversion of surface runoff into vegetated filter strips will do much to protect water quality.

Ultimately, the management of a forested property is based on an individual owner's personal objectives and needs. These objectives and needs may evolve over time as the landowner's personal situation changes. Management of the individual properties, if desired, would begin with landowner and a forester defining the landowner's management objectives and needs. The forester would then conduct an inventory and develop a long-term forest management (stewardship) plan based upon the defined objectives. The plan can be modified as necessary if the landowner's objectives evolve and/or conditions in the forest change.

Hazard Trees

A hazard tree survey should be conducted around all public access areas and trails. A hazard tree is a tree with structural defects likely to cause failure of all or part of the tree, which could strike a target. A target is a vehicle, building or other improvement, or a place where people gather. These surveys should be completed at least annually and after each significant storm/wind event. All trees determined to be hazardous should be removed if any potential target/risk cannot be moved. Trails can be relocated if needed and practical.

Fisheries Resources

The reviewer for this section is a Fisheries Biologist with the Inland Fisheries Division, Habitat Conservation and Enhancement program (HCE). The HCE program provides technical advice to various offices within the Department of Environmental Protection, the Federal Government, local officials and the public regarding the conservation of fish habitat in waters ranging from the estuarine waters of Long Island Sound to the freshwaters of the state.

This Team member participated with the ERT to identify fisheries resources in the vicinity of the Oswegatchie Hills and management issues that can be addressed by local jurisdictions. He attended the site walks on August 23, 2006 and October 4, 2006, and the boat trip on the Niantic River on October 4, 2006.

Of the 700 acres comprising the Hills, the town has acquired 345 acres. Most of this land has been designated as a nature preserve and only passive recreation is allowed. Of particular interest to the town are 230 privately owned acres that are the subject of applications for a zoning change to allow affordable housing development. The town aspires to permanently protect the 230 acres, as well as a portion of the remaining 128 acres that is in private ownership[1]. The town plans to use the ERT report to help support the following: (1) develop a comprehensive management plan for preserved land, (2) develop educational materials for public access trails, (3) develop land use guidelines for potential development on unprotected land, and (4) apply for state and federal grants to preserve remaining unprotected land.

Please note that the *Niantic River Watershed Protection Plan: Watershed-wide Strategies to Prevent Nonpoint Source Pollution* (CTDEP 2006) is now available to Town of East Lyme staff and residents (hereafter referred to as the Watershed Protection Plan or The Plan). The Plan was developed in cooperation with the towns in the Niantic River/Latimer Brook watershed. It provides the essential information the Town of East Lyme needs to understand fisheries and fish habitat in Latimer Brook and the Niantic River and the measures needed to protect fish habitat. The information I have presented here is meant to

[1] Acreage was provided in materials handed out at the August 23rd meeting. The three categories total 703 acres, a slight difference from the reported total of 700 acres.

supplement The Plan and further emphasize the value of Latimer Brook and the Niantic River.

Fish Habitat and Fish Populations in the Vicinity of Oswegatchie Hills

Within the Hills, Clark Pond is the only waterbody that supports fish. An intermittent stream flowing into and out of the pond may be used by fish during periods of high rainfall and snowmelt. The Niantic River and Latimer Brook are two significant waterbodies bordering the Hills, and so can be affected by activities in the Hills. Taken together, these three waterbodies contain a variety of fish habitats, ranging from freshwater to estuarine, that support many species of fish.

Clark Pond

Clark Pond is a relatively shallow pond of approximately seven acres. At the time of the August 23 site walk, the pond appeared to be 100% vegetated with a variety of submerged, emergent and floating plants. Floating plants, such as water lilies, covered approximately 75% of the surface. The largest area of open water is at the southern end where there is a small earthen and concrete dam. Bathymetry data was not available, but based on the aquatic plant community it appears that depths are typically no more than two or three feet, and possibly up to five feet at the southern end near a small earthen and concrete dam.

It appears the pond is fed primarily by surface runoff and an intermittent stream that flows into the northern end of the pond. It is unknown if any groundwater springs feed the pond; however, the extensive vegetation cover and lack of flow out of the pond in summer indicates that significant groundwater upwelling is unlikely. Water flows out of Clark Pond primarily over the concrete portion of the dam, which is about three feet high. No water was flowing out of the pond at the time of the August 23rd site visit.

Fish community sampling data is not available for Clark Pond. Since the pond and most of the associated watershed are within the nature preserve and not subject to land development, it was decided not to conduct the sampling needed to determine the resident fish community. However, this type of pond – shallow, dominated by aquatic plants, highly organic bottom sediments, stagnant, and warm in summer – is common in Connecticut and the list of species inhabiting

the pond probably includes some or all of the following species: pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), and largemouth bass (*Micropterus salmoides*)[2].

During the August site walk a member of the town delegation mentioned that Clark Pond and the intermittent stream discharging into the northern end of the pond supports a brook trout population. It is believed the fish descended to Clark Pond before flows ceased, and returned to the stream when it was flowing again.

Since the brook trout, *Salvelinus fontinalis,* is our only native species of trout, the Inland Fisheries Division is very interested in documenting self-sustaining wild populations, particularly those that may be isolated and did not originate from stocking. Staff from the Inland Fisheries Division's Diadromous Fisheries Program volunteered to help me sample the intermittent stream. Sampling was scheduled for the fall when the fish should be ascending the stream to spawn.

Once I confirmed water was flowing in the stream for a period of time, we sampled the stream on October 24 with a backpack electroshocker (this device delivers enough current to stun fish so they can be captured but does not kill or injure the fish). The water temperature was 54 degrees Fahrenheit. Two 150-foot sections were sampled; the first sample was conducted in the relatively flat area near Clark Pond where the bottom ranged from mud to sand and the second sample was conducted just upstream where there is a gradient and the stream flows over rocks and tree roots. No brook trout were observed. The only fish observed was a small bluegill in the lower section near the pond.

Although this was only one sampling event, when coupled with the habitat characteristics it is our best professional judgment that a brook trout population does not exist. The stream and pond do not contain suitable spawning habitat (beds of gravel sized rocks and larger cobbles). Brook trout prefer cool waters ranging from 54 to 63 degrees Fahrenheit, with lethal temperatures starting around 79 degrees (Jacobs and O'Donnell 2002). Given that temperatures in the pond likely exceed 79 degrees in the summer, and the likelihood that no

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[2] It would be interesting to determine if banded sunfish (*Enneacanthus obesus*), which is listed by the State of Connecticut as a Species of Special Concern, occurs in the pond. The species is relatively rare, occurring in only one percent of Connecticut's lakes and ponds (Jacobs and O'Donnell 2002). The species is found primarily in coastal freshwater ponds in the eastern part of the state, and has been found in habitat similar to that of Clark Pond.

significant upwelling of cool groundwater occurs in the pond, the fish would not have a cool-water refuge when the stream is dry. There also appears to be significant impediments to fish movement up the stream (e.g. debris jams amongst the rocks and tree roots).

It is unknown if any diadromous species (i.e. species that spend part of their lives in both fresh and salt waters) utilize Clark Pond. There is a connection with the Niantic River by way of the small stream that flows out of the pond to Smith Cove approximately 0.5 miles away. However, diadromous fishes migrating between the pond and the Niantic River face three obstacles (1) the stream flowing out of the pond is intermittent and so periods of adequate flows must coincide with migratory periods, (2) a portion of the stream has a relatively steep slope, and (3) the dam. Of the various diadromous species, the American eel (*Anguilla rostrata*) is probably the only species that could ascend the steep portion of the stream, providing there was water flowing during the right periods, and small juveniles might be able to ascend the concrete dam.

Latimer Brook

Latimer Brook originates in Salem and flows south to the head of the Niantic River at Golden Spur. A thorough description of the stream and watershed and a brief description of recreational fisheries can be found in the Watershed Protection Plan. The information here is meant to provide additional details about the fish assemblage in the stream and the efforts of the Inland Fisheries Division to restore and enhance fish populations and fishing opportunities.

Latimer Brook contains diverse fish habitat ranging from areas with slow currents and silty bottom to fast flowing water with riffle habitat. Accordingly, there is a diverse assemblage of fish species. Sampling conducted by the DEP Inland Fisheries Division in 1993 and from 2000 to 2002 observed the following species in reaches north of Latimer Brook Pond Dam: American eel, black crappie (*Pomoxis nigromaculatus*), blacknose dace (*Rhinichthys atratulus*), bluegill, bridle shiner (*Notropis bifrenatus*), brook trout (wild and stocked), brown bullhead, brown trout (*Salmo trutta*, wild and stocked), chain pickerel, creek chubsucker (*Erimyzon oblongus*), golden shiner (*Notemigonus crysoleucas*), largemouth bass, longnose dace (*Rhinichthys cataractae*), pumpkinseed, rainbow trout (*Oncorchynchus mykiss*), tessellated darter (*Etheostoma olmstedi*), white sucker (*Catostomus commersoni*), and yellow perch. Some of the same species were observed between the dam and head of tide, particularly American eel, brown trout and brook trout, as well as some additional species typical of brackish

waters: Atlantic tomcod (*Microgadus tomcod*), banded killifish (*Fundulus diaphanous*), fourspine stickleback (*Apeltes quadracus*), mummichog (*Fundulus heteroclitus*), ninespine stickleback (*Pungitius pungitius*) and white perch (*Morone americana*).

Two diadromous species are known to occur in Latimer Brook: alewife (*Alosa pseudoharengus*), which is anadromous (i.e. returns to freshwater to spawn), and American eel, which is catadromous (i.e. spawn and spend part of their life history in saltwater and return to freshwater to grow to sexual maturity). Individual brown trout that have become anadromous – called sea-run brown trout – are known to use the stream but the population demographics of sea-run brown trout are unknown and are currently being investigated. Also, it is possible that blueback herring (*Alosa aestivalis*), an anadromous species, occur in the stream, but their presence has not yet been confirmed (see discussion below).

Latimer Brook is a popular destination for anglers. Trout is the primary species sought from spring through early fall. Also, in late fall and winter anglers fish for sea-run trout in the area below the old mill dam near the head of tide, as well as various locations around Golden Spur and up to Oil Mill Brook.

Because Latimer Brook has good water quality, excellent fish habitats, and is popular among anglers, the Inland Fisheries Division has included the stream in a number of programs designed to enhance fish populations and recreational fishing. There are three programs:

1) Latimer Brook is stocked every year with trout as part of the statewide stocking program designed to provide recreational fishing opportunities. In 2005 for example, 3,150 adult trout (2,850 brown trout and 300 rainbow trout) were stocked (DEP 2005).
2) In 1999 the Inland Fisheries Division revived an earlier program that sought to enhance sea-run brown trout populations in select coastal streams, including Latimer Brook. Sea-run brown trout typically live in saltwater from spring through early fall. Due to the abundance and diversity of prey species, they grow more quickly and achieve larger sizes than trout that remain in streams. In late fall sea-run trout return to freshwater to spawn. Similar to their freshwater counterparts, they excavate redds in rocky substrates such as gravel.

   The first sea-run brown trout program was conducted from the mid 1950's to the late 1970's (Hyatt et al 2000). Several domestic and wild sea-run

strains were stocked as juveniles in the lower reaches of coastal streams. Latimer Brook was added to the program not long after the State of Connecticut acquired Latimer Brook Pond Dam when Interstate I-95 was built. The dam was probably built in the early 1700's, and it eliminated any populations of anadromous species that may have migrated up the river to spawn. The State Board of Fish and Game built a fishway around the dam in early 1960's as part of the sea-run brown trout introduction program. The program had some success – some stocked trout did migrate to the Niantic River and Long Island Sound and returned to spawn in Latimer Brook. As a result, a small recreational fishery for sea-run trout developed in the Niantic River and Latimer Brook (Jones 1965 and 1966, cited in Hyatt et al 2000). However, the program was abandoned in the late 1970's because adequate numbers of fish returning to spawn could not be sustained.

Despite the end of the program, there were reports of anglers continuing to catch sea-run brown trout, and some anglers expressed an interest in re-starting the program. The Inland Fisheries Division began a new program in 1999. Various strains of trout are being evaluated for sea-run potential. As an example of stocking effort, in 2005 Latimer Brook was stocked with a Seeforellen strain of brown trout, with 6,500 fry, 4,000 parr and 910 yearlings stocked. Also, 400 tiger trout (a hybrid between brown trout and brook trout) yearlings were stocked in the Niantic River (Gephard et al 2005).

3) Restoration and enhancement of anadromous fish populations (other than sea-run brown trout) in Latimer Brook began in the late 1980's. Species other than sea-run brown trout could not ascend the fishway on Latimer Brook Pond Dam, so an aluminum steep pass fishway was installed in 1990. Alewife obtained from Bride Brook in East Lyme were stocked in Latimer Brook and a self-sustaining run was established by the year 2000.

The Inland Fisheries Division has continued to make improvements to the Latimer Brook Pond fishway. Major repairs to the remaining portions of the old fishway, additional modifications to improve passage and installation of a fish trap were completed in 2005. The fish trap, located at the top of the fishway, became operational in 2006. All fish ascending the fishway are retained, counted and released. This data enables staff to evaluate fish restoration and enhancement measures and monitor the trend in anadromous fish populations. In 2006, a total of 1,659 alewife were observed. A number of trout were observed,

but none of these fish were identified as sea-runs. In 2005 and 2006 staff observed a small number of herring after the alewife run was believed to be finished. It is possible these fish were blueback herring since they generally arrive after the alewife run; however the runs can overlap and the two species are very similar in appearance. A definitive identification of the fish was not attempted. Therefore, as of 2006 the status of blueback herring in Latimer Brook is still uncertain.

Niantic River up to Latimer Brook

A thorough discussion of the fish community in the Niantic River can be found in the Watershed Protection Plan. Much of the discussion about fish species was derived from the extensive and long-term environmental monitoring conducted by the Millstone Environmental Laboratory (MEL) at Millstone Nuclear Power Station. MEL staff observed 84 species in sampling programs conducted from 1976 to 2004. The Watershed Protection Plan provides considerable detail and some interesting interpretations of the MEL data. In light of this report, it is sufficient here to reiterate that the Niantic River provides diverse and important habitat for a variety of estuarine species and excellent recreational fishing opportunities, with winter flounder, tautog, striped bass, bluefish and hickory shad attracting the most effort. The river is also a migratory pathway and feeding area for both juveniles and adults of the diadromous species discussed above that migrate in and out of Latimer Brook.

Potential Impacts from Future Development

Due to the importance of Latimer Brook and the Niantic River to Connecticut's fisheries, any development in the Hills, as well as the rest off the watershed, should be carefully considered to ensure degradation of fish habitat is avoided. According to the information provided to the ERT, much of the Hills comprises moderate to steep slopes and thin soils. These characteristics make it difficult to avoid or minimize impacts to aquatic habitats.

The various types of potential impacts associated with development that could affect watercourses in the Niantic River watershed are well described in the Watershed Protection Plan. In addition, a report prepared by the Institute of Environmental Stewardship, LLC discusses these impacts as they relate to a specific proposal for development in the Hills (De Santo 2006). The following discussion is meant to supplement these reports and emphasize some of the most significant issues relevant to fisheries and fish habitat.

Stream Sedimentation

Development tends to increase the amount of sediment loading to streams, which can negatively impact watercourses that support fisheries resources. The two main sources are stormwater surface runoff and stormwater systems. The negative impacts of sediment runoff have been well documented by researchers. Sediment can reduce populations of aquatic insects and fish by eliminating physical habitat while suspended sediments can reduce dissolved oxygen levels (Cordone and Kelley 1961). Suspended sediments may prevent successful nest development of trout (Bell 1986). As reported by Meehan (1991), sediment deposition can severely impact spawning substrate abundance and quality. Reductions in egg survival are caused by smothering, insufficient oxygen supply and lack of proper removal of catabolic products (Bell 1986). Meehan (1991) indicated that erosion and sedimentation of instream habitat could alter channel morphology by increasing the stream width-depth ratio, incidence and severity of stream bank erosion, channel braiding, and reduce pool volume and frequency. Although modern stormwater systems can be effective in retaining sediment, it should be noted that the fine silts in stormwaters that remain in suspension for prolonged periods often cannot be effectively removed from engineered stormwater detention basins and/or roadway catch basins.

