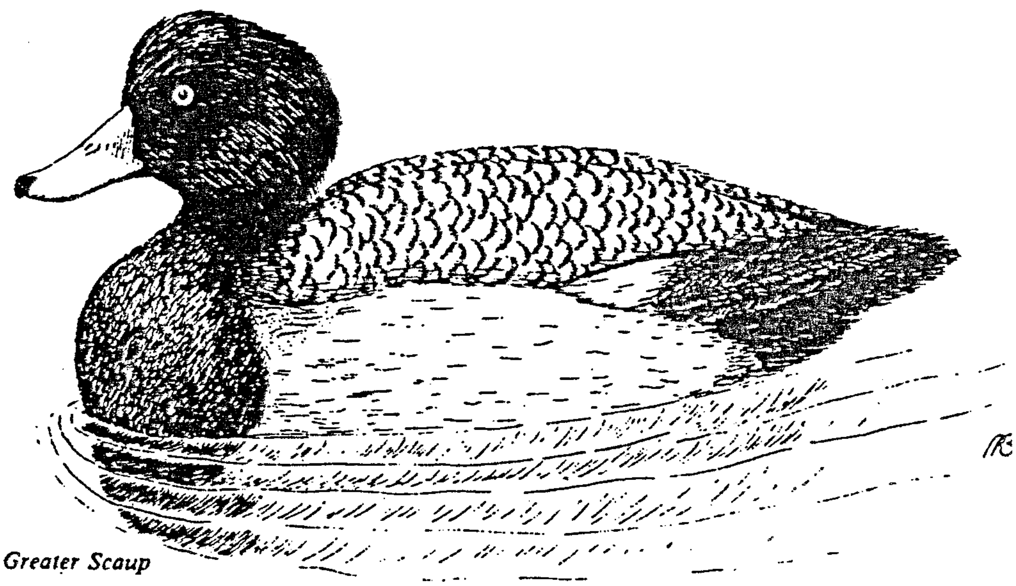
King's Mark Environmental Review Team



Greater Scaup

Lake Housatonic Study

Report for
The Lake Housatonic Authority

Derby, Oxford, Seymour and Shelton
Connecticut

LAKE HOUSATONIC STUDY

DERBY, OXFORD, SEYMOUR AND SHELTON

CONNECTICUT

Environmental Review Team Report

Prepared by the King's Mark Environmental Review Team
of the King's Mark Resource Conservation
and Development Area, Inc.

Wallingford, Connecticut

for the

Lake Housatonic Authority

This report is not meant to compete with private consultants by supplying site designs or detailed solutions to development problems. This report identifies the existing resource base and evaluates its significance to the proposed development and also suggests considerations that should be of concern to the Lake Authority and the Towns. The results of the Team action are oriented toward the development of a better environmental quality and long-term economics of the land use. The opinions contained herein are those of the individual Team members and do not necessarily represent the views of any regulatory agency with which they may be employed.

NOVEMBER 1988

ACKNOWLEDGEMENTS

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* William Warzecha, Geohydrologist
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* Duncan Graham, Executive Director
  Central Naugatuck Valley Regional Planning Agency

* Robert Frey, Regional Planner
  Valley Regional Planning Agency

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Finally, special thanks to Max Jaroszewski, Karl Atkins, Ed Oviatt, Alice Oviatt and Edmund Everetts, Sr. of the Lake Housatonic Authority and the Mayors of Derby, Oxford, Seymour and Shelton, for their cooperation and assistance during this environmental review.

Cover drawing by Ronald Boisvert from the Coastal Area Management Plan for the Town of Darien.

EXECUTIVE SUMMARY

Introduction

The Lake Housatonic Authority requested that an environmental review be conducted on Lake Housatonic which is an impoundment on the Housatonic River formed by the Derby Dam. The lake is bordered by the Towns of Derby, Oxford, Seymour and Shelton. Access is provided to the public by a boat launch at Indian Well State Park in Shelton.

The Lake Authority wishes to improve the lake for recreation and fishing by dredging. Currently, there are many sand bars and shallow spots that make recreational boating dangerous. The Lake Authority also wishes to know which areas of the lake are important to fish and wildlife, so that these areas may be left intact. Before dredging Lake Housatonic, the Lake Authority would like to know the potential environmental impacts of dredging and what might be found during dredging.

The review process consisted of four phases: (1) inventory of the site's natural resources; (2) assessment of these resources; (3) identification of resource problem areas; and (4) presentation of planning and land use guidelines. Based on the review process, specific resources, areas of concern, development limitations and development opportunities were identified. Below is a brief description of the major findings of the ERT study.

Setting, Topography and Land Use

Lake Housatonic is a long narrow impoundment formed by the Derby Dam. Many streamcourses feed the lake from the east and west. Road drainage, especially from the east outlets into the lake. The shoreline is developed with a mix of seasonal and year-round homes. The southern end of the lake has some industrial development. Many of the residences are served by on-site septic systems. Some areas also rely on well water. The terrain around the lake is steep and controlled by the underlying bedrock. The water in the lake appeared turbid during the field review and there was a weed harvester working. Bacterial counts from 1987 did not indicate significant contamination of the lake by sewage.

Geology

The bedrock underlying the site consists mainly of bands of crystalline, metamorphic rocks called schists and gneisses. A narrow band of igneous rock called Butress Dolerite underlies the lower part of the lake. Surficial geologic materials consist of those unconsolidated materials overlying bedrock. Stratified drift (sand and gravel) covers most of the immediate vicinity of the lake. These deposits are generally highly permeable and can store and transmit water easily. They can be important sources of water for large water supplies. The deposits in the central sections of the lake have been explored for groundwater development. Active sand and gravel mining has also taken place in these deposits. The remainder of the land in the vicinity of the lake is covered by glacial till deposits.

Hydrology and Water Resources

Lake Housatonic is an artificial impoundment of about 328 acres and has a water shed of over a million acres. The water level fluctuates depending on the industrial needs of the dam. The lake is recharged by precipitation either directly or indirectly. The water quality can be influenced by sources of pollution such as septic systems, erosion, fertilizers and chemicals, industrial discharges and stormwater runoff. There are areas of dense development along the lake with septic systems close to the water. A sanitary survey of areas close to the lake might be considered. Other sources of pollution could be investigated during the study. The Lake Authority is concerned about the shallow spots in the lake that have caused some boating accidents. Possibilities for dredging these spots include a drawdown of the water and excavation and hydraulic dredging.