Effects of Toxics on Aquatic Communities

Stormwater systems and stormwater surface runoff transport a variety of toxics to the aquatic environment. Stormwater systems that outlet to wetlands, ponds and watercourses can contain a variety of pollutants that degrade downstream water quality to the detriment of aquatic organisms (Klein 1979). Pollutants commonly found in stormwaters include hydrocarbons (gasoline and oil), herbicides, heavy metals, road salt, fine silts, and coarse sediment. Phosphorous and nitrogen in stormwater runoff fertilize stream waters and can cause water quality degradation (discussed below). Accidental spills of petroleum based chemicals or other toxicants can cause fish kills if the materials drain into streams.

Thermal Loading

Thermal loading, or increases in ambient water temperatures, is a serious concern with any development that results in the increase in the amount of

impervious surfaces. Impervious areas act as a heat collector, with heat being imparted to stormwaters as they pass over impervious surfaces. In addition, stormwater temperatures can be elevated from solar radiation as they as collected and stored in detention basins that may be constructed as part of any development. Removal of trees along stream banks eliminate shading and result in elevated water temperatures. Surface water temperatures of downstream areas of streams are greatly influenced by temperatures of upstream headwaters.

Effects of Nutrient Enrichment

Nutrient enrichment can result in significant impairment of water quality conditions necessary to support diverse fish communities and cause major ecological shifts in aquatic environments. Typical symptoms of nutrient enrichment are loss of eelgrass, phytoplankton blooms, increased production of certain species of macroalgae and low dissolved oxygen in bottom waters. Nutrients can come from a variety of sources, including septic systems, stormwater systems and stormwater surface runoff. Additional development in watershed will likely increase the amount of nutrients entering the Niantic River.

There have been indications that nitrogen enrichment may be occurring in the Niantic River, with significant consequences for fisheries resources and habitat. As discussed in the Watershed Protection Plan, there has been a general decline in eelgrass abundance and distribution within the Niantic River since the 1980's. This is notable because eelgrass typically thrives in low nutrient environments, and when nutrient levels increase it is out-competed for light and space by various species of algae (refer to the Watershed Protection Plan for more details). The decline of eelgrass is of concern to fisheries biologists since eelgrass meadows perform a number of ecological functions, including serving as fish habitat.

On July 28, 2003 DEP staff responded to a report of a fish kill in the upper Niantic River in the vicinity of Golden Spur. Staff observed "hundreds of thousands" of dead grass shrimp, and smaller numbers of fish and crustaceans including American eel, winter flounder, cunner, blackfish, pipefish, blue crab, and mantis shrimp. American eels and blue crabs were observed close to the waters edge, apparently trying to find adequate oxygen. There was evidence of a pronounced algal bloom in much of the upper river and there were significant

quantities of rotting seaweed (probably *Ulva lactuca*, or sea lettuce) along the shoreline paralleling Oswegatchie Road[3].

Water samples were examined by staff of the DEP Planning and Standards Division to determine what phytoplankton species were present. There were more dinoflagellates than diatoms in the sample and so staff concluded there had been a bloom of dinoflagellates.

On July 29, 2003 MEL staff measured dissolved oxygen concentrations in the upper river and recorded a low of 1.3 mg/l in the vicinity of Golden Spur. On August 11, 2003 UCONN researchers recorded anoxic (i.e. zero oxygen) in bottom water[4].

Based on this information, it is clear that the fish kill was due to low dissolved oxygen, which in turn was partly the result of large blooms of phytoplankton and macroalgae. The decay of these plants consumes oxygen. High levels of nitrogen often cause such blooms of algae in marine waters.

The Marine Fisheries Division does not have any other reports or knowledge of fish kills involving as wide variety of species as was observed during the July 28th, event and the magnitude of the blooms of phytoplankton and macroalgae also appears to have been unusual. Fish kills have been observed in this area in the past (personal communications with Dave Simpson, Supervising Fisheries Biologist, Marine Fisheries Division and Paul Whitehouse, East Lyme resident), but typically involved one species, such as menhaden. Fish kills involving a single species are not unusual and are most often caused by natural events.

Although the decline of eelgrass and the severe fish kill in 2003 could be indicative of nitrogen enrichment, it would be premature to conclude that nitrogen enrichment is the cause of these events. There are other factors that affect the growth of eelgrass, such as temperature and salinity. With regard to low dissolved oxygen levels, seasonally low dissolved oxygen probably occurs naturally in the upper Niantic River. The DEP provided a Long Island Sound Fund grant to the Coast and Harbor Institute at Woods Hole to study this issue in several locations, including the Niantic River. In 2001, the researchers reported hypoxic conditions (i.e. less than 3.0 mg/l) in the upper Niantic River in

[3] Niantic River fish kill report, CT DEP Marine Fisheries Division, Marine Headquarters, Old Lyme.
[4] The MEL sent staff to investigate after discussing the fish kill with DEP. Jim Kremer's research team acquired the August sample at the request of Ron Rozsa, Supervising Analyst with DEP OLISP. The oxygen data is included in the Marine Fisheries Division's fish kill report.

September (Gaines and Pratt 2003). They did not find any evidence that the low dissolved oxygen levels they measured were a result of nutrient enrichment, and concluded the right conditions exist for low dissolved oxygen to occur naturally in the upper river. And while the 2003 fish kill and algal blooms appears to be an unusual event that was more severe than what evidently occurs naturally, there have not been any additional reports of serious algal blooms or fish kills since the 2003 event.

The question of whether there is excessive nitrogen loading to the Niantic River is currently being studied. These studies, which are described in the Watershed Protection Plan, have a number of objectives, including describing and quantifying the total nitrogen load to the Niantic River and understanding the role of nitrogen in the river's ecology. In addition, the DEP Bureau of Water Protection and Land Reuse, (DEP BWP) in partnership with the U.S. Geological Survey (USGS) and through a grant with the University of Connecticut, proposes to use this information to determine if nitrogen is affecting eelgrass vitality in Connecticut's embayments and, if so, what level of nitrogen loading should not be exceeded. If warranted, the DEP BWP will further investigate the possibility of setting nutrient-based water quality criteria and strategies for controlling nitrogen such as a total maximum daily load approach.

Recommendations

1) The best course of action to protect fisheries and fish habitat in Latimer Brook and the Niantic River would be to acquire the remaining undeveloped portions of the Hills for the purposes of preservation and passive recreation.
2) If the Hills cannot be preserved, it would be prudent for the parties involved to postpone decisions on developing the Oswegatchie Hills until it has been determined if nutrient enrichment of the Niantic River is occurring and if nutrient loading should be held to particular levels. The effects of development on fish habitat in the Niantic River could then be better understood and the right course of action determined.
3) If development of the Oswegatchie Hills proceeds, then all the measures outlined in the Watershed Protection Plan should be incorporated. These include an effective sediment control plan[5], a state of the art stormwater system that treats stormwaters as best as possible and minimizes thermal

[5] Town officials and developers are encouraged to consult the 2002 Connecticut Guidelines for Soil and Sediment Control, DEP Bulletin 34.

loading[6], proper design and location of septic systems, and adoption of measures to minimize the use of fertilizers.

4) The Inland Fisheries Division highly recommends that an undisturbed riparian buffer zone be maintained along the Latimer Brook, the Niantic River and tributaries. The CT DEP Inland Fisheries Division recommends a minimum 100-foot wide riparian buffer zone along perennial streams and a 50-foot wide buffer along intermittent streams. A copy of the Inland Fisheries Division riparian zone policy can be found on the Long Island Sound Riparian Toolbox website (http://www.hydroqual.com/projects/riparian/index.htm .

5) If future plans call for installing a bridge across Latimer Brook or the Niantic River, the bridge should be designed to avoid impacts to habitat and fish passage. In addition, measures should be adopted to ensure bridge construction does not interfere with anadromous fish spawning runs. Consultation with the Inland Fisheries Division is strongly advised (contact: Mark Johnson).

6) Clark Pond and the surrounding watershed are within property owned by the town and are well protected by the natural landscape; it is recommended this condition be maintained.

7) When the concrete dam on Clark Pond is replaced, it is recommended that the downstream face be roughened and have a moderate slope so as to facilitate American eel passage over the dam.

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[6] Town officials and developers are encouraged to consult the 2004 Connecticut Stormwater Quality Manual, available on-line at http://dep.state.ct.us

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Appendix

Landmark Development Group Riverview Heights V Overall Site Plan

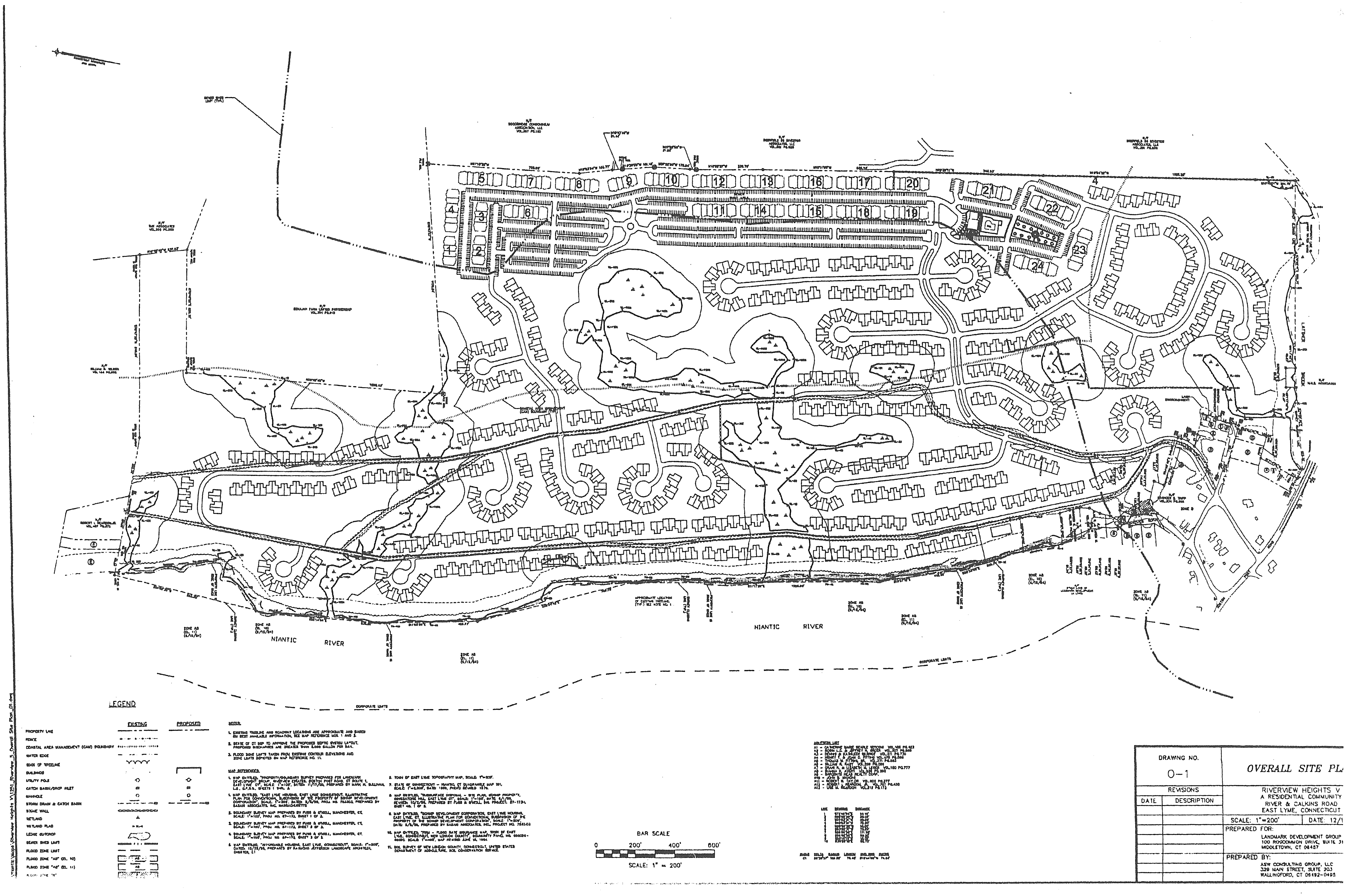
Management Plan for the Oswegatchie Hills Nature Preserve

Oswegatchie Hills Nature Preserve Trail Guide

Windham County SWCD Report 3/2002 Oswegatchie Hills

Impervious Surface Coverage: *The Emergence of a Key Environmental Indicator*

Niantic River Estuary Canoe/Kayak Trail


NIANTIC RIVER
NIANTIC RIVER
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BUILDINGS
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CATCH BASIN/DROP INLET
MANHOLE
STORM DRAIN & CATCH BASIN
STONE WALL
WETLAND
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LANDMARK DEVELOPMENT GROUP
100 ROSCOMMON DRIVE, SUITE 31
MIDDLETOWN, CT 06457
PREPARED BY:
ASW CONSULTING GROUP, LLC
329 MAIN STREET, SUITE 203
WALLINGFORD, CT 06492-0495
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MANAGEMENT PLAN FOR THE OSWEGATCHIE HILLS NATURE PRESERVE

I. DESCRIPTION OF THE PROPERTY

The Oswegatchie Hills, formed 200 million years ago, is a pristine, 700 acre rocky woodland about 2 1/2 miles long and 2000' – 3200' wide, that rises from a mile of shoreline on the East Lyme side of the Niantic River to 260' above sea level. The undeveloped portion of the Hills provide a critical habitat for a multitude of flora and fauna, including several endangered species. This undeveloped land protects the fragile ecosystem of the Niantic River, which is already on the CT Department of Environmental Protection's List of Impaired Water Bodies.

II. ACQUISITION OF THE PROPERTY

Acquisition of Oswegatchie Hills continues to be a high priority for the Town of East Lyme along with the help and assistance of our friends the East Lyme / Niantic Land Trust, Friends of the Oswegatchie Hills Nature Preserve, the Trust for Public Land, Save the River / Save the Hills, CT Department of Environmental Protection and the Federal Government. Our collective vision is to acquire all 700 acres of open space in Oswegatchie Hills. As each acquisition of land is realized, the plan of management of this precious resource will be governed by this Management Plan. The Nature Preserve will provide a protected haven for existing flora and fauna, controlled open space for the public to enjoy passive recreation and protection for the ecosystem of the tidal Niantic River.

III. ENVIRONMENTAL REVIEW TEAM

The Town of East Lyme has requested an Environmental Review Team (ERT) to recommend management strategies for preserving the watershed qualities of the property, and to examine the property's resources and open space access.

IV. MANAGEMENT PARTIES

The Primary Manager is the Town of East Lyme's Board of Selectmen with consultation from the CT Department of Environmental Protection. The Cooperator is the Oswegatchie Hills Nature Preserve Council consisting of the volunteer local environmental organizations, the Friends of the Oswegatchie Hills Nature Preserve and the East Lyme / Niantic Land Trust with assistance and support from the Town Departments such as the Parks and Recreation Commission and the Public Works Department.

The Oswegatchie Hills Nature Preserve Council shall rotate Chairmanship annually between the Friends of the Oswegatchie Hills Nature Preserve and the East Lyme / Niantic Land Trust. The Chairmanship shall start with the Friends of Oswegatchie Hills and alternate thereafter. The primary responsibility of the Council is coordination of the day to day operation and the maintenance of the Nature Preserve with assistance from volunteers and Town Departments.

V. STATEMENT OF GENERAL PURPOSE

As public property, the Nature Preserve is to be used for the benefit and enjoyment for the people of the State of CT and the general public.

In an attempt to allow optimum public use and access to the Nature Preserve, the uses and management practices of the Nature Preserve will be those which will not compromise the natural, historical, aesthetic, watershed or biological significance of the property.

VI. PROPOSED USES AND PROHIBITED USES

These uses shall be in accordance with the applicable Conservation Agreement(s).

VII. PUBLIC ACCESS

The main access to the Nature Preserve from its south end is from the parking lot at the Veteran's Memorial Park where restrooms are located. Veteran's Memorial Park is located to the left off Route 161 across from the Sunoco Gas Station and Convenience Store at the intersection of Oswegatchie Hills Road. A secondary access exists at the end of Damon Heights Road where it intersects Route 161 at Dunkin Donuts.

Other possible secondary accesses will be determined.

VIII. AMERICANS WITH DISABILITIES (ADA)

Recreational opportunities for handicapped individuals are currently to scenic views of the Nature Preserve. Given the varied and rough topography of the Nature Preserve, access and increased recreational opportunities for Americans with disabilities are limited. However, the Primary Manager and the Cooperator, will consider any opportunities for the handicapped in any future recreational enhancements or activities that may be proposed for the Nature Preserve.