Effects of Erosion and Sedimentation

Sediment is a product of erosion and is a natural process. Problems arise when development alters the natural character of the land by removing vegetation and increasing quantities of runoff. Lake Housatonic, because of its large watershed, is almost impossible to plan for and manage sediment control. A practical approach is to develop a management plan for the lakeshed lands. This can begin with a land use inventory. Erosion control plans and conservation plans for farming are important in preventing erosion. ConnDOT and the local public works departments could help reduce road sanding and design special catch basins to contain road sediment. Emphasis should be placed on maintenance of the basins. Other items could include limiting lawn fertilizers and chemicals near the lake, using non-phosphate detergent and upgrading marginal septic systems.

Water Quality

The lake is classified as Class B and eutrophic by the Connecticut Water Standards. The lake is suitable for fishing and recreation. Recreation can be impaired by nuisance weeds. The trophic conditions have improved since the baseline study due to controls for phosphorus. The sediments have been monitored for PCB's by the DEP. The levels have been low, however a dredging feasibility study should sample the areas to be dredged for verification.

The effects of dredging can be addressed by a dredging feasibility study which can be funded by the new state lakes grant program. Beneficial effects can include decreased weed growth and safer boating. A potential negative effect can be increased turbidity.

Lake Housatonic Dam

The dam is located on the Housatonic River approximately 1.3 miles north of the confluence of the Naugatuck and Housatonic Rivers. It was constructed in 1870 and includes 2 gatehouses, an earthfill dike and two canals used for industrial water supply. The dam was inspected in 1981 and again in 1986 and 1987. It is considered to be in good condition.

Wetland Considerations

The wetlands of Lake Housatonic include upper perennial riverine habitat, lower perennial riverine habitat, limnetic open water habitat and palustrine emergent wetland habitat. The proposed dredging of the river would require a Water Diversion Permit. Information needed for this permit can be obtained through a diagnostic feasibility study of the lake. Dredging the entire lake would not be feasible. Dredging in selected areas is recommended.

Fisheries

Lake Housatonic can be characterized as a moving pool. The substrate consists of ledge, boulder, gravel, coarse sands and sand/silt fines. The prolific weeds and irregular bottom provide in-water fisheries habitat. The lake contains a warmwater fishery population.

Dredging is the most practical method for reversing the effects of siltation and eutrophication. Impacts include turbidity, release of nutrients, disruption of the littoral zone species, excessive depth resulting in anoxic conditions. Recommendations include selective dredging, dredging shallow areas to depths not greater than 10-feet, storing removed materials in a proper manner, adding a sanitary sewer for the homes around the lake and limiting fertilizers and lawn chemicals close to the lake.

Threatened and Endangered Plant and Animal Species

According to the Natural Diversity Data Base, there are no Federal Endangered and Threatened Species or Connecticut "Species of Special Concern" within the open space areas. The area is considered a Natural Areas Inventory Site. While this designation provides no legal protection, it identifies areas that should receive consideration before any proposed development is approved.

Planning Considerations

The zones along the lake consist of residential zones from 1.5 acres to 5,000 sq.ft. Areas of commercial zoning exist in Derby, Seymour and Shelton. The municipal plans for the Towns support the existing uses along the lake. The principal sources of sediment to the lake are the brooks and the road culverts. Gravel mining operations have also contributed to sediment problems. Erosion control with strict enforcement should reduce the erosion in the area of the lake. Much of the surrounding lake shore is part of the 100-year flood boundary. Some recommendations include appearing before the Town planning boards to remind them how important sediment and erosion control is to the lake and mapping the watershed boundary on the zoning maps.

Recreation Considerations

The two major forms of recreation are boating and swimming. The lake experiences substantial boating traffic. Lake fluctuations and shallow areas may make boating hazardous. Nuisance weeds also can create problems for both boaters and swimmers. Dredging can increase the depth of the lake and will create safer channels. It can also control the weed growth. One negative point is that dredging may open the lake to faster and larger boats.

TABLE OF CONTENTS

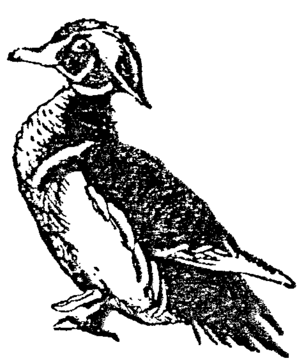
LAND USE AND PLANNING CONSIDERATIONS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION



INTRODUCTION

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The primary concern of the Lake Housatonic Authority is assessing the current status of the environment and the impacts of lake improvement on the environment. Specific objectives include:

1) Determining the bedrock and surficial geology of the lake and discussing the potential for finding saleable materials during dredging;

2) Providing watershed management guidelines for the site, including those for soil erosion and sediment control;

3) Providing fishery management guidelines to enhance fish habitat and populations;

4) Assessing existing wetland conditions and providing alternatives on how best to save and manage wetland resources;

5) Assessing the environmental condition of Lake Housatonic and the bank community and providing management guidelines; and

6) Determining the recreational opportunity of the lake and the potential recreational impacts of dredging.

THE ERT PROCESS

Through the efforts of the Lake Housatonic Authority and the King's Mark ERT, this environmental review and report was prepared. This report primarily provides a description of on-site natural resources, and presents planning and land use guidelines.