IX. REGULATIONS

The Council will use the CT DEP's Regulations for State Parks and Recreation Areas as a guide during preparation of the Nature Preserve Regulations. The Town of East Lyme will enforce these Regulations.

X. HOURS OF OPERATION

The Nature Preserve will be open to the general public daily from 8 a.m. until sunset.

XI. SIGNAGE

The Council will post and maintain signs that will include information on trail locations, hours of operation, prohibited activities, designated parking, etc., using the CT DEP's Regulations for State Parks and Recreation Areas as a guide.

XII. MANAGEMENT RESPONSIBILITIES

Town of East Lyme through the Board of Selectmen with input from the CT DEP will enforce the following responsibilities as set forth below.

PRIMARY MANAGER: (The Town)

1. Establish policy and provide guidance to the Cooperator, the Council, as considered necessary or as requested.
2. Provide emergency police and fire services for the Nature Preserve.
3. Provide assistance, as requested by the Council, in the enforcement of regulations.
4. Provide technical assistance, as requested by the Council, in the management and stewardship of the Nature Preserve's natural resources.
5. Provide stewardship funding assistance if available, as requested by the Council, for management and maintenance activities. It is anticipated that most labor and material required for these activities will be provided by the Council at no cost.
6. All significant proposed improvements or major physical changes to the Nature Preserve must be approved in writing by the Primary Manager.
7. The Town of East Lyme Board of Selectmen will be the final arbitrator in situations where the members of the Council cannot agree.

THE COUNCIL: COOPERATOR: Friends of the Oswegatchie Hills Nature Preserve Inc. / East Lyme / Niantic Land Trust Inc.

1. Provide, install and maintain any necessary signage, fencing, boundary and trail markers, trail guides and site amenities.
2. Coordinate regular trail maintenance including trail upkeep, debris-removal and trail modifications / expansion with the help of other volunteer groups. The Primary Manager will be notified of new trail locations and modifications prior to enactment.
3. Patrol the Nature Preserve as necessary and take action to resolve any abuse or safety concerns keeping the Primary Manager informed.
4. Coordinate annual walks of the Nature Preserve to monitor for encroachments, compliance with applicable Conservation Agreements and to identify potential management issues.
5. The Council will not provide emergency police or fire services to the Nature Preserve.
6. Prepare and submit an Annual Report by June 30th of every year to the Board and the Deputy Commissioner of Conservation and Preservation. The Report shall include an overview of the Cooperator's activities at the Nature Preserve as they relate to the management duties and responsibilities pursuant to the Management Plan.

XIII. PRIMARY MANAGER

Town of East Lyme
P.O. Box 519
Niantic, CT 06357

THE COOPERATORS

Friends of the Oswegatchie Hills Nature Preserve

East Lyme / Niantic Land Trust

860-739-6931 x 110
Primary – Bd. Of Selectmen

This Management Plan has been reviewed and approved:

_____

Gina McCarthy, Commissioner DEP
State of CT

Welcome!

This is a "Carry In – Carry Out area", which simply means please leave the area as you found it. Leave nothing behind, except your tracks, and take out only your enjoyment and photographs. Future generations of people and animals thank you. There is no admission fee.

As you will soon see, this Nature Preserve is ideally suited for a wide variety of passive recreational pursuits. With Clark's Pond, approximately 350 acres of varied terrain and the nearby Niantic River, this is a truly unique and beautiful place. The opportunity for bird and wildlife observation and photography are abundant from the many miles of trails running throughout.

Only Passive Recreation is allowed in The Hills. No motorized vehicles, hunting or fires.

Warning: Please be careful. There are steep sections and cliffs in The Hills. You are responsible for your own safety.

Oswegatchie Hills Nature Preserve Trail Guide

Draft 10/24/05

Trail Descriptions and Points of Interest

Near the main entrance at Veterans Memorial Field, the southern section of the Preserve features Clark Pond with its many birds and animals. This is an excellent spot for bird watching and biologic studies. The trails in this area are mostly easy and suited for a pleasant stroll. A side trail leads to a good elevated vista of Clark Pond after the leaves fall. ① ✸

The middle section of the Hills is more challenging, with steeper trails featuring rocky ridges. Glaciers dug out these ravines such that they extend from the north to the south, just like the Niantic River. The eastern and western legs of the trail loop are elevated ridges running north and south, with a stream in between. The trail sections that transect the ridges east to west are challenging climbs and descents. This area really shows off the Hill's glacial history and is highlighted by some spectacular vistas. ②

Many "glacial erratic boulders" can be found in Oswegatchie Hills. These are simply rocks deposited in new locations by long-ago glaciers. West of the stream is a bald ledge section, which some say is reminiscent of a lunar landscape and includes a beautiful view ③ over the treetops in the ravine below.

Near the high point of the Nature Preserve, Mount Tabor (260 feet), are two quarries ④ that were worked in the 1800s. Teams of oxen or horses dragged granite down Quarry Dock Road to barges, where it would be hauled to such destinations as the foundation of Grand Central Station.

✸ See trail map on back for the numbered features.

OSWEGATCHIE HILLS NATURE PRESERVE

Windham County
Soil and Water Conservation District, Inc.

P.O. BOX 112, 139 WOLF DEN ROAD • BROOKLYN, CT 06234 • (860) 774-8397 / FAX (860) 779-0148

March 19, 2002

Meg Parulis
Planning Director
Town of East Lyme
P.O. Box 519
Niantic, CT 06357

Dear Ms. Parulis:

SUBJECT: Oswegatchie Hills

This letter covers a site review report I'm submitting on Oswegatchie Hill. The accompanying report addresses many of the more prominent features on the hill that turned up during my site visit and my comments about them. I'm including some additional remarks in this letter apart from observations in the report.

Concerning erosion and sedimentation control, unless there is in some way a waiver for affordable housing, I'm presuming this project would need to comply with the National Pollution Discharge Elimination System (NPDES) requirements administered through Connecticut's Department of Environmental Protection Bureau of Water Management—involving a permit, a Notice of Intent (NOI), a Storm Water Pollution Prevention Plan (SWPPP), and a Notice of Termination (NOT). Should the project move forward, compliance with this rule is meant to ensure that an appropriate set of erosion and sedimentation control measures are planned and in place. Chris Stone at Connecticut Department of Environmental Protection's Bureau of Water Management, 860-424-3850, is the contact person for more information about these requirements.

If you need or want more background on any of these resource issues please contact me.

Sincerely,

D. Glenn Miller
District Manager

Attachment/Enclosure – Report

Oswegatchie Hill Review
East Lyme, Connecticut
D. Glenn Miller
District Manager
Windham County
Soil and Water
Conservation District
March 19, 2002
Field Visit: March 6, 2002

INTRODUCTION

Oswegatchie Hill is a prominent north-south oriented feature composed of various formations of gneiss bedrock. Soils are mostly shallow and vegetation is typical of other ledgy woodland in the region. Tree cover here includes a significant complement of chestnut oak, *Quercus prinus;* mountain laurel, *Kalmia latifolia,* is ubiquitous in the understory, forming dense thickets in many places. Although not actively surveyed as part of this review, other species noted in dry upland areas include (in no particular order): white oak, *Q. alba;* scarlet oak, Q. coccinea; American beech, Fagus grandifolia; and sassafras, *Sassafras albidum.* (This is not a comprehensive list.)

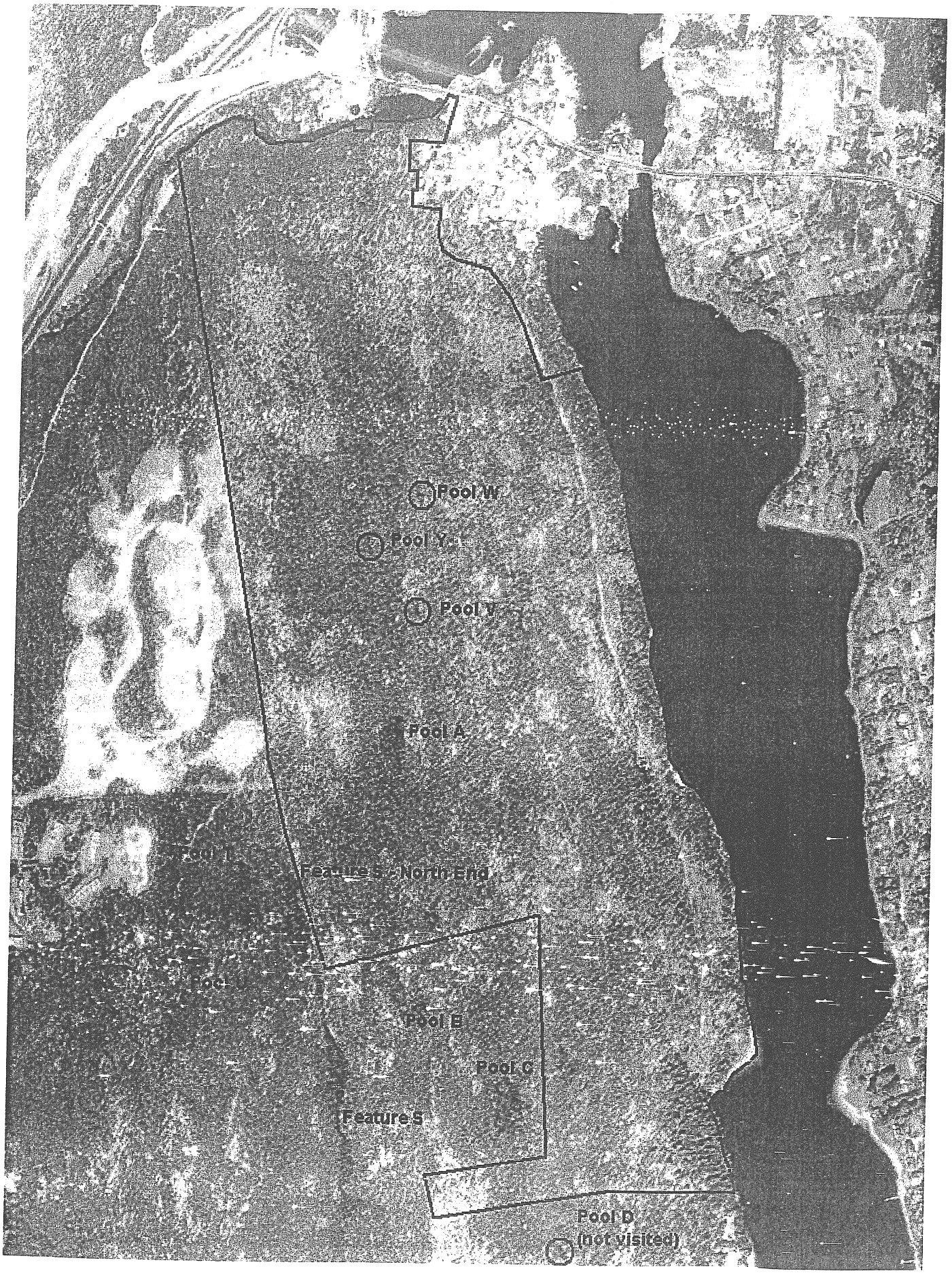
Among the most significant features on Oswegatchie Hill is a constellation of isolated woodland pools. Most or all of these are likely hosts to a suite of organisms typical of these habitats, including: wood frogs, *Rana sylvatica (confirmed during site visit);* spotted salamanders, *Ambystoma maculatum* (likely immigrants to the pools during a relatively warm rain event in the early morning hours of March 10, 2002); marbled salamanders, *Ambystoma opacum;* and a variety of invertebrates, including the vernal pool fairy shrimp, *Eubranchipus vernalis.*

Tupelo, *Nyssa sylvatica,* is notable in that it is a hallmark tree species for pools like these and is present in or near most or all pools in this review.

Red maple, *Acer rubrum,* and highbush blueberry, *Vaccinium corymbosum,* are prevalent at these isolated wetlands, and sweet pepperbush, *Clethra alnifolia,* is well represented in and around some pools. (Again, this is not a comprehensive list.)

This review began with an inspection of aerial photographs, a step that revealed an array of pools (some 25+/- possible features for the hill overall) and led to assigned letter designations along the system of ledges on Oswegatchie Hill. Since some of these labeled pool features fall outside the current review area, labels for those included here are not sequential (please see aerial photograph for approximate locations).

(The aerial photograph below is from a circa 1991 digital orthophotograph quarter quadrangle. Source: Univ. of Conn. Map and Geographic Information Center. The scale is altered from its native 1:24,000 for this report and the parcel boundary is an approximation.)


Pool W
Pool Y
Pool V
Pool A
Feature S - North End
Pool B
Pool C
Feature S
Pool D
(not visited)

Following are descriptions of salient pools and other features within or near the review area in evidence during a site visit on March 6, 2002. This is anything but an exhaustive inventory.

QUALIFIERS PERTAINING TO ALL THE DESCRIPTIONS

The following statements should serve in lieu of repetitive qualifiers like 'about,' 'approximately,' or 'perhaps' for each entry below. Dimensions and direction (e.g., N-S = running north-south, ENE = running east-northeast) included in the descriptions are based on fairly crude visual estimates. This was necessary given time constraints for the review. For purposes of this review it was more prudent to pay a cursory visit to each prominent feature than to complete a more detailed assessment at any one. Dense thickets of mountain laurel, *K. latifolia*--though an integral and important functional component here--present a decided impediment to off-trail travel on the hill.

Water depths in the pools are perhaps less certain than other dimension estimates due to visual obstruction from vegetation, low observation angle, and glare. It is evident that many or most pools are at least a foot deep in their deepest sections, and several may by 2 to 2.5 feet or more, even under these relatively low water conditions. Since most or all pools are below their high water marks, horizontal dimensions at review time are less than maximum. These pools are underlain by bedrock.

POOL A

Pool A is 200 feet long N-S. The southern 2/3 of the pool is fairly densely vegetated with highbush blueberry, *Vaccinium corymbosum*. There is a low ledge shoreline (the vantage point for the photograph below) at the pool's ENE edge with some greenbriar, *Smilax* spp. near its base and some sedge, probably *Scirpus* spp. in portions of the more open water region of the pool at its more northerly end. (By virtue of this relatively clear, elevated ledge directly along one edge, with a sizable log providing a place to stand, pool A presents an exception to some of the visual limitations noted previously.) There is no obvious concentrated surface inlet or outlet from this pool. There is a breeding population of wood frogs, *R. sylvatica*, active during the field review on March 6, 2002.

POOL A Photo by Linda Dufresne

POOL B

Pool B is rounded and 100 feet in diameter. It is somewhat less crowded by low vegetation than other pools and the water level--though sufficient for mole salamander (e.g., spotted salamander and others) and wood frog breeding--is well below the high water mark. There is a set of ledges (12-15 feet high) with some pitch pine, *Pinus rigida*, on their tops just west of the pool, overlooking it.

POOL C

Pool C is 200 feet long N-S by 100 feet E-W. It is vegetated with many moss-covered island hummocks of red maple, *A. rubrum;* maleberry, *Lyonia ligustrina*, is present in addition to the vegetation listed in the INTRODUCTION above. There is an emergent sedge, probably *Scirpus* spp. in more open water sections at the north end of the pool. There is no obvious concentrated surface inlet or outlet from this pool. Wood frogs are present.

FEATURE S

Feature S is an elongate wetland in a bedrock cleft running N-S. At its head is a diminutive but significant pool isolated from the watercourse proper. From this point, feature S extends to the north within this cleft in the rocks some 1700-1800 feet and has its northern terminus in a cul-de-sac. (A 325 foot intervening section along feature S is a narrow woodland channel rather than the broader, shrub-pools to either end.) The cul-de-sac pool presents somewhat of a departure from others in that it appears to be vegetated with more of a variety of shrubs, including winterberry, *Ilex verticillata*, and an herbaceous emergent that appears to be swamp loosestrife, *Decodon verticillatus*. The drainage here exits through a channel leading to pool U and collects drainage from pool T on its way.

POOLS T & U

Heavy logging perhaps 2-3 years ago in the proximity of the northern portion of feature S and pools T and U (particularly around pool T) has altered conditions here fairly dramatically.

POOL V

Pool V is completely isolated surface-wise and is 80 feet N-S by 35 feet E-W. The pool is crowded with overhanging woody vegetation around its shore but its bed is essentially un-vegetated.

POOL W

Pool W is 140 feet N-S X 60 feet E-W.

POOL Y

Pool Y is an elongate feature 200 feet long X 20 feet wide (perhaps narrower in some reaches) running NNW-SSE. At its SE end is some surface spillage coming from where the pool widens to 35 feet before forming a surface streamlet. This streamlet undoubtedly drains the pool when levels are high and is trickling at the time of this site visit.

(Pools A, B, C, D, V, W, and Y are in the Niantic River subregional drainage basin whereas features S, T, and U are within the Pattagansett River subregional basin. The drainage divide between these two subregional basins more or less bisects Oswegatchie Hill N-S.)

OTHER FEATURES

SCARLET OAK W/ STICK NEST

Two tenths of a mile east of Pool B was a sizable stick nest in a scarlet oak, *Q. coccinea*. A hawk-sized bird flushed from this general area on approach but at too great a distance and through too many obscuring branches to be identified. Later, two hawks were soaring over the area of pool T; at least one of these was almost certainly a red-shouldered hawk, *Buteo lineatus*. Co-occurrence of the nest and the bird/birds is suggestive of red-shouldered hawks investigating a nest from last season in preparations for reuse, though it may be a bit early in the season. The red-shouldered hawk is currently on Connecticut's Natural Diversity Data Base list as a species of 'special concern.' (This list may be due for revision soon.)

Special Note: There is what appears to be an American chestnut tree, *Castanea dentata*, in the vicinity of pool T that may prove to be an exceptional specimen in terms of its stature and possible resistance to the chestnut blight fungus, *Cryphonectria parasitica*. This tree is some 70 feet tall and 10.5 inches dbh (diameter at breast height). Confirmation of its genetic integrity as an American chestnut may require testing by appropriate specialists; however, if this tree is indeed what it appears to be, its whereabouts and state of health could be of considerable significance. Additionally, its occurrence here leads to the question of whether there may be others of exceptional stature in and around these tracts. Heavy logging has occurred in very close proximity to the woodland area where this chestnut is growing.

General Comments

The term *vernal pool* is used extensively in popular and in more technical literature, but many wetlands of this ilk defy definitions and labels. One tenet of at least one vernal pool definition is that the pool's bed lacks standing water for at least part of the year. Despite this, there are permanent or semi-permanent pools with basins that may seldom dry but that are nonetheless isolated features with many or all the other characteristics of *vernal* pools.

There are a other criteria that are debated as much, but whatever the definition, a hallmark of pools such as these in our region is their use by a suite of amphibians that live in forested uplands, often far from the pool, except for brief but critical breeding periods during which they migrate to and rely heavily upon these isolated wetlands.

Notwithstanding debates over definitions, isolated pools represent a unique and emerging class of resources that figure prominently in land use decisions across our region.

# # #

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EDUCATION

THE UNIVERSITY OF CONNECTICUT, STORRS, CONNECTICUT

December 1981

Bachelor of Science Degree in Natural Resources Conservation.

A wide range of studies in the biological sciences and natural resources, including course-work in: botany; soil science; plant anatomy, physiology, and pathology; limnology; ecology; biogeography; wildlife; dendrology; and forestry.

Dean's List, December 1981

NON-INSTITUTIONAL SELF-EDUCATION

Ongoing

Eclectic background in Natural History/ Environmental Science through life experiences (please see Notable Areas of Interest/Proficiency below).

EMPLOYMENT

FREELANCE

January 1989--Present

Writer/Photographer. Write feature articles and columns on environmental science and natural history topics for major magazines, including *Boys' Life* and *American Forests* (published samples available on request).

WINDHAM COUNTY SOIL AND WATER CONSERVATION DISTRICT

May 1994--Present

District Manager. Responsible for the many and varied demands of an active and changing Conservation District serving eastern Connecticut. Prioritize and manage multiple projects and project components. Develop/write grant proposals, administer grants, plan, coordinate, and conduct workshops (including those on rapid bioassessment, vernal pools, and 'streamwalks'), produce project-related publications. Develop and maintain annual plan of work and annual budget. Coordinate activities, supervise, and train other district staff and volunteers. Serve on Eastern Connecticut Environmental Review Team—review and report on proposed development projects. Conduct site reviews for area towns upon request. Collaborate and cooperate with a range of government agency and NGO partners. Conduct educational programs, including CT 'Envirothon' workshops. Foster partnerships and work cooperatively with partners including those through the Thames River Basin Partnership Initiative. Use Microsoft Office (Word, Excel, Access, Power Point) and ESRI ArcView GIS software extensively for project applications. Troubleshoot computer problems and manage/maintain computers (hardware and software).

(Next page, please)

U.S. FOREST SERVICE, NORTHEASTERN INSECTS AND DISEASE LABORATORY, HAMDEN, CONNECTICUT

January 1992--April 1993

Biological Laboratory Technician—Microbiology. Performed laboratory and field procedures in forest decline research. In charge of processing soil cores from sugar maple and high-elevation spruce/fir stands and for isolating and identifying pathogenic fungi involved in beech bark disease. Supervised part-time laboratory aides. Maintained laboratory records for the research.

CITY OF NORWICH, CONNECTICUT
NORWICH BOARD OF EDUCATION

August 1984--April 1990

Environmentalist (Environmental Educator). Responsible for teaching a diverse K-8 outdoor and indoor environmental education curriculum, including classes in aquatic studies, birds, acid rain, soils, and glacial geology. Helped plan and conduct teachers' workshops. Scheduled all program details via computerized database. Developed and wrote curriculum as needed and prepared reports.

EASTERN CONNECTICUT STATE UNIVERSITY
WILLIMANTIC, CONNECTICUT

April 1983--August 1984

Laboratory Assistant (Manager). Management of Biological, Chemical, and Earth & Physical Sciences laboratories. Supervised student assistants in laboratory set-up, breakdown, and general operation. Worked with department heads, vendors, and purchasing department to order equipment and supplies within departmental budgets. Maintenance and preparation of laboratory equipment and supplies and set-ups for lecture demonstrations. In charge of hiring, training, and supervising student lab workers. Managed departmental records, inventory, and supply orders. Computerized department records.

NOTABLE AREAS OF INTEREST/PROFICIENCY

Herpetology: well versed in the natural history of southern New England's herpetofauna, particularly snakes. *Forestry*: (dendrology, silvics and silviculture, management implications/issues). *Ephemeral/Isolated Pools ('Vernal' pools)*: extensive field experience visiting, observing, and documenting isolated woodland pools. Other areas of interest/degrees of expertise include: *limnology* (including stream ecology), *botany* (in general), *ornithology*, *entomology*, *mycology*, *mammalogy* (tracking and behavior), *astronomy*.

# # #

Impervious Surface Coverage

The Emergence of a Key Environmental Indicator

Chester L. Arnold, Jr. and C. James Gibbons

Planners concerned with water resource protection in urbanizing areas must deal with the adverse impacts of polluted runoff. Impervious surface coverage is a quantifiable land-use indicator that correlates closely with these impacts. Once the role and distribution of impervious coverage are understood, a wide range of strategies to reduce impervious surfaces and their impacts on water resources can be applied to community planning, site-level planning and design, and land use regulation. These strategies complement many current trends in planning, zoning, and landscape design that go beyond water pollution concerns to address the quality of life in a community.

Arnold is a Water Quality Educator, and Gibbons a Natural Resource Planning Educator, at the University of Connecticut Cooperative Extension System. They are currently principals in the NEMO Project, which uses geographic information system technology to educate municipal land-use decision-makers about nonpoint source water pollution.

Journal of the American Planning Association, Vol. 62, No. 2, Spring 1996.

Impervious land cover has long been characteristic of urban areas, but has only recently emerged as an environmental indicator. Natural resource planning using impervious surface coverage as a framework can be a pragmatic and effective way of addressing a host of complex urban environmental issues, particularly those related to the health of water resources.

Water resource protection at the local level is getting more complicated, largely due to the recognition of nonpoint source pollution, or polluted runoff, as a major problem. This diffuse form of pollution, now the nation's leading threat to water quality (Environmental Protection Agency 1994), is derived from contaminants washed off the surface of the land by stormwater runoff, and carried either directly or indirectly into waterways or groundwater. As programs directed at nonpoint source control cascade down from federal to state to local governments, the technical complexities involved with such control are further complicated by regulatory and management considerations.

Stormwater runoff problems are nothing new to local land-use decision-makers. However, the principal concern about runoff has always been safety, with the focus on directing and draining water off of paved surfaces as quickly and efficiently as possible. Once off the road and out of sight, stormwater has been largely out of mind—downstream consequences be damned (or dammed). Regulations have been expanded in recent years to include consideration of flooding and erosion, yet these factors fall far short of a comprehensive and effective approach to mitigating the water quality impacts of development.

How do planners and other local officials get a handle on protecting their local water resources? While no magic bullet exists to simplify all the complexities involved, an indicator is emerging from the scientific literature that appears to have all the earmarks of a useful tool for local planners—the amount of impervious, or impenetrable, surface. This article reviews the scientific underpinning, usefulness, and practical appli-

cation of impervious surface coverage as an urban environmental indicator.

People, Pavement and Pollution

Impervious surfaces can be defined as any material that prevents the infiltration of water into the soil. While roads and rooftops are the most prevalent and easily identified types of impervious surface, other types include sidewalks, patios, bedrock outcrops, and compacted soil. As development alters the natural landscape, the percentage of the land covered by impervious surfaces increases.

Roofs and roads have been around for a long time, but the ubiquitous and impervious pavement we take for granted today is a relatively recent phenomenon. A nationwide road census showed that in 1904, 93 percent of the roads in America were unpaved (Southworth and Ben-Joseph 1995). This changed with the early twentieth century ascendancy of the automobile over the railways, capped by the mid-century massive construction of the interstate highway system, which served to both stimulate and facilitate the growth of suburbia. From that point on, imperviousness became synonymous with human presence—to the point that studies have shown that an areas's population density is correlated with its percentage of impervious cover (Stankowski 1972).

Impervious surfaces not only indicate urbanization, but also are major contributors to the environmental impacts of urbanization. As the natural landscape is paved over, a chain of events is initiated that typically ends in degraded water resources. This chain begins with alterations in the hydrologic cycle, the way that water is transported and stored.

These changes, depicted in figure 1, have long been understood by geologists and hydrologists. As

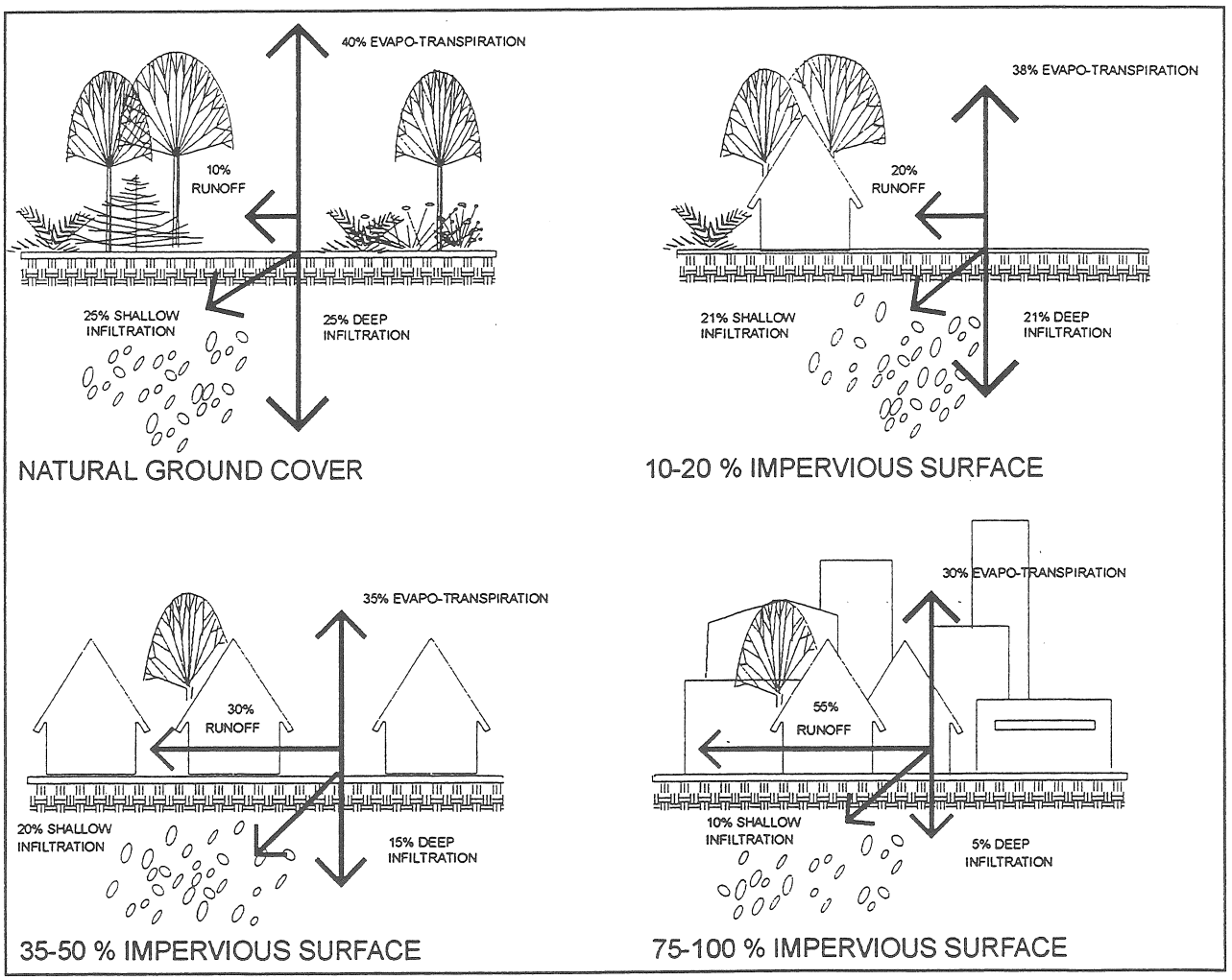

FIGURE 1. Water cycle changes associated with urbanization
Source: Environmental Protection Agency 1993a

impervious coverage increases, the velocity and volume of surface runoff increase, and there is a corresponding decrease in infiltration. The larger volume of runoff and the increased efficiency of water conveyance through pipes, gutters, and artificially straightened channels result in increased severity of flooding, with storm flows that are greater in volume and peak more rapidly than is the case in rural areas (Carter 1961; Anderson 1968; Leopold 1968; Tourbier and Westmacott 1981). The shift away from infiltration reduces groundwater recharge, lowering water tables. This both threatens water supplies and reduces the groundwater contribution to stream flow, which can result in intermittent or dry stream beds during low flow periods (Dunne and Leopold 1978; Harbor 1994).

Hydrologic disruption gives rise to physical and ecological impacts. Enhanced runoff causes increased erosion from construction sites, downstream areas and stream banks. The increased volume of water and sediment, combined with the "flashiness" of these peak discharges, result in wider and straighter stream channels (Arnold, Boison, and Patton 1982). Loss of tree cover leads to greater water temperature fluctuations, making the water warmer in the summer and colder in the winter (Galli 1991). There is substantial loss of both streamside (riparian) habitat through erosion, and in-stream habitat as the varied natural stream bed of pebbles, rock ledges, and deep pools is covered by a uniform blanket of eroded sand and silt (Schueler 1992). Engineered responses to flooding like stream diversion, channelization, damming, and piping further destroy stream beds and related habitats like ponds and wetlands. Finally, with more intensive land uses comes a corresponding increase in the generation of pollutants. Increased runoff serves to transport these pollutants directly into waterways, creating nonpoint source pollution, or polluted runoff.

Major categories of nonpoint source pollutants include pathogens (disease-causing microorganisms), nutrients, toxic contaminants, and debris. Pathogen contamination indicates possible health hazards, resulting in closed beaches and shellfish beds. Overabundance of nutrients such as nitrogen and phosphorous can threaten well water supplies, and in surface waters can lead to algal "blooms" that, upon decaying, rob the waters of life-sustaining oxygen. Toxic contaminants like heavy metals and pesticides pose threats to the health of aquatic organisms and their human consumers, and are often persistent in the environment. Debris, particularly plastic, can be hazardous to animal and human alike, and is an aesthetic concern. Sediment is also a major nonpoint source pollutant, both for its effects on aquatic ecology and because of the fact that many of the other pollutants tend to adhere to eroded soil particles (Environmental Protection Agency 1992, 1993a).