The review process consisted of four phases:

1) Inventory of the site's natural resources (collection of data);

2) Assessment of these resources (analysis of data);

3) Identification of resource problem areas; and

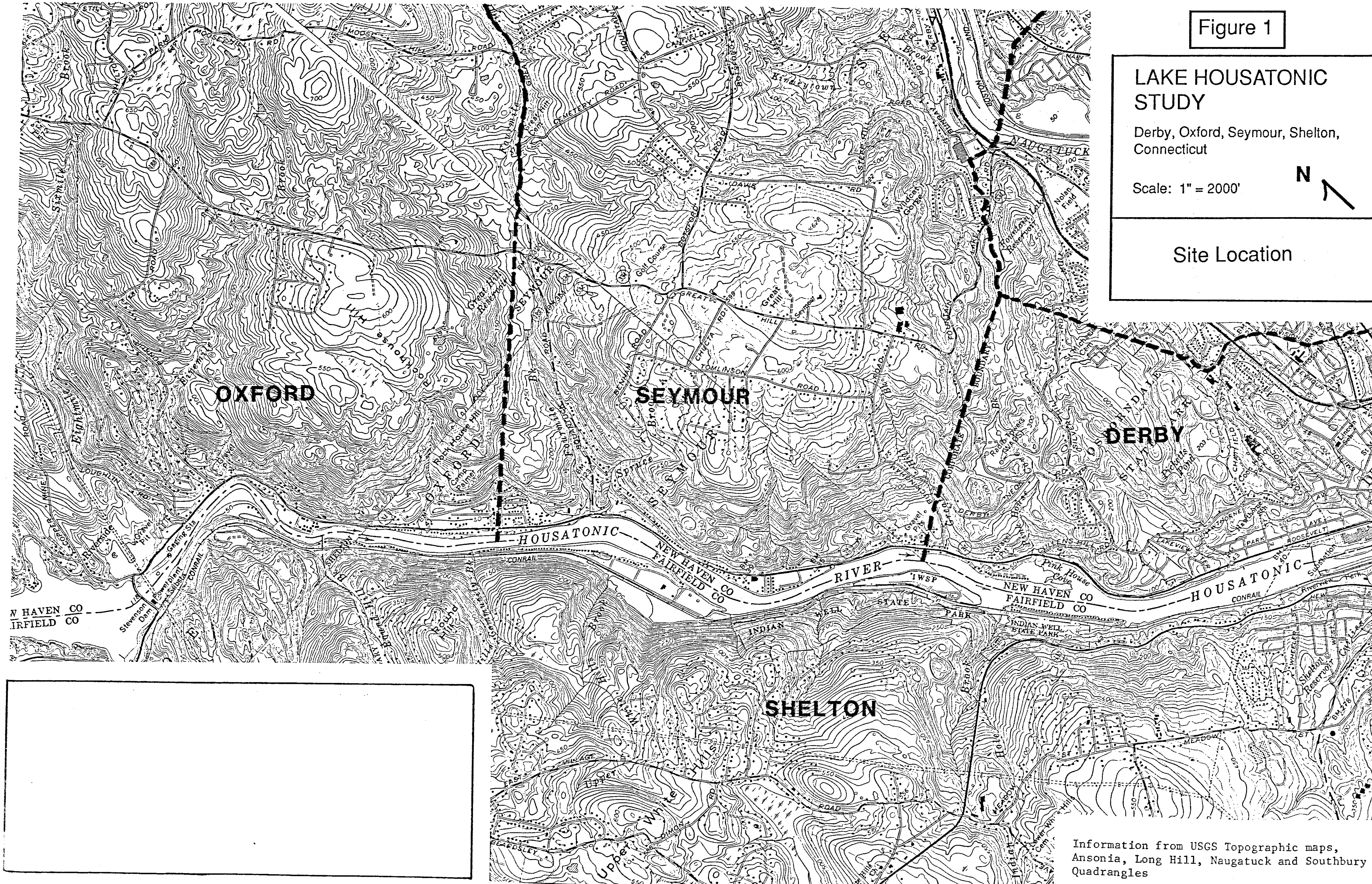
4) Presentation of planning and land use guidelines.

The data collection phase involved both literature and field research. The ERT field review took place on September 28, 1988. Field review and inspection of the site proved to be a most valuable component of this phase. The emphasis of the field review was on the exchange of ideas, concerns or alternatives. Mapped data or technical reports were also perused, and specific information concerning the site was collected. Being on site also allowed Team members to check and confirm mapped information and identify other resources.

Once the Team members had assimilated an adequate data base, it was then necessary to analyze and interpret their findings. The results of this analysis enabled the Team members to arrive at an informed assessment of the site's natural resource development opportunities and limitations. Individual Team members then prepared and submitted their reports to the ERT Coordinator for compilation into the final ERT report.

The primary goal of this ERT is to inventory and assess existing natural resources occurring on the site as well as to provide management guidelines.

Figure 1



LAKE HOUSATONIC STUDY

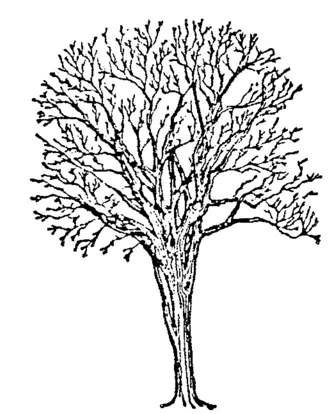
Derby, Oxford, Seymour, Shelton, Connecticut

Scale: 1" = 2000'

Site Location

Information from USGS Topographic maps, Ansonia, Long Hill, Naugatuck and Southbury Quadrangles

PHYSICAL CHARACTERISTICS



SETTING, TOPOGRAPHY AND LAND USE

Lake Housatonic, a long, narrow artificial impoundment on the Housatonic River, is located in the physiographic region of Connecticut known as the Western Uplands. It was formed by the creation of the Derby Dam and extends northward for about 6.5 miles to the Stevenson Dam. The lake is bounded by four towns: Shelton on the west and Oxford, Seymour and Derby on the east. The morphological characteristics of the lake include the following:

Surface Area	328.2 acres
Maximum Depth	26 feet
Mean Depth	9.4 feet
Volume	134,386,084.8 cubic feet
Retention Time	15 hours
Watershed Area	1,574 square miles or just over one million acres (represents the lake's watershed area from the Housatonic River's intersection with Derby Dam)

There are many streamcourses that directly feed the lake from the east and west. They include: Round Hill Brook, White Hills Brook, Indian Hole Brook, Curtiss Brook, Pink House Cover Brook, Great Hills Brook, Spruce Brook, Four Mile Brook, Five Mile Brook, Eight Mile Brook, as well as many other unnamed perennial and intermittent streamcourses. Road drainage, especially on the east side, outlets into the lake at various points.

Public access to the lake is available at Indian Well State Park, located on the west bank of the Housatonic River. Swimming, picnicking and a boat launch are available at the state park. Other bathing areas on the lake include Maples Beach, Seymour Beach and Riverside.