The results of polluted runoff are evident in every corner of the United States. According to the Environmental Protection Agency (1994), nonpoint source pollution is now the number one cause of water quality impairment in the United States, accounting for the pollution of about 40% of all waters surveyed across the nation. The effects of nonpoint source pollution on coastal waters and their living resources have been of particular concern (U.S. House of Representatives 1988; Environmental Protection Agency 1993a). Urban runoff alone ranks as the second most common source of water pollution for lakes and estuaries nationwide, and the third most common source for rivers (Environmental Protection Agency 1994).

As point source pollution is increasingly brought under control, the true impact of urban nonpoint source pollution is being recognized. For instance, even in an urbanized estuary like Long Island Sound, where the major environmental problems have been strongly linked to point source discharges from sewage treatment plants, an estimated 47% of the pathogen contamination is from urban runoff (Long Island Sound Study 1994).

Imperviousness as an Environmental Indicator

Planners wishing to protect their community's water resources against these threats may not know where to begin. The site-specific and diffuse nature of polluted runoff seems to demand extensive technical information on pollutant loadings, hydrologic modeling, and the effectiveness of various management practices. This information is difficult to acquire, not only because of the cost of such studies, but because nonpoint-source-related research and engineering are new and evolving fields.

Enter impervious surfaces. When doing community-level planning, or where detailed site information is unavailable, impervious coverage may often be the most feasible and cost-effective vehicle for addressing water pollution. Two major factors argue for its potential utility to the local planner.

First, imperviousness is integrative. As such, it can estimate or predict cumulative water resource impacts without regard to specific factors, helping to cut through much of the intimidating complexity surrounding nonpoint source pollution. Although impervious surfaces do not generate pollution, they: (1) are a critical contributor to the hydrologic changes that degrade waterways; (2) are a major component of the

intensive land uses that do generate pollution; (3) prevent natural pollutant processing in the soil by preventing percolation; and (4) serve as an efficient conveyance system transporting pollutants into the waterways. It is not surprising, then, that research from the past 15 years consistently shows a strong correlation between the imperviousness of a drainage basin and the health of its receiving stream (Klein 1979; Griffin 1980; Schueler 1987; Todd 1989; Schueler 1992; Booth and Reinfelt 1993; Schueler 1994a).

Figure 2 is a stylized graph of this general relationship, showing stream health decreasing with increasing impervious coverage of the watershed, or drainage basin, of the stream. The horizontal lines mark average threshold values of imperviousness at which degradation first occurs (10%), and at which degradation becomes so severe as to become almost unavoidable (30%). These thresholds serve to create three broad categories of stream health, which can be roughly characterized as "protected" (less than 10%), "impacted" (10%–30%), and "degraded" (over 30%).

Thresholds are always controversial and subject to change, yet it is important to note that to date, the threshold of initial degradation in particular seems to be remarkably consistent. The scientific literature includes studies evaluating stream health using many different criteria—pollutant loads, habitat quality, aquatic species diversity and abundance, and other factors. In a recent review of these studies, Schueler (1994a) concludes that "this research, conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion—stream degradation occurs at relatively low levels of imperviousness (10–20%)" (100). Recent studies also suggest that this threshold applies to wetlands health. Hicks (1995) found a well-defined inverse relationship between freshwater wetland habitat quality and impervious surface area, with wetlands suffering impairment once the imperviousness of their local drainage basin exceeded 10%. Impervious coverage, then, is both a reliable and integrative indicator of the impact of development on water resources.

The second factor in favor of the use of imperviousness is that it is measurable. This enhances its utility both in planning and regulatory applications. (Examples follow in a later section.) Depending on the size of the area being considered and the particular application being applied, a wide range of techniques—with a wide range of price tags—exists for the measurement of impervious coverage.

For site level applications, on-site measurement

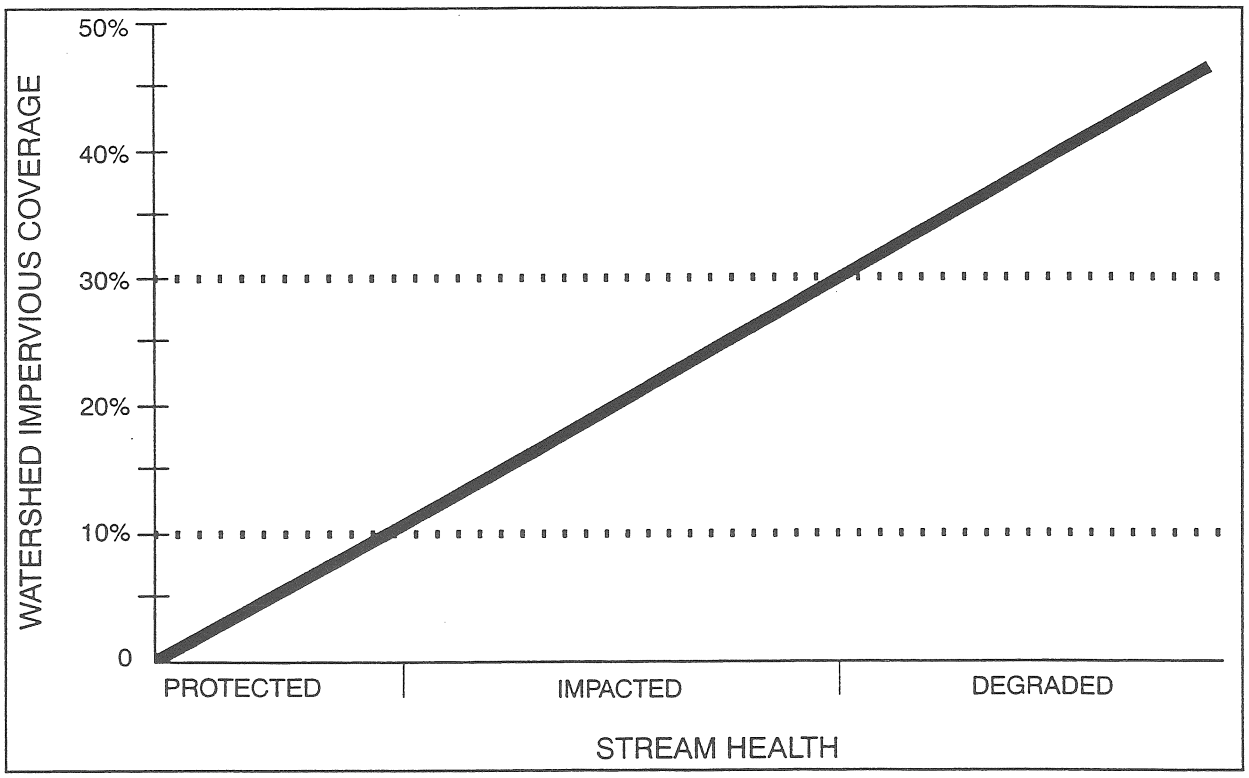

FIGURE 2. Stylized relationship of imperviousness to stream health
Modified from Schueler 1992

using surveying equipment (sometimes as basic as a tape measure) is the most accurate and appropriate method. On the neighborhood level, "windshield" surveys may be appropriate where it is less important to have exact numbers. For community- or regional-scale areas, land cover derived from aerial photographs provides perhaps the best compromise between accuracy and cost. Finally, for applications encompassing even larger areas, remotely-sensed satellite-based land cover can be a viable option. At present, impervious estimates based on satellite data must be calculated by applying literature values of imperviousness to satellite land cover categories. We are currently involved with a remote sensing research project at the University of Connecticut that is attempting to devise a method for directly estimating imperviousness from satellite images (Civco and Arnold 1994).

It is important to note that all of these methods of measurement are increasingly being digitized and presented in the form of computerized maps in a geographic information system, or GIS. This trend eventually will make the information easier to acquire, often at lower expense. Many communities have been unable to afford GIS, and others have been disillusioned at its cost and complexity once they invested in it. Evolution of the technology, however, is making GIS more accessible to local officials every day.

The Components of Imperviousness

To measure and use impervious coverage as a tool for protecting water resources, it is necessary to know how imperviousness is distributed about the landscape. On a scale of increasing refinement, impervious coverage can be broken down by land use, by function within each land use, and by its relative impact on runoff. Each of these pieces of the puzzle can help to target planning and/or regulatory approaches to reducing impervious coverage. As with measurement techniques, the extent to which planners need detailed information on these components depends on the particular application.

The percentage of land covered by impervious surfaces varies significantly with land use. The most frequently cited estimates come from a report by the Soil Conservation Service (1975) (figure 3). "Strip" type

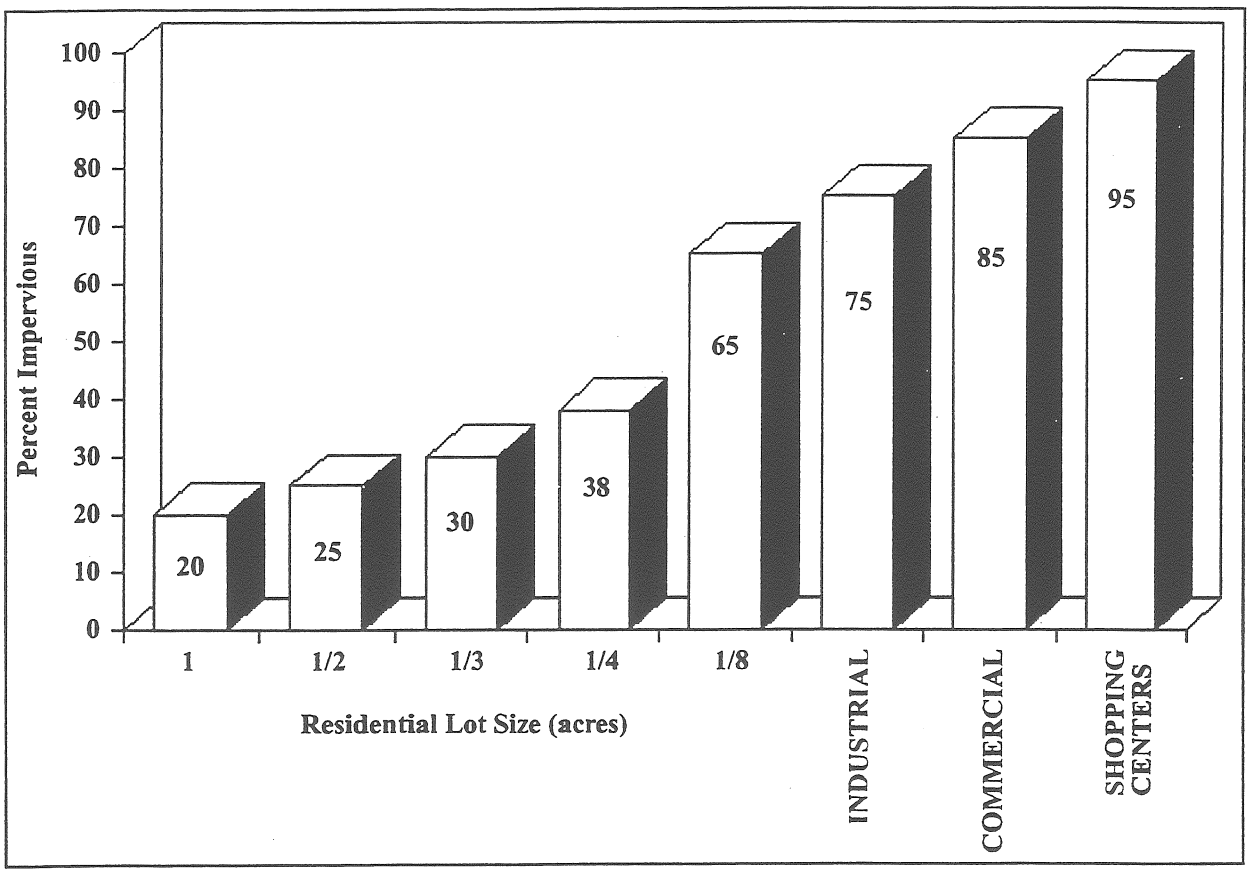

FIGURE 3. Average percentage of impervious coverage by land use
Source: Soil Conservation Service 1975

commercial development tops the chart at around 95% coverage, with other business areas and industrial development lagging slightly behind. In residential areas, there is a wide range of imperviousness that varies predictably with lot size, going from about 20% in one-acre zoning to as high as 65% in one-eighth-acre zoning.

The City of Olympia, Washington, recently conducted a thorough study of impervious coverage in their area. For 11 sites measured, they found coverage values similar to the SCS values, finding four high-density residential developments (3–7 units/acre) to average 40% impervious, four multifamily developments (7–30 units/acre) to average 48% impervious, and three commercial/industrial sites to average 86% impervious coverage (City of Olympia 1995) (table 1).

In addition to the relationship between land use and the total amount of impervious coverage, studies show that all land uses are not equal with regard to the levels of contaminants present in the runoff. As noted, pollutant or land-use-specific studies are relatively new to the scientific community, but existing information supports the common-sense assumption that some land uses are more contaminating than others; for instance, runoff from gasoline stations contains extremely high levels of hydrocarbons and heavy metals (Schueler 1994b).

Recent research from Wisconsin goes one major step further, actually determining the pollutant concentrations from specific categories of impervious surfaces. Using micro-monitoring samplers that collected the runoff from 12 different types of surfaces (e.g., roofs, streets, parking lots, lawns, driveways) in residential, commercial, and industrial areas, Bannerman et al. (1993) were able to show distinct differences in the types and amounts of certain pollutants, depending on the source of the runoff. The study clearly identified streets as the impervious surfaces having the highest pollutant loads for most land-use categories (table 2). Roofs, with the exception of the zinc from industrial roofs, were generally low in pollutant loads, while parking lots had surprisingly moderate

TABLE 1. Site coverage for three land uses in Olympia, Washington

Surface Coverage Type	Average Approximate Site Coverage, % High Density Residential (3–7 units/acre)	Multifamily (7–30 units/acre)	Commercial
1. Streets	16	11	03
2. Sidewalks	03	05	04
3. Parking/driveways	06	15	53
4. Roofs	15	17	26
5. Lawns/landscaping	54	19	13
6. Open space	n/a	34	n/a
Total impervious surface (1–4)	40	48	86
Road-related impervious surface (1–3)	25	31	60
(Road-related as a percentage of total impervious coverage)	(63%)	(65%)	(70%)

Adapted from City of Olympia 1995

TABLE 2. Surfaces exhibiting highest levels of runoff-borne pollutants, out of twelve surface types sampled in selected urban areas in Wisconsin

POLLUTANT	SURFACE Highest levels	Second highest levels	Third highest levels
e. coli (pathogens)	residential feeder streets	residential collector streets	residential lawns
solids (sediment)	industrial collector streets	industrial arterial streets	residential feeder streets
total phosphorous	residential lawns	industrial collector streets	residential feeder streets
zinc	industrial roofs	industrial arterial streets	commercial arterial streets
cadmium	industrial collector streets	industrial arterial streets	commercial arterial streets
copper	industrial collector streets	industrial arterial streets	residential collector streets

Adapted from Schueler 1994d

levels of pollutants. The one unpaved surface monitored, residential lawns, showed high levels of phosphorous, presumably from lawn and garden fertilizers. As this study is augmented by others over time, reliable relationships between pollutant loads and specific landscape components will undoubtedly emerge.

Impervious cover can be further broken down into its functional components. Schueler (1994a) and others point out the two major categories of impervious surface: rooftops, and the transport system (roads, parking lots, driveways, sidewalks). In general, the transport system is the dominant component, reinforcing the concept of an automobile-centric society. In the Olympia study, for instance, the transportation component ranged from 63% for single-family residential development to 70% for commercial development (City of Olympia 1995) (table 1).

One last refinement of the impervious component is its relationship in the landscape to surrounding areas, in the sense of how much of the rainfall onto a given surface is actually conveyed to a stream or stormwater collection system. In general, the rooftop component, which often drains to a lawn or other permeable areas, has less impact than roadways, which typically channel runoff directly to the stormwater system. The Olympia study (1994b) calls this factor the *effectiveness* at producing runoff, and estimates impervious areas in low-density residential developments to be about 40% effective, while those in commercial/industrial areas are close to 100% effective. In theory this concept could be applied to all surfaces—lawns themselves, for instance, can have a significant coefficient of runoff—but to our knowledge this level of refinement has not been researched, nor is it generally needed for most applications.

Imperviousness in Planning: A Framework, Some Examples

By considering the distribution of impervious cover by land use, function, and contribution to runoff, strategies begin to emerge for the reduction of both current and future levels of imperviousness. We suggest that these strategies can be grouped into three basic categories: community or regional planning; neighborhood and site planning, and regulation. Each category presents opportunities to revisit the *status quo* with an eye to water resource protection. Following are some general concepts and specific examples of such opportunities.

Planning at the Community or Regional Level

Land-use planning, even at the town level, need not be based on traditional political boundaries. Increasingly, environmental and natural resource professionals recommend planning based on the organization of natural systems (Environmental Protection Agency 1993c). Ecosystems as an organizational unit have been suggested, but the functional definition of an ecosystem remains elusive.

A more promising trend has been toward using watersheds as planning units (Environmental Protection Agency 1993b). A watershed, or drainage basin, is an area that drains to a common body of water, be it a lake, river, stream, aquifer, or bay. Watersheds have an advantage in that they can be clearly defined as geographic units. In addition, the watershed can be used as a system of organization at any number of scales, from a major basin encompassing several states, to a regional basin involving several municipalities, to a local sub-basin on the neighborhood level.

Thinking in terms of watersheds is particularly appropriate for stormwater management, which, after all, is all about drainage. At the University of Connecticut, we have developed a regional/community-level planning approach that provides an example of the use of both watersheds and impervious coverage. The Nonpoint Education for Municipal Officials (NEMO) project was initiated in 1991 to assist communities in dealing with the complexities of polluted runoff management (Arnold et al. 1993). The project, funded by the United States Department of Agriculture's Cooperative State Research, Education and Extension Service, is run by an interdisciplinary team that includes water quality, natural resource planning, and computer technology expertise. NEMO uses geographic information system (GIS) technology as a tool to educate local land-use decision-makers about the links between their town's land use and its water quality. Natural resource information on waterways and watersheds is combined with satellite-derived, land-cover information, and then displayed on colorful maps created with the GIS.

At the heart of NEMO is an analysis of impervious cover. Literature values for the percentage of impervious cover are applied to satellite land-cover categories to come up with rough estimates for the current level of imperviousness within a town or watershed. These values are averaged and displayed by local drainage basin (average area about one square mile) and categorized according to the protected/impacted/degraded scale of increasing impervious cover previously described and shown in figure 2. The current values are then contrasted with a zoning-based, build-out analysis of imperviousness, again displayed by local subbasin (figure 4). The build-out allows town officials a look into the possible future of their town, not in conventional terms of population or lot coverage, but in

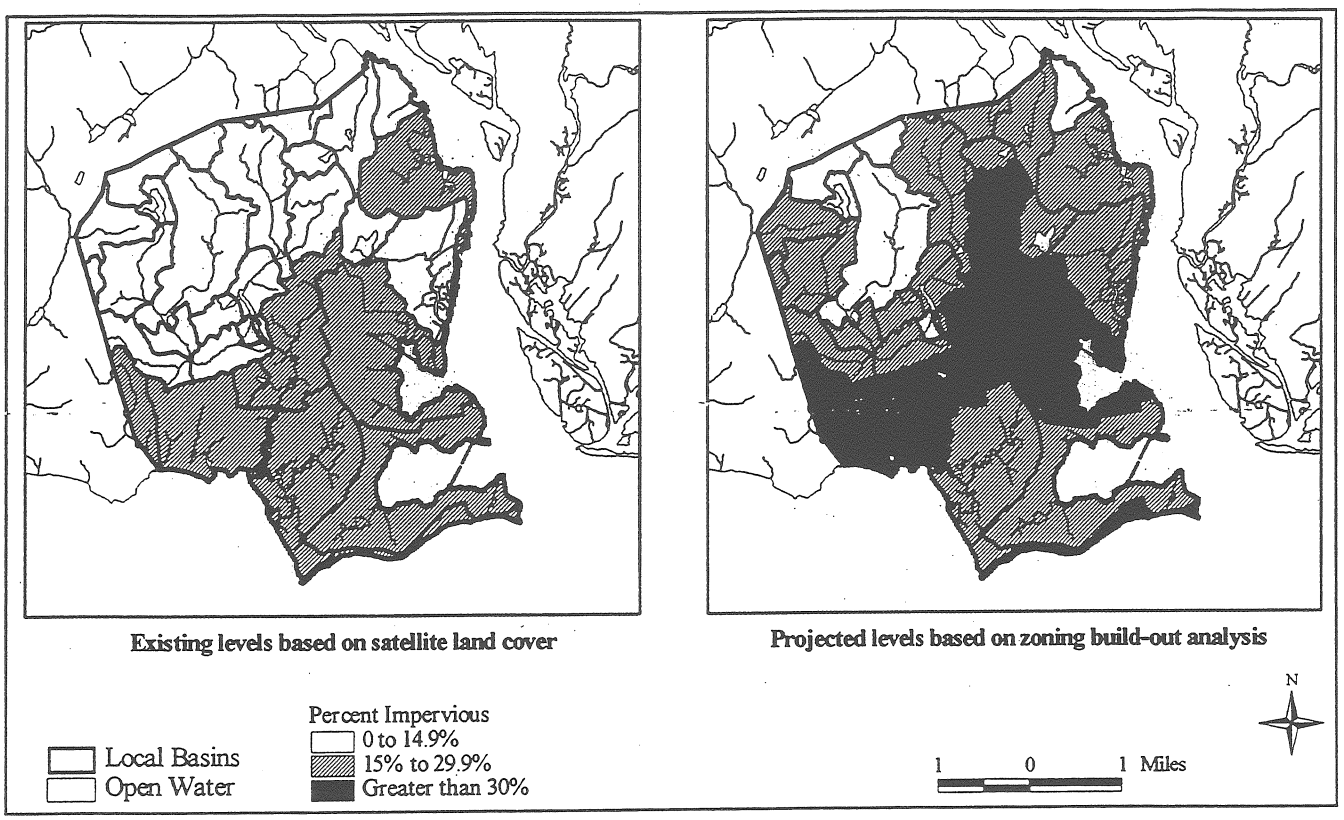

FIGURE 4. Impervious coverage analysis for Old Saybrook, CT

terms of impervious cover—and by inference, the health of their local water resources.

The results of the impervious surface analysis can be used to help guide planning emphasis within each local basin area. For areas in the lower impervious zone, emphasis should be placed on preventive measures that retain existing natural systems, using techniques like open space planning and stream buffers. For areas that are in, or will be in, the "impacted" (10–30%) zone, preventive planning should be accompanied by a focus on site design considerations that reduce runoff and imperviousness. Finally, for areas at (or climbing into) the "degraded" (over 30%) zone, the focus shifts to remediation through pollutant mitigation and resource restoration.

NEMO is one example of the use of imperviousness for broad-based community or regional water resource planning. Similar approaches are beginning to spring up around the country. Schueler (1994a) recommends watershed-based zoning that "is based on the premise that impervious cover is a superior measure to gauge the impacts of growth, compared to population density, dwelling units or other factors." In Alpine Township, Michigan, concern about the effects of urbanization on a formerly productive cold-water trout fishery has prompted researchers from Grand Valley State University to design a watershed-based GIS decision support system for local land-use authorities (Frye and Denning 1995). The system makes use of a number of hydrologic and land-use factors, including impervious surface estimates and zoning-based build-out analyses. In Montgomery County, Maryland, a detailed planning study was done to formulate a land-use strategy to protect the water resources of the Paint Branch stream (Montgomery County MD 1995). The study both measures and projects future impervious surface coverage by subwatershed basin, and uses this information to help guide its recommendations for protective actions.

Each of these efforts contains the elements of impervious cover, subbasin-level analysis, and build-out projections. An even more comprehensive treatment is that undertaken by the City of Olympia, Washington. During 1993 and 1994, Olympia conducted their Impervious Surface Reduction Study (ISRS), from which information is cited repeatedly in this paper. The ISRS Final Report (City of Olympia 1995) contains an impressive and comprehensive body of research, policy analysis, and build-out scenarios, culminating in 19 specific action recommendations. The study concludes

that "a 20% reduction [in future impervious cover] is a feasible and practical goal for Olympia and will not require exceptional changes in the Olympia community." The recommended reduction is equal to approximately 600 fewer acres of impervious coverage by the year 2012. Planners wishing to see an example of a comprehensive approach to reducing imperviousness would do well to read the Olympia ISRS report.

As with other natural resource protection efforts, community and watershed-level planning approaches like these are often the most effective way of achieving results. Addressing the issue at this scale provides an overall perspective and rationale for the design and regulatory tools described in the following sections. Site-level considerations are then based not only on the immediate impacts of a given development on the local stream or pond, but also on the site's incremental contribution to the pollution (or protection) of a larger-scale water body or aquifer. Review of site design and stormwater management plans, for instance, can be checked for consistency with goals for the appropriate watershed.

Providing this broad context has the added benefit of allowing for greater flexibility at the site level. Planners can evaluate individual factors like a site's location within the watershed, its land use, and the relative priority of the receiving stream as they relate to the overall plan, rather than applying a rigid and uniform set of requirements to all parcels.

Site-Level Planning

Site planning is perhaps the least-explored approach to reducing water pollution. Kendig (1980) states that "good design begins with an analysis of the natural and environmental assets and liabilities of a site," and that these factors should be the determinants of development patterns. Applying this principle to water resource protection translates to maintaining the natural hydrologic function of a site, through retaining natural contours and vegetation to the maximum extent possible. Consideration of impervious surface is a key element of this overall strategy, extending to all site-level considerations. These include construction practices, design that reduces imperviousness, and design that includes measures to mitigate the effects of the runoff from impervious areas.

Construction activity itself usually creates impervious surface, severely compacting earth with heavy machinery. Although erosion control practices may require procedures for limiting the area of exposed soil and how long it remains exposed, that requirement does not necessarily minimize the amount of compacted soil. Construction should be sequenced with this goal in mind, and it may be necessary later to loosen compacted areas and/or cover them with additional pervious materials (Craul 1995).

From construction, we move to reduction. For virtually all land uses, one of the best design-related opportunities for reducing imperviousness is through the reduction of road widths. As has been seen, roads both constitute a major fraction of a community's impervious coverage, and tend to produce the most pollutant-laden runoff.

The long-established concept of road hierarchies, which relates road size to the intensity of use, has many positive aspects beyond water-quality, among them cost reductions and aesthetic benefits. Yet Southworth and Ben-Joseph (1995), in a recent article on the history of residential street design, found that, for a variety of historical and institutional reasons, road hierarchies are often overlooked by local planners and commissions. The authors conclude that an overemphasis on traffic control has resulted in a "rigid, over-engineered approach ... deeply embedded in engineering and design practice." Simple math dictates that for a given length of subdivision road, reduction from a typical 32-foot to a 20-foot width results in a 37.5% reduction in pavement, or over 63,000 square feet (about one and one-half acres) per linear mile. The Olympia study estimated that changing the width of local access roads from 32 to 20 feet would result in an overall 6% reduction in imperviousness for a given development site in their region, that is, six acres less street pavement for a typical 100-acre subdivision (City of Olympia 1994b).

Road surface reduction is a primary reason why clustering is the most pavement-stingy residential design. Large-lot subdivisions, which have long been recognized as being antithetical to most conservation goals (Arendt 1994a, 1994b) generally create more impervious surface and greater water resource impacts than cluster-style housing does. This is true even though the large lots may have less impervious coverage per lot, because the attenuated design requires longer roads, driveways, and sidewalks, which make the overall subdivision parcel more impervious (figure 5). Schueler (1994c) states that cluster development can reduce site imperviousness by 10–50%, depending on lot size and the road network.

In commercial and industrial zones, the focus of design-related reductions in imperviousness shifts to parking areas, the largest component of impervious cover (table 1). Research has shown oversupply of parking to be the rule. Willson (1995), citing his research and that of many others, found that the "golden rule" of 4.0 parking spaces per 1,000 square

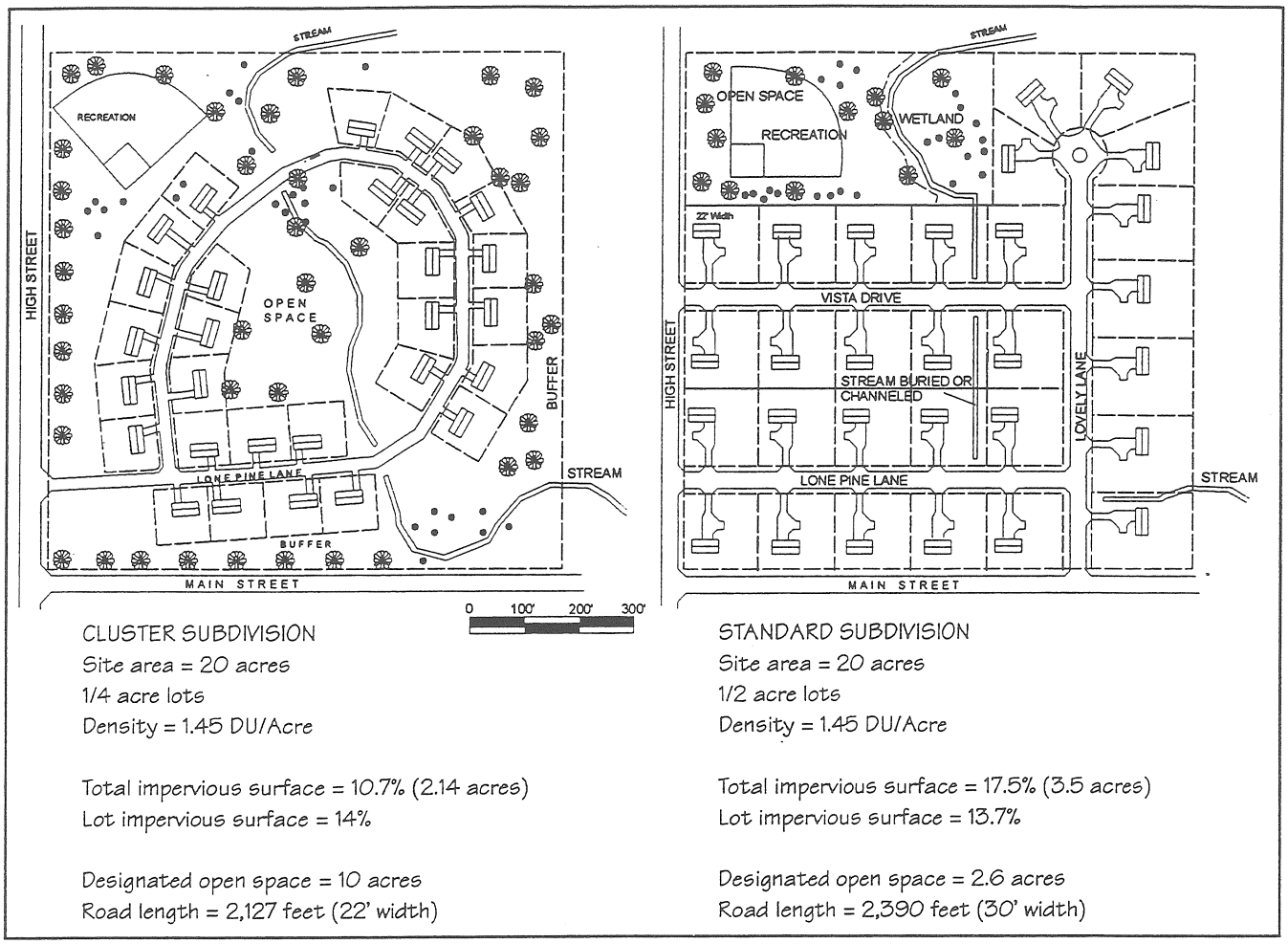

FIGURE 5. Clustering reduces overall site imperviousness.
Source: John Alexopoulos, University of Connecticut

feet of office floor space is often almost twice what is actually needed. Using a generic, medium-sized office building as a hypothetical example, he shows that a typical parking supply ratio of 3.8 results in an extra 55,000 square feet of parking lot, compared to using a more factually-based ratio of 2.5.