The shoreline of the lake is fairly well developed in several places with a mixture of seasonal cottages and year-round dwellings. The areas with the heaviest concentration of residences are the area east of Indian Well State Park at its southern limits, the area north of Pink Grove, the area between

White Hills Brook and White Hills Community Brook and the entire length of the lake along Route 34 in the Towns of Oxford and Seymour. It is understood that most residences are served by on-site septic systems. The Shelton side of the lake is serviced by public water, but there are many residences along the lake's edge that rely on individual on-site wells. A heavy concentration of industrial and commercial land uses occurs at the southern limits of the lake and in scattered areas along Route 34 on the east side of the lake.

The terrain immediately surrounding the lake is steep to very steep and is controlled largely by the underlying bedrock (see Figure 2). There are some flatter sections principally occurring in Oxford and Seymour and at Indian Well State Park. Most of the flatter areas have been developed for residential purposes.

Based on visual observations made at various points along the lake's shore during the field review, the lake water appeared to be slightly turbid. Some weedy areas were also observed. A weed harvester was working on the lake during the field review. Sanitary bacteriological quality of the water, as reviewed by samples collected during the summer of 1987 at Indian Well State Park, was generally good for swimming purposes. Bacterial counts, with the exception of one during mid-August, were well below the upper limit (1,000 coliform colonies/100 ml.), which is considered acceptable for swimming. The one high count obtained during mid-August possibly may have reflected surface wash runoff resulting from a period of heavy rainfall. Overall, the findings (fecal coliform) for 1987 did not indicate a significant or consistent degree of sewage contamination from septic systems, waste disposal facilities, etc. Experience in Connecticut has shown that intake lakes with relatively clean watershed should show coliform counts under 200 per 100 ml.

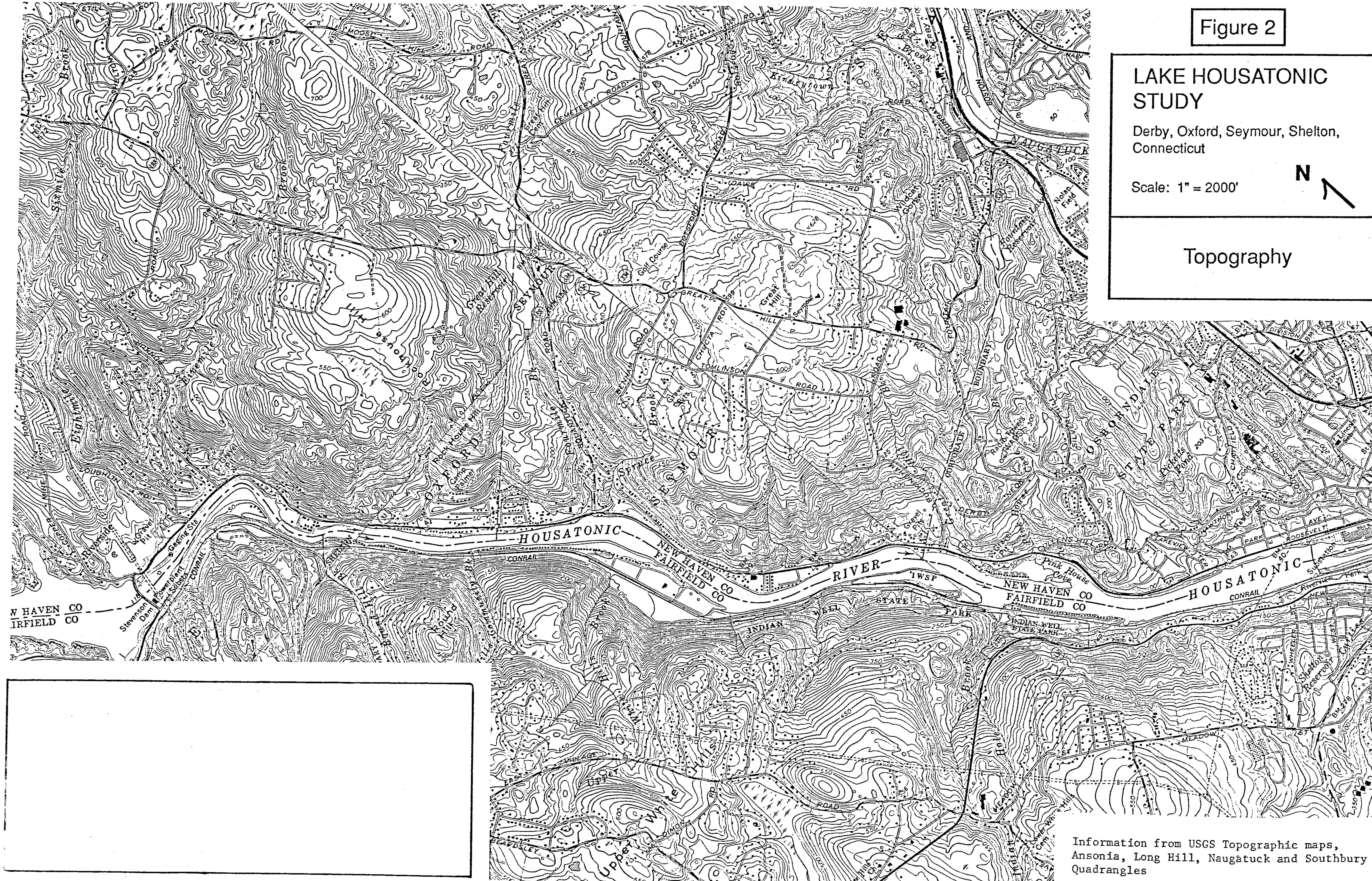


Figure 2

LAKE HOUSATONIC STUDY

Derby, Oxford, Seymour, Shelton, Connecticut

Scale: 1" = 2000'

N

Topography

Information from USGS Topographic maps, Ansonia, Long Hill, Naugatuck and Southbury Quadrangles

lake is stratified drift. Stratified drift was deposited by retreating glacier ice that occupied the Housatonic River Valley approximately 10,000 to 12,000 years ago. These sediments, which consist mainly of sand and gravel, were sorted by flowing waters emanating from glacial ice and were subsequently deposited in regular or irregular layers.

Stratified drift deposits are generally highly permeable and can store and transmit water easily. They can be an important source of water for large water supplies, particularly where the deposits are extensive, are coarse-grained and have a saturated thickness of 40 feet or more.

According to Connecticut Water Resources Bulletin #20 "Hydrogeologic Data for the Lower Housatonic River Basins" (Grossman & Wilson, 1970), the sand and gravel are thickest in the central parts of the lake where they range between 220 and 1800 feet. In general, the thickness of the sand and gravel beneath the remainder of the lake ranges between 40 and 80 feet. Transmissivity rates of the stratified drift beneath and surrounding the lake were also high, ranging between 2,700 to greater than 20,000 square feet per day. Because of these favorable hydrogeologic characteristics, the sand and gravel deposits, particularly in the central parts, have been investigated for groundwater development. As a result, there is an abundance of hydrogeologic information available in Water Resources Bulletins #19 and 20. The logs of numerous test holes and selected wells describe the thicknesses, textures and compositions of the sand and gravel materials in the vicinity of the lake. According to Water Resources Bulletin #19, there are at least four principal groundwater reservoirs in the study area that are named as follows: Zoar at the northern limits, Housatonic in the central parts, Indian Well in the southcentral parts

Figure 3

LAKE HOUSATONIC STUDY

Derby, Oxford, Seymour, Shelton, Connecticut

Scale: 1" = 2000'

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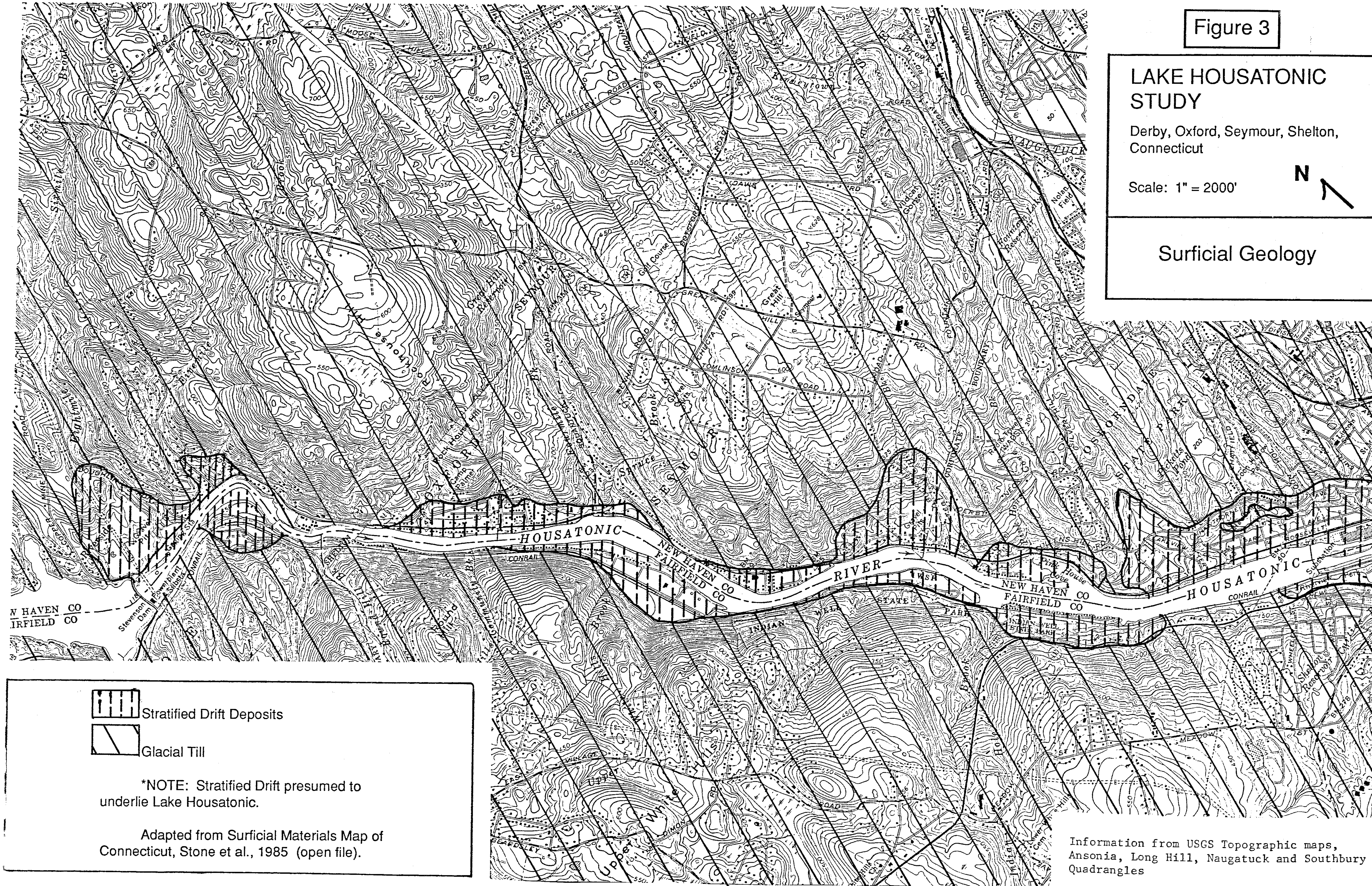
Surficial Geology



Stratified Drift Deposits

Glacial Till

*NOTE: Stratified Drift presumed to underlie Lake Housatonic.

Adapted from Surficial Materials Map of Connecticut, Stone et al., 1985 (open file).

Information from USGS Topographic maps, Ansonia, Long Hill, Naugatuck and Southbury Quadrangles

Lake Housatonic is recharged by precipitation, either directly or indirectly. Rainfall onto the lake is the most direct route. Rainfall in the form of surface runoff may pass overland to the lake or to an inlet stream. Finally, water may move into and through the ground, discharging downslope into a spring, seep, wetland, stream or directly into the lake. Therefore water quality depends upon both the initial quality of the precipitation and the route the precipitation takes to reach the lake. The natural route that water would take toward the lake may be interrupted by a man-made diversion such as a home or business and returned through an on-site waste disposal system.

The natural water quality in a watershed can be adversely influenced by various sources of pollution such as septic systems, sedimentation and erosion, agricultural practices, lawn and garden fertilizers, industrial discharges and stormwater runoff from roads. These sources of pollution, either singularly or in combination, can severely impact the environmental health of the lake. Potential sources of pollution (i.e., direct discharge of industrial wastes, direct discharge of sewage, overflowing septic tanks or septic tank effluent which is not completely renovated, etc.) closest to the lake will pose the greatest risk to water quality.