The City of Olympia found not only parking oversupply, with vacancy rates of 60–70%, but also developers consistently building parking above minimum ratios, with 51% more parking spaces at their 15 survey sites than were required by zoning (City of Olympia 1994c). This agrees with our observation that, at least in Connecticut, overbuilding of parking appears to be a recent trend with "big box" retail store developers, who typically require at least 5 spaces per 1,000 square feet, principally to meet peak demands on weekends and during the busy period from Thanksgiving to Christmas.

Reductions in parking-related impervious coverage can be attained in ways other than adjusting parking supply ratios. Shoup (1995) suggests that parking can be reduced through economic incentives that effectively end the subsidy provided by employer-paid parking. Employee commuter option programs, mandated by the Clean Air Act Amendments of 1990 in areas of "severe nonattainment" for ozone standards, hold some promise for reducing parking demand. The Olympia study (City of Olympia 1994d) concluded that sharing, joining, or coordinating parking facilities can reduce parking significantly. Finally, vertical garages (above or below ground) can be encouraged, although this alternative can be expensive. Many of these strategies were recently combined in an innovative office park design in Lacey, Washington, where the new 360,000-square-foot headquarters of the state Department of Ecology was designed around a "parking diet" that slashed parking spaces from 1500 to 730 (Untermann 1995).

Imperviousness also has a role in design related to mitigation of polluted runoff. "Best management practices" (BMPs) is the most commonly-used term to describe the wide range of on-site options available to manage stormwater runoff. BMPs are often divided into two major types: those involving structures such as stormwater detention ponds or infiltration trenches, and "nonstructural" practices that usually involve use of vegetated areas to buffer, direct, and otherwise break up the sea of asphalt. Maintenance measures like road sand sweeping and storm drain cleaning are also included.

It is not within the scope of this article to give a thorough discussion of these practices; choosing the correct assemblage is a combination of art and science, and involves many considerations. From the standpoint of imperviousness, however, BMPs can be viewed in terms of how well they replicate the natural hydrological functioning of the site. This perspective puts a premium on restoring infiltration, which has been suggested by Ferguson (1994) and others to be highly preferable to surface detention.

Emphasizing infiltration and nonstructural solutions often comes into conflict with established development practices. Curbing is a good example. Just as Southworth and Ben-Joseph (1995) found the over-engineering of road widths to be ingrained in local practice, our experience has been that to many town engineers, the necessity of curbing is a given. Safety and structural integrity of the road are often given as reasons for curbing, above and beyond its drainage function. Highway engineers in our state, however, have told us that the sole purpose of curbing is to direct stormwater, and even then, it is only truly needed during the unstable construction phase (Connecticut Department of Transportation 1995). In many cases, more pervious alternatives to directing runoff should be investigated. Grassy swales, for instance, might be constructed in the margin created when existing right-of-way widths are retained while road widths are reduced.

Mitigating the impacts of polluted runoff in the "ultra-urban" inner city environment is a particularly thorny issue. Regional approaches like the Olympia ISRS may target these areas for increased impervious cover (City of Olympia 1994a). Growth policies that encourage urban "infilling" may result in higher inner-city imperviousness in order to reduce sprawl and overall imperviousness, region-wide. In effect, this is "clustering" on a regional scale.

Nonetheless, even for these seemingly intractable areas, using imperviousness as a planning framework can be useful. Usually, this involves linking the reduction of impervious surfaces to complementary urban initiatives. Parking is one example. Excess parking can be attacked from many angles other than water quality, including air quality, traffic congestion, promotion of sprawl, and inefficient use of building lots. A parking reduction initiative could be combined with a plan to use the recouped paved area either for active stormwater treatment (infiltration basins, detention ponds) or for more modest stormwater management (vegetated strips). Such a strategy could be combined with the creation of "vest pocket" parks and other green spaces, shown by urban forestry research as having positive sociological and psychological effects on city dwellers (Gobster 1992; Schroeder and Lewis 1992).

Research on the pollutant-processing capability of various types of vegetation suggests a slight twist on parking lot design that may reap large benefits in water quality for urban areas. Parking lots often incorporate landscaped areas, usually in raised beds surrounded by asphalt curbing. However, these vegetated areas can be planted *below* the level of the parking surface, serving as infiltration and treatment areas for runoff (Bitter and Bowers 1994) (figure 6). This idea can be extended to other areas where vegetated "islands" are traditionally used, such as in the middle of cul-de-sac circles.

Another consideration for urbanized areas is pervious alternatives to pavement. This includes various mixes of asphalt with larger pore spaces (e.g., "popcorn" mix), and alternative systems such as open-framework concrete pavers filled with sand or gravel, or turf reinforced with plastic rings. These systems can become clogged with sediment, particularly during construction, but are often a suitable alternative in low traffic areas like emergency roads, driveways, and overflow parking areas. Cahill (1994) asserts that, contrary to common belief, pervious pavement can be used successfully in many places if certain siting, construction, and maintenance practices are followed; for instance, he recommends vacuum cleaning at least twice per year. Granular surfacings are being promoted by some landscape architects as attractive, inexpensive, and more aesthetically-pleasing alternatives to paved pathways and trails (Sorvig 1995).

One last important note about reducing imperviousness through planning and design—it can save money. Savings to both the private and public sectors in reduced construction and infrastructure costs can be considerable. For instance, a recent study done for the Delaware Estuary Program compared the impacts on twelve communities in the watershed, over a 25-year horizon, of a continuation of current "sprawl" development patterns versus the Program-recommended pattern of promoting mixed uses, open space, and

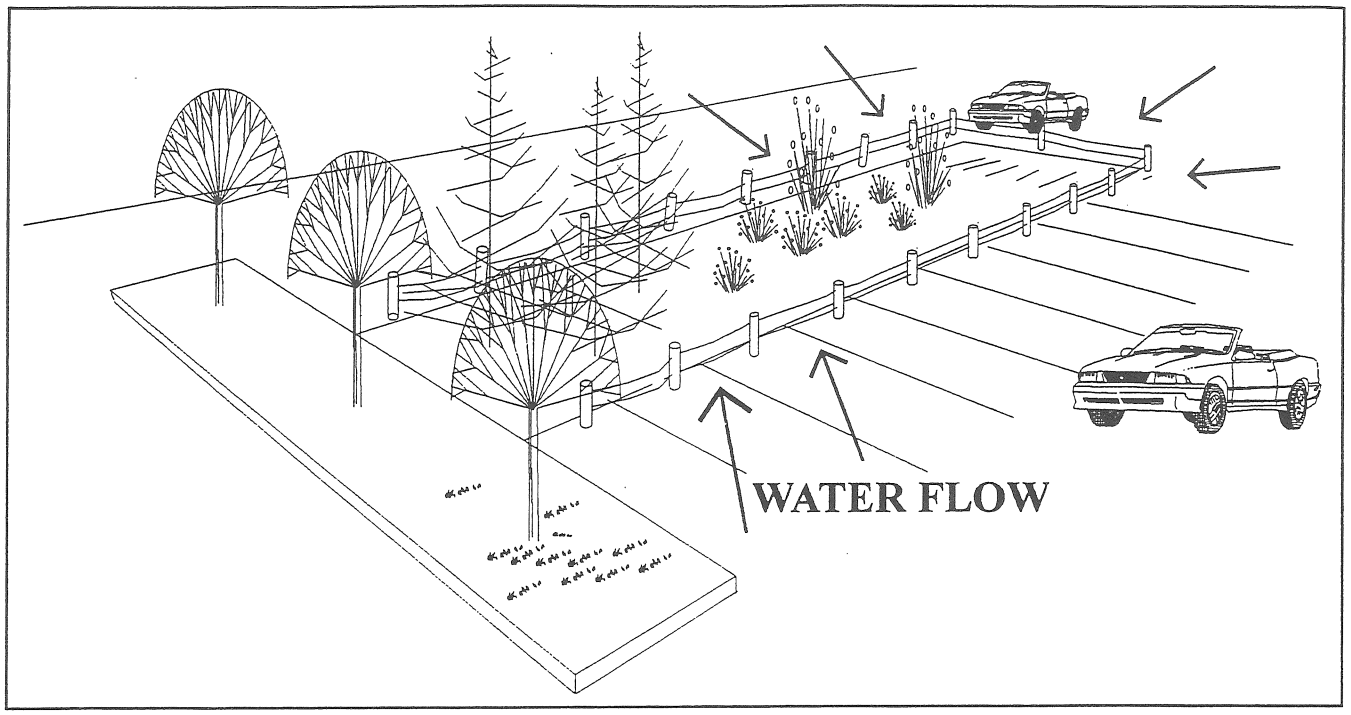

FIGURE 6. Sunken vegetated parking lot "islands" intercept and treat runoff.
Source: John Alexopoulos, University of Connecticut

growth around existing centers. They concluded that for these communities, the less consumptive pattern resulted in savings of $28.8 million in local road costs, $9.1 million in annual water treatment costs, $8.3 million in annual sewer treatment costs, as well as an 8.4% reduction in overall housing costs, and a 6.9% savings in annual costs of local public-sector services (Burchell, Dolphin, and Moskowitz 1995).

The Use of Imperviousness for Regulation

Planning approaches at the community and site level can be complemented with specific applications that give regulatory teeth to planning objectives. To begin with, planners can revisit their current zoning and subdivision requirements with an eye to imperviousness. For instance, many lot coverage limits, particularly for residential uses, refer to rooftops but do not include parking space, sidewalks, and driveway coverage.

Impervious cover lends itself well to zoning that uses performance standards. In fact, Kendig (1980) defines performance zoning as that which regulates development on the basis of four fundamental measures of land-use intensity, one of which is the impervious surface ratio. Jaffe (1993), in a critical assessment of performance-based zoning, concludes that "Kendig's recreational and impervious surface ratios are especially effective in achieving local environmental objectives for stormwater management and groundwater recharge." Performance zoning has the added effect of encouraging mixed uses, which generally result in less impervious coverage and less pollution, by reducing roads and vehicle traffic.

Community-wide applications encompassing large areas with varied land use will require sliding scales of impervious coverage limits that depend on the location, size, and type of use. Such standards have been in place in some Florida communities for almost a decade (American Planning Association Zoning News 1989). More recently, ordinances limiting impervious cover have been enacted in Austin and San Antonio, Texas, driven by concern about pollution of the area's major drinking water aquifer (City of Austin 1992; City of San Antonio 1995).

In instances where protection of a particularly important resource is desired, strict limits on impervious coverage may be imposed. Such is the case in Brunswick, Maine, where a "coastal protection" zone was created for areas draining to Maquoit Bay, site of shellfish beds critically important to the town. The special zone has certain stringent performance standards, among them a maximum impervious-surface lot coverage of 5%. This coverage includes ". . . buildings, roads, driveways, parking areas, patios, and other simi-

lar surfaces" (Town of Brunswick 1991). In this case, the very low impervious limit was feasible because the total area affected was fairly small, the use was largely residential, and the specific pollutant of concern was nitrogen emanating from septic systems, resulting in zoning that called for a minimum lot size of one unit per five acres. This "down-zoning" approach, which has also been used in the Buttermilk Bay area in Massachusetts (Horsley and Witten 1991), is practicable for small areas with septic-related concerns, but if applied over large areas, can lead in the long run to promotion of sprawl.

Strict limits may be appropriate, yet in practice they can result in the need for complicated exemption provisions, or even raise the specter of private property rights takings (Land Use Law and Zoning Digest 1995; Ross 1995; Settle,Washburn, and Wolfe 1995). One method for "softening" the concept of limits is to allow for flexibility on the site level. In this scenario, an ordinance setting a limit (or goal) for a site's impervious coverage would require more stringent on-site stormwater treatment when the limit is exceeded. This type of approach will undoubtedly become more common as the information base on removal efficiencies of various treatment measures expands. Another type of flexibility comes from applying performance standards to specific elements of imperviousness within the landscape. In their discussion of next steps, the Olympia study (City Of Olympia 1995) cites the development of performance-based standards for sidewalks, parking, and landscaping "to encourage innovation and provide flexibility in meeting impervious surface reduction goals."

One practical regulatory application of impervious coverage is for stormwater utility assessment, an "impact fee" that is growing in use in urban areas of the country as a way of paying for the treatment and control of polluted runoff. Impervious surface has long been a key determinant in mathematical models that predict the volume of runoff from a given piece of land. Stormwater utility assessments have taken the lead from these models in using imperviousness as a basis for a utility rate structure that fairly distributes the cost of treatment according to a property's contribution to runoff.

Such systems are now in place in many areas, including Kansas City, Missouri; Kitsap County, Washington; and throughout the state of Florida. This type of application requires a community-wide assessment of impervious coverage, and a wide range of techniques is being used. In Kansas City, rate structures are based on digitized high-resolution orthorectified aerial photos (Murphy 1995), while in Florida they are based on statistical surveys of area lots (Livingston 1995). The Kitsap County, Washington, Comprehensive Surface and Stormwater Management Program, established in 1994, creates a rate structure based on an "equivalent service unit" equal to the average estimated amount of impervious surface area on a single-family residential parcel (Kitsap County 1994).

Such programs not only raise funds for mitigation of adverse impacts, but also, by attaching a cost to imperviousness, provide an economic incentive to reduce it. Apparently, this effect is beginning to be seen in Florida, where the cost savings associated with lower stormwater utility fees have provided the impetus for reduction of impervious cover during site redevelopment (Livingston 1995).

Integrating Stormwater Control into Community Planning

The strategies described above demonstrate that for the planner, imperviousness can provide a useful framework for addressing the impacts of urbanization on water resources. But the advantage of this approach goes beyond any specific application. We have found that working with a town on water resource protection often leads to related natural resource issues like open space preservation and forest management. Our recent experience with NEMO has taught us that framing water issues largely in terms of imperviousness serves to expand the range of these connections.

Once water pollution is linked to impervious coverage and its various components, it has a way of insinuating itself into issues currently "on the table" in town. Road widths and curbing may be subjects of town debate about cost or neighborhood character. Parking and landscaping requirements for commercial zones may be undergoing reexamination for aesthetic reasons. The appropriateness of "big box" retailers may be a hot topic, with arguments centered around traffic congestion and the impact on local merchants. An open space plan may be in the formative stages, or the use of stream buffers being questioned. Citizens may be interested in naturalistic landscaping, water conservation, or volunteer monitoring of local waterways. These typical local debates, drawn from towns working with the NEMO Project, now have elements of water quality and impervious surface reduction as part of the mix. And through these debates, the subject of water quality in the community is extended beyond land-use-related staff and boards to include engineering and public works departments, land trusts and other nonprofits, and citizens.

Cross connections of this type are an important key to ensuring the implementation of any planning initiative. For the professional planner, they create

opportunities to reinforce complementary planning concepts from several different angles. Beyond the well-established concept of planning and designing with nature (McHarg 1969), there are many relatively recent themes in transportation, subdivision design, and landscape architecture that go hand-in-glove with the reduction of impervious surfaces. Performance zoning is one example. Another is neotraditional residential design, which champions styles of development patterned after the traditional New England village in order to foster a sense of community (Duany and Plater-Zyberk 1991). The open space subdivision designs promoted by Arendt (1994b) for land conservation are also a good fit. On another front, residential street layouts promoting "traffic calming" for a variety of safety, aesthetic, and sociological benefits (Hoyle 1995; Ben-Joseph 1995) could easily incorporate pavement reduction. Landscape architects are calling for more naturalistic schemes that follow the natural contours and make use of low-maintenance, drought-resistant plants (Ash 1995). Planners should seize the opportunity to "piggy-back" water quality with these complementary initiatives, making sure to explicitly incorporate the reduction of paved surfaces and their impacts into official policy, plans, and procedures.

The other advantage of the cross-cutting nature of water resource protection in general, and imperviousness specifically, is that it seems to make sense to the average citizen. Reduction of paved areas is one of relatively few planning initiatives that "plays" at all levels, from the suburban driveway to the big box parking lot, and even to the Chief Justice of the Supreme Court, who recognized the link between the growth of paved surfaces and increased runoff (in *Dolan v. City of Tigard*) (Merriam 1995).

From our standpoint as educators, this feature is critical to the success of any local planning initiative. Education of citizens and local officials on the issues is a necessary and integral part of the process of changing land-use procedures. Volunteer commissioners on local land-use boards are particularly important. In our experience, almost any narrowly-framed issue or problem (environmental or otherwise) brought before busy city, town, or county boards is already operating with two strikes against it. Few issues are isolated, yet they are frequently presented to communities as such, reflecting not the nature of community planning but that of regulatory agencies. A regional planner we work with has called this the "environmental flavor of the month" syndrome.