If a septic system is not properly designed, installed and maintained, there is a good chance it will malfunction. A malfunctioning septic system will either result in the backflow of sewage effluent into a house or the breakout of septic effluent on the surface of the ground. Sewage effluent discharging onto the ground surface may ultimately reach the lake. Other particular concerns are areas of highly permeable soils (sand and gravel). Groundwater pollution from sewage is more likely to occur in permeable soils than in poor soils, and noticing sewage disposal system failure or overflow is

TABLE 1 POTENTIAL YIELDS OF PRINCIPAL GROUNDWATER RESERVOIRS

GROUNDWATER RESERVOIR		HYPOTHETICAL WELL FIELD				AQUIFER STORAGE		AQUIFER CAPACITY		GROUND-WATER RUNOFF Annual minimum calendar year groundwater runoff. Recurrance interval	
Letter designation and name	Size (sq. mi.)	No. of wells	Well spacing (ft)	Saturated thickness of aquifer at well sites. (ft)	Maximum available draw down (ft)	Initial average transmissivity (ft2/day)	Yield from storage during period of no recharge (mgd)	Initial average transmissivity (ft2/day)	Capacity during period of no groundwater recharge; stream acts as recharge boundary (mgd)	2-yr (mgd)	10-yr (mgd)
C. Zoar	.097	3	500 - 1,300	80	55	8,000	.95	7,100	1.9	.82	.52
D. Housatonic	.22	9	200 - 300	200	169	13,400	6.8	10,300	15	1.9	1.2
E. Indian Well	.39	6	1,000	120	83	4,700	2.5	5,900	4.0	1.1	.68
F. Shelton-Derby	.31	5	1,000	80	55	4,700	1.5	9,400	3.6	.52	.32

INDUCED INFILTRATION OF STREAMFLOW AT LOW FLOW CONDITIONS

		Streambed Deposits							Stream Flow Annual minium 7-day flow Recurrence interval		
Letter designation and name	Principal stream entering groundwater reservoir (River)	Wetted area (million sq. ft.)	Thickness (ft)	Vertical hydraulic conductivity (ft/day)	Average drawdown beneath stream (ft)	Average stream depth (ft)	Hydraulic gradient (ft/ft)	Infiltration capacity (mgd)	2-yr (mgd)	10-yr (mgd)	Augmentation at low flow; in 1960's (mgd)
C. Zoar	Housatonic	.48	15	6.8	34	1	1.1	26	154	77	64
D. Housatonic	Housatonic	2.4	8	0.7	70 - 95	6	1.8	22	154	77	64
E. Indian Well	Housatonic	4.1	8	0.7	21	12	2.5	51	155	77	64
F. Shelton-Derby	Housatonic	3.6	8	0.7	20	10	1.8	32	155	77	64

TABLE 1 POTENTIAL YIELDS OF PRINCIPAL GROUNDWATER RESERVOIRS (Continued)

	POTENTIAL YIELDS		
Letter designation and name	During periods of no groundwater recharge (mgd)	During groundwater recharge period (mgd)	Actual groundwater reservoir pumpage in 1960's (mgd)
C. Zoar	1.9	2.7	0
D. Housatonic	15	17	8.5
E. Indian Well	4	5.1	0
F. Shelton-Derby	3.6	4.1	1.9

rare in such permeable soils. The sewage effluent can contribute phosphorous, nitrates and other pollutants to the lake. A far more important consideration, however, is that a failing septic system is a public health hazard which demands immediate correction.

There are several areas along the lake that are characterized by very dense residential development. Many of these homes were probably originally summer homes that have been converted to year-round use with no upgrading of the on-site septic systems. In addition, the densest residential areas along the lake are underlain by highly permeable soils (sand and gravel) and are very close to the high water mark of the lake. For these reasons, it might be wise to conduct a sanitary survey of the heavily developed areas along the lake that rely on individual on-site septic systems. Given the size of the Lake Housatonic watershed, it would be virtually impossible to survey the entire watershed. The sanitary survey should be coordinated with each Town's Health Department. Other sources of pollution (i.e., industrial discharges, sedimentation, etc.) also could be investigated as part of the survey. Also, it might be wise to consider an ordinance for lakeside residents to use non-phosphate laundry detergents. The use of non-phosphate laundry detergent can reduce the phosphorous passing through a residential septic system by 30 to 40%.

Another potential source of pollution which may threaten the environmental health of Lake Housatonic is erosion and siltation. Eroded soils, which are transported directly or via streams into the lake, contribute to the physical "filling in" of the lake and can accelerate lake eutrophication by enriching water nutrients. This nutrient loading of the lake can accelerate the nuisance growth of aquatic weeds or algae.

The major source of sediment to the lake is probably generated by the road system (i.e., paved roads and driveways, gravel driveways and road shoulders) and streambed and streambank erosion due to increased runoff from newly developed areas. As required by Public Act 183-388 "An Act Concerning Soil Erosion and Sediment Control," any new development that takes place in the lake's watershed in Connecticut should be accompanied by a comprehensive erosion and sediment control plan.

During the pre-review meeting, Lake Authority members expressed concern about the shallow areas that have developed in the lake. This has resulted in an increased number of boating accidents. If the lake could be drawn down, it may be possible to excavate the lake substrate that has accumulated in various areas. The drawdown and excavation process requires the use of heavy equipment, and it must be determined whether the lake bottom could support this weight. Any drawdown would need to be coordinated with the owners of the Derby Dam. Another concern with a lake drawdown is the potential impact to shallow wells serving homes along the lakefront that may be hydraulically connected to the lake. Dug wells that serve homes around the lake may be dried up or the volume in the wells seriously diminished. Domestic wells, in particular those close to the lake, will need to be surveyed. If drawdown and excavation is considered, a feasibility study should be conducted to "map" lake sediments according to depth, composition and underlying substances. Also, final disposal of excavated sediments should be explored during the feasibility study.

Another method for removing the accumulated sediments would be hydraulic dredging. This method utilizes specialized sediment dredges that remove underwater sediments by suction as a slurry. The slurry must be dewatered prior to final disposal, and the decant water usually must be treated to remove solids and nutrients prior to disposal. The development of dewatering containment basins of suitable size and location is a major and expensive undertaking. However, where environmentally and financially feasible, this method can provide improvement. Hydraulic dredging accomplishes the same goal as drawdown and excavation, but is more costly due to increased specialization and complexity.

EFFECTS OF EROSION AND SEDIMENTATION

Sediment is usually the product of the erosion process and very often becomes the major non-point pollutant within a stream/lake system. The effect is to impair the quality of water for existing uses and reduce the volume of a lake basin available for water storage. Sediment is usually a mix of soil, rock fragments and organic debris eroded from upland areas and carried by concentrated flowing water across land surfaces to a stream system. Once in the stream, the heavier material is carried by the current as bed load, and the finer material, including silt size particles, may be in the water column as suspended solids. When these materials reach an area where the current slows, they settle out and become sediment.

Erosion and sedimentation are natural processes. Some streambank and streambed erosion occurs within all stream systems, the extent depends upon the soil types, landform and land uses. Problems usually arise when commercial and residential development alter the natural character of the land by removing vegetation and increasing quantities of runoff through a reduction of permeable soils (i.e., increasing pavement and rooftops). Agricultural operations, such as growing row crops on highly erodible lands without provisions for soil erosion control, also contribute to sediment loading.

Sediment within the stream and lake system can reduce sunlight penetration, alter water temperatures and absorb chemicals and organic matter. This contributes to chemical contamination, eutrophication and BOD loading, thereby creating unfavorable conditions for recreation and aquatic life and other water uses. Over time, sediment can fill a lake basin which is happening to Lake Housatonic.

The subject of erosion and sediment (E&S) control and related effects on water quality is a discussion of watershed characteristics and watershed management. The Lake Housatonic watershed can be divided into two components. The first is the Housatonic River watershed upstream of the lake, and the second is the lakeshed lands directly adjacent to the lake which, because of their proximity, have a direct linkage and impact on the water quality of the lake.

The Housatonic River watershed at the lake inlet contains approximately 1,574 square miles or 1,007,360 acres. That is an area roughly one-third the size of the state of Connecticut. From a practical watershed management standpoint, a land area that large with such a diverse pattern of land use, governmental authorities and ownership patterns is almost impossible to plan and manage for sediment control and other water quality concerns.

A practical approach may be developing a lakeshed management strategy or plan for the first component of watershed area, that is, the lakeshed lands within the Town boundaries.

A management scheme for the watershed or lakeshed lands should begin with an inventory of the land resources and the development and land use patterns. The slopes of the Lake Housatonic watershed are very steep. Loss of vegetation cover can result in soil eroding into the stream. The steep slopes create a high velocity of streamflow which results in very little sediment filtering out before it reaches the lake. In a steep watershed such as this, there is little opportunity to design and install sediment basins effectively. Therefore, an added emphasis needs to be put on keeping soil in place rather than catching it downstream after erosion and transport has begun.

All existing and future commercial and residential development should have adequate erosion and sediment control plans and implementation of these plans during the construction phases. Connecticut statutes provide for Towns to take immediate corrective action at the developer's expense on problems where developers allow unchecked erosion to occur.

Similarly, all farming operations should have conservation plans which adequately treat cropping practices and management of manures so that they do not constitute a source of sediment and non-point pollution. Help to develop or review a plan is available to individuals through the local Soil and Water Conservation District.

The Lake Authority should consider meeting with the Connecticut Department of Transportation (ConnDOT) and with Town Public Works Authorities to discuss minimizing winter road sanding and to explore the possibility of using specially designed catch basins at road crossings to contain sediment from road sanding. Emphasis should be on maintenance to remove the materials before they fill the basins to capacity. Any operations which remove or disturb the existing vegetative cover of the watershed over a long period of time should be reviewed for adequacy of erosion control provisions including revegetation. This includes land uses such as gravel mining and waste areas. Other items a watershed plan might address are limiting fertilization of lawns and planning for the containment of oil and gas spills from parking areas and marinas near the lake. Using low phosphate detergents and maintaining and upgrading marginal septic systems should be a priority where on-site sewage systems occur.

Adjacent lakeshed lands constitute only a small part of the total watershed for the lake. This indicates that with all practical management opportunities implemented, the upstream watershed and its impact on the lake may overshadow the local management efforts. Fortunately for the lakeshed property owners and users, two other lakes exist upstream to act as sediment basins from materials carried by the river. In the long-term, dredging may be continued on an as needed basis. Dredging should solve some local problems including deltas forming where tributaries enter the lake.

WATER QUALITY

Hydrology

General principles of lake watershed management are described in the Department of Environmental Protection (DEP) handbook, "A Watershed Management Guide for Connecticut Lakes" (1988) (Appendix A). This handbook should be used by the Lake Housatonic Authority to develop a management plan for the land immediately adjacent to the lake. The Lake Authority should also consider applying for a state grant to study the immediate watershed in more detail. The Lake Authority is aware of the grant program, established by Public Act 87-492, which could fund 75% of the cost of the study.

The Connecticut DEP has been implementing a phosphorous control program in the Housatonic River watershed to mitigate eutrophication in the Housatonic Lakes. The program is based on seasonal phosphorous removal at wastewater treatment plants and non-point source controls for agriculture. The Lake Authority should support DEP's efforts in seeking to implement controls for out-of-state sources in New York and Massachusetts.

Lake and Water Resources

A baseline water quality survey was conducted in 1980 to determine the trophic status of the lake. The lake is classified as eutrophic, based on low water clarity and elevated levels of phosphorous, nitrogen and chlorophyll A. Approximately 15% of the lake surface supports dense growth of a variety of aquatic weeds. The lake does not stratify into different temperature layers in the summer. This data is reported in DEP Bulletin #3 "The Trophic Classifications of Seventy Connecticut Lakes" (1982) (see Appendix B). The trophic conditions at Lake Housatonic have improved since the 1980 survey due to subsequent controls for phosphorous sources.

The concentrations of PCB's in Housatonic River sediments and fish have been monitored by the DEP. PCB levels in Lake Housatonic have been low in comparison to Lake Zoar and Lake Lillinonah. However, any dredging feasibility study should sample sediments in the specific area(s) proposed for dredging to verify that PCB levels are low. Although trace levels of PCB's have been measured in sediment and fish in past years, the concentrations have been quite low and have not warranted a fish consumption advisory.