The result is that even legally mandated initiatives may be doomed to failure by the sheer inertia involved in integrating new and complex information into the busy world of local land-use decision-making. Framing the issue of nonpoint source pollution in terms of imperviousness, although it may be a bit simplistic, appears to be an effective way of enabling local decision-makers to grasp the issue sufficiently to take action.

Conclusion

Water pollution is getting more complex, while at the same time the responsibility for water resource protection is shifting toward local authorities. The use of impervious surface coverage as an environmental indicator can assist planners to construct a game plan to protect their community's natural resources.

Imperviousness integrates the impacts of development on water resources, so it can help to cut through much of the complexity. It is measurable, and so appropriate for a wide range of planning and regulatory applications. It is a cross-cutting feature that is a frequently hidden, but nonetheless substantial, component of many current trends in road, neighborhood, and landscape design, so it can be used as a reinforcing connection between seemingly unrelated planning initiatives. Finally, the basic tenets of reducing imperviousness—retaining the natural landscape, minimizing pavement, promoting infiltration to the soil—are simple concepts that can be understood by a community and its residents.

Impervious cover is rarely specifically identified or addressed in community goals, policies, or regulations. It should be. In this article, we have tried to facilitate the use of this indicator by (1) reviewing the scientific literature to provide a comfort level with its appropriateness; (2) creating a framework for its use in overall planning, site-level planning, and regulation; and (3) providing real-world examples of such applications. With imperviousness as a foundation, planning that begins with water resources often leads to character, design, and aesthetic issues that, taken together, define much of the overall quality of life in a community.

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THE NIANTIC RIVER: A TREASURE WORTH PROTECTING

The Niantic River is a shallow marine estuary that was formed when the receding glaciers of the Wisconsin glaciation raised the sea level sufficiently to flood a low coastal valley. During the glacial period, the glaciers held enough water to lower the oceans as much as 300 feet from their current level. Most of the shoreline is made up of glacial stream deposits and till that are10 to 80 thousand years old. Also exposed in a few places along the shore, especially along the western shoreline at the foot of the Oswegatchie Hills and the southeastern shore of Keeney Cove are crystalline rocks of the Brimfield Schist and Monson Gneiss (Goldsmith, 1967). Both of these formations are approximately 350 - 400 million years old and were metamorphosed to their current form about 280 million years ago (Aleinikoff and others, 2003; Wintsch and others, 2004).

Coastal wetlands, a fragile transitional zone between marine and terrestrial environments, have significant economic and ecological value. They are the most productive ecosystems known, providing nutrients and habitats that support the entire coastal ecosystem. Most of the Nation's coastal commercial and recreational fisheries depend upon wetlands for spawning, hatching, and nursery activities. Coastal wetlands also play vital roles as habitats for wildlife, waterfowl, and migratory birds.

The Niantic River forms the political boundary between the towns of East Lyme and Waterford. Several small local streams empty into the Niantic River, the largest of which is Latimer Brook. The river has historically supported healthy populations of marine animals, like shellfish, crustaceans, and finfish. In past years, the Niantic River supported extensive eelgrass beds. Eelgrass serves as an important sanctuary for marine animal species, particularly as a refuge for the juveniles of many species.

For Further Information: Websites

Local conservation organizations

www.savetheriver-savethehills.org – Save the River-Save the Hills, Inc.
www.oswhills.org – Friends of the Oswegatchie Hills Nature Preserve, Inc.

Info on estuaries

www.estuaries.gov
www.estuarylive.org
www.coastalcleanup.org
www.longislandsoundstudy.net
www.epa.gov/owow/estuaries/
www.epa.gov/owow/estuaries/kids/
www.whatsanestuary.com
www.anep-usa.org

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Directions

To Launch Sites from the North:

Take Route 9 South to I-95 North or take I-395 to I-95 South. Follow To Launch Sites from the East/West.

To Launch Sites from the East/West:

Take I-95 to Exit 74 for Route 161 South toward Niantic. Proceed south on Route 161 through the Village of Niantic. At traffic light at end of 161 in Niantic, turn left on Route 156 (also known as Main Street).

Choose a launch site below:

1 **For Cini Park East Lyme Town Launch:**
Turn left into Cini Park before crossing over the Draw Bridge over the Niantic River. Follow signs to the Cini Park Launch Ramp which is on the left. Parking is available near ramp. See Map – Diamond #1.

2 **For Mago Point State Launch Site, Waterford:**
Continue on Draw Bridge over Niantic River into Waterford. Take first left at traffic light onto Niantic River Road. Take left at T-section and immediate right and follow straight to the State Launch site. See Map – Diamond #2.

A SAFETY REMINDER: When canoeing or kayaking along the Niantic River Estuary Canoe/Kayak Trail, always be aware what time high and low tide will occur. Strongest currents, both outgoing and incoming, occur half way between low and high tides: **the Channel under the rail and highway bridges carries a very rapid current at these times.** Weakest currents occur when the tides are at their highest or lowest point. Each tidal cycle (from low to high) has a duration of approximately 6 hours. Children, 11 years and under, are required by State law to wear a *Personal Floatation Device* (PFD) at all times while on a vessel although PFD usage is strongly encouraged at all times for both children and adults while on any vessel. ALL canoe and kayak users must wear a *PFD* during cold weather months between October 1 and May 30. Please take this into account when planning your expedition.

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HISTORIANS/MAP: Marvin Schutt, Wilbur Beckwith & Frank Skewes

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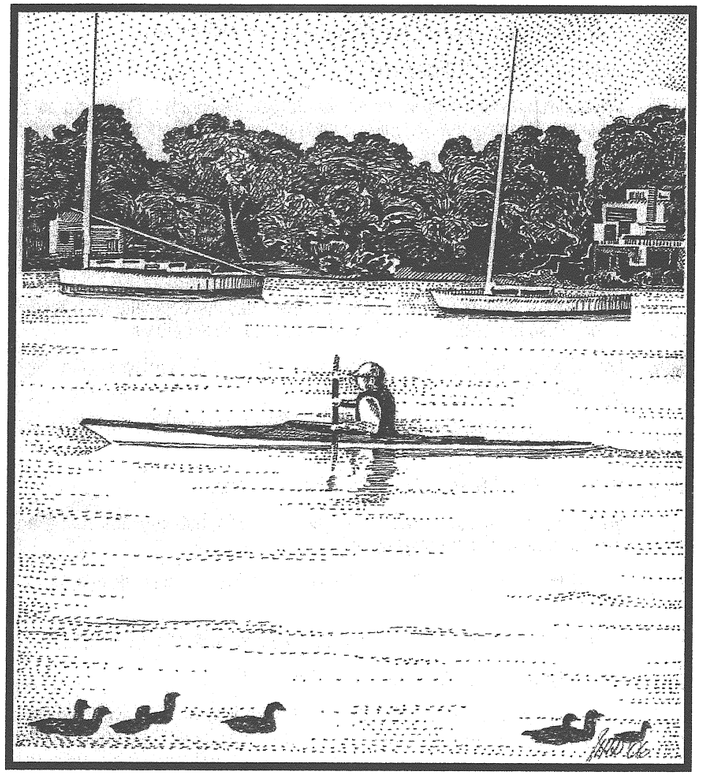
CONNECTICUT DEPARTMENT ENVIRONMENTAL PROTECTION

Funded by the Long Island Sound License Plate Program
Connecticut Department of Environmental Protection

NIANTIC RIVER ESTUARY CANOE / KAYAK TRAIL



Access Points:

1 Cini Park Launch, East Lyme

2 State Launch Area at Mago Point, Waterford

3 East Lyme: Grand Street Launch (Near Boats, Inc.)

4 Waterford: Kiddie Beach (Keeny Cove)

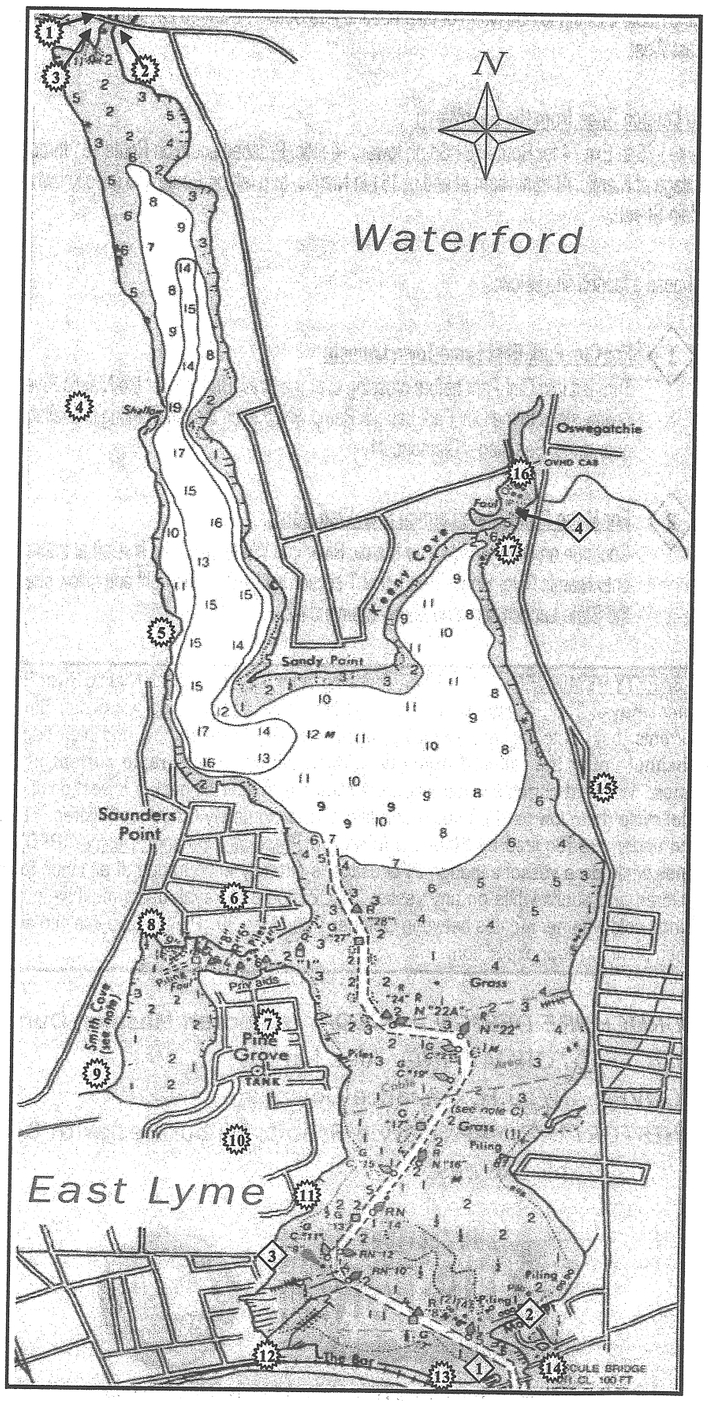
Historic Points of Interest

1. **Golden Spur Amusement Park** - Site of the World Famous Diving Horses (1905-1924). (See pictures of these horses diving from a 20' tower in Tri-town Foods on Rt. 161).
2. **Boston Post Road Bridge** - Car and Trolley Overpass (1905-1924). Trolleys ran daily from New London to the Golden Spur Amusement Park.
3. **Beckwith Shipyard** (Early 1800's)
4. **Oswegatchie Hills** (Known earlier as Sargeant's Head) – Proposed as a Nature Preserve. Possibly the last mile of undeveloped waterfront in Southern Connecticut.
5. **Old Quarry Dock for Barges** (1819) - Serviced a granite quarry in Oswegatchie Hills which provided granite for several famous buildings, many in New York City.
6. **Saunders Point** (1650) - One of the oldest points of settlement in East Lyme. Inhabited by the Nehantics for thousands of years prior to white settlers.
7. **Pine Grove** (1880's) – Developed by white settlers originally as a religious tent colony. Also inhabited by the Nehantics prior to white settlers.
8. **Old Stone House** (1815) - Built after the 1815 hurricane (On hill behind Bayreuther's Boat Yard).
9. **Land surrounding Smith Cove** - Many Native American relics were unearthed here.
10. **National Guard Camp** - Active for about 110 years.
11. **White Storrs House** - Site of skirmish in 1781 between the militia and local residents trading with Long Island.
12. **Boats Inc. Property** - Site of the home of Avery Smith, developer of Niantic Village.
13. **Railroad tracks** - Single-Rail track first came through Niantic in 1852.
14. **Site of Rope Ferry** - Operated in the Colonial Period.
15. **Land along east shore** – Running south from Keeny Cove almost to Rope Ferry Road was known as the "Wigwams." Tradition has it that the Nehantics wintered in the Wigwam woods. Several skeletons were washed out of the bank during different Hurricanes; four were found in 1944 as covered in The New London Evening Day on 8/30/1945.
16. **Trolley Trestle** (1905 - 1924) - Trolley ran between Amusement Park and New London
17. **Beckwith Shipyard** - Revolutionary War era

Local Events

- Kayak Regatta – Last Saturday in August each year sponsored by www.SavetheRiver-SavetheHills.org
- East Lyme Day –mid-July weekend day each year. Vendors on Main Street and fireworks display. Check the Town's website www.eltownhall.com.
- Waterford Week – a 10-day annual summer celebration in its 30th year. See www.WaterfordCT.org.

NIANTIC RIVER ESTUARY CANOE/KAYAK TRAIL



Natural History

The Nehantics

The first people who called the Niantic River area home, the Nehantics, were direct descendents of the original humans who arrived in the Americas an estimated 15,000 to 18,000 years ago. The first evidence of human life on the Niantic River dates back 12,000 years. It is generally believed that the ancestors of the Nehantics followed the mammoth, mastodon, bison, elk and other large and small game north to this region as the glaciers retreated. The "Western Nehantics," so named because they settled on the west side of the Pawacatuck River, lived in villages that dotted the landscape from there to the Connecticut River. There is evidence of substantial settlements along both sides of the Niantic River at such places as Saunders Point, Pine Grove and Mago Point. They subsisted on scallops, oysters and both hard and soft shelled clams that the women and children gathered from the Niantic River and Bay. Men caught striped bass, bluefish, tautog, sheepshead, tomcod, sturgeon and estuarine fishes. It is known that they traveled as far as Fishers and Long Islands in their dugout canoes and they caught porpoises, pilot whales, seals, black sea bass, lobsters, sandbar sharks and skates. There is also evidence that they grew corn, beans and squash and hunted wild fowl.

Shellfish and Other Sea Creatures

The Niantic River is probably best known for its Bay Scallops. After record harvests in the years between 1930 and 1950, a marked decrease prompted the Shellfish Commisission to stop its scallop harvest licensing program. The exact cause of this decline is unknown. Different theories look to poor water quality, lack of eelgrass or other submerged surfaces for scallop larvae to attach to and over-harvesting of first-year scallops prior to their ability to spawn.

Other shellfish are found here also. The soft-shell clams in the sandy beaches, scarce razor clams in the bare flats, hard-shell clams in deeper water and the mussels attached to rocks and pilings join the occasional oyster to round out the shellfish crowd. Also found are: Spider and green crabs (a major predator of scallops), drills (the snails that drill holes through the shells of scallops, clams and oysters to eat them), and two species of jellyfish (red in the early Spring and a colorless species in the summer).

In addition to the fish mentioned in the Nehantic section above, winter flounder travel into the river each year to spawn. Summer flounder (fluke), sea robins, toadfish, puffers, American eels, silversides, anchovies and the occasional sea horse also call the Niantic home.

Birds

From mid-fall to early spring, Bald Eagles, which winter in the lower Connecticut River valley, periodically fly over to visit the Niantic River and give the hardy kayaker a wonderful surprise. In the Spring and Summer months, the beautiful Osprey, or Fish Hawk, can be heard singing their soft calls as they soar over the river, looking for their prey. Many other coastal fishing birds, including the majestic Great Blue Heron, White Egrets, Cormorants and the small, but spunky Kingfishers, can be found along the shores. Swans, geese, and many species of ducks also call the Niantic River home, many staying through the winter. **SAFETY NOTE: Please do not feed the birds of the Niantic River. Feeding wild birds encourages dependent behavior, changes their diet and otherwise interferes with their part in the natural food chain. Also, swans and geese can be very aggressive if approached, especially if they have young nearby. Please keep a respectful distance.**