Lake Housatonic is a waterbody which is classified as Class B and eutrophic by Connecticut Water Standards. As Class B water, the lake is suitable for recreational fishing and water based recreation. Recreation is impaired somewhat by eutrophication, primarily nuisance aquatic weeds. The Lake Housatonic Authority has conducted weed harvesting in summer months to manage this problem.

Lake Housatonic is an impoundment on the Housatonic River. River flow is measured continuously by the U.S. Geological Survey Station 01205500 immediately below the Stevenson Dam which forms Lake Zoar. The average discharge, adjusted for storage and diversion, for the 57-year period of record is 2,616 cubic feet per second. The maximum discharge recorded was 75,800 cubic feet per second on October 16, 1955. The average hydraulic residence time in the impoundment is 15 hours. The rapid flushing rate prevents the development of thermal stratification and inhibits the development of nuisance planktonic algae blooms.

The water quality effects should be addressed in detail by a dredging feasibility study which could be 75% funded under the new state lakes grant program. Beneficial effects could include aquatic plant control if weed bed areas are dredged sufficiently deep to prevent regrowth. A potential negative effect would be turbidity caused by the operation of dredging equipment. This could be minimized by selection of appropriate equipment and use of proper operating procedures. Potential release of PCB's during dredging should also be evaluated during a feasibility study. Water quality effects from hydraulic dredge discharges would be controlled by a discharge permit requiring treatment of return water.

Current water quality management has focused on the problem of eutrophication. The DEP has been implementing a watershed management program for the Housatonic River to control sources of phosphorous. Seasonal phosphorous removal at wastewater treatment plants has resulted in improvements in phosphorous levels, algae blooms and water clarity. Alternatives for managing the nuisance weed problems in Lake Housatonic have focused on harvesting. The alternative of dredging should be considered as a means of providing long term improvements.

LAKE HOUSATONIC DAM (A.K.A. DERBY DAM)

Lake Housatonic Dam is located on the Housatonic River on the border of Shelton and Derby approximately 1.3 miles upstream of the confluence of the Naugatuck and Housatonic Rivers. It was constructed around 1870 and includes two gatehouses and associated canals at either end of the dam. The westerly gatehouse directs water to the Shelton Canal and the easterly gatehouse to the Derby Canal, which have been used for industrial water supply. Two sets of locks are present on the Shelton Canal which were used in the past for the passage of boats. A detailed history of the dam and canals is found in Appendix C.

The dam was inspected by the Army Corps of Engineers in 1981 under the National Program for Inspection of Non-federal Dams. Recommendations for additional engineering investigation and repair generated by Corps of Engineer's Report have essentially all been completed. The dam is considered to be in good condition, based on follow-up DEP inspections of the structure in 1986 and 1987.

Currently, the dam is owned by McCallum Enterprises and is being retrofitted for hydropower production. Mr. E.J. McCallum, Jr., President of McCallum Enterprises, can provide additional information regarding this project and can be reached at 386-1745.

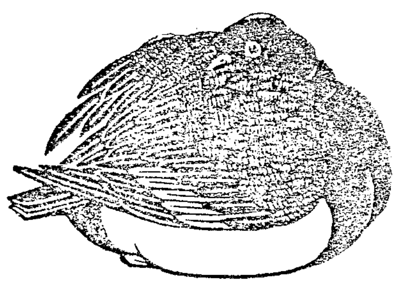
NATIONAL DAM INSPECTION PROGRAM

Brief Assessment

The Lake Housatonic Dam, formerly known as the Derby Dam, was completed in October, 1870 to facilitate river traffic on the Housatonic River and supply water to nearby factories. The entire facility consists of a 400-foot-long earthfill dike along the left bank (average crest elevation 39.4 NGVD), a gatehouse at the left abutment that regulates flow into an industrial water supply canal, a 675-foot-long by 23-foot-high spillway section spanning the river and a second gatehouse and boat lock at the right abutment. The earthfill dike has a maximum height of approximately 10 feet and is 15 feet wide at the crest. The total height of the dam from the downstream toe of the spillway section to the top of the earthfill dike is approximately 40 feet.

The left gatehouse contains three 8-foot by 8-foot gates that may be operated manually or with a portable device that is driven by an electric motor. Discharge from the gatehouse flows through a canal, paralleling the river, before it is returned to the Housatonic River approximately 2,230 feet downstream. The spillway section is curved in plan and has an average crest elevation of approximately 23.7 (top of flashboards elevation 25.2). The downstream face of the spillway is concave and terminates at an apron. The gatehouse and boat lock, located at the right abutment, regulate flow into a canal which is approximately 80 feet wide and 3,200 feet long. An emergency spillway, located adjacent to the spillway section and ending 145 feet downstream from the gatehouse, discharges excess flow from the canal into the river. A three gate lock system lies approximately 1,680 feet downstream of the gatehouse, in the left bank of the canal. The canal is formed by an earthfill embankment on the left side and a vertical concrete wall, which retains a railroad embankment, along the right side.

BIOLOGICAL RESOURCES



residents along the lake who depend upon private wells for their domestic water supply may be affected by a lowering of the lake level. Contingency plans to supply water to anyone whose well is diminished due to lowering of the lake level would have to be formulated.

For all practical purposes, the dredging of the entire lake would not be feasible. The dredging of the 328-acre lake to a depth 2 feet deeper than present would generate approximately 1.06 million cubic yards of material. A volume of dredging material of this magnitude may pose a significant disposal problem for the Lake Authority.

FISHERY RESOURCES

Site Description

Lake Housatonic is an artificial waterbody formed by impounding the flows of the Housatonic River. Lake Housatonic is classified by the DEP as Class B surface waters. Designated uses for Class B waters are: swimming, fishing, certain fish and wildlife habitat, certain recreational activities, agricultural uses, industrial uses and other legitimate uses including navigation.

Lake Housatonic is located within an area of extensive urban development. The lake shoreline has been developed with numerous cottages, year-round housing, and commercial businesses, severely limiting areas of open space. Lake Housatonic has a surface area of 328 acres, a maximum depth of 26 feet and an average depth of 9.4 feet. Because it is an impoundment, the lake can be characterized as a moving pool. The lake substrate consists of ledge, boulder, gravel, coarse sand and sand/silt fines. The lake is considered a eutrophic waterbody with macrophytes proliferating in the shallows. Substrate structure of irregular bottom contours, boulders and macrophyte growth provide in-water fisheries habitat.

Figure 4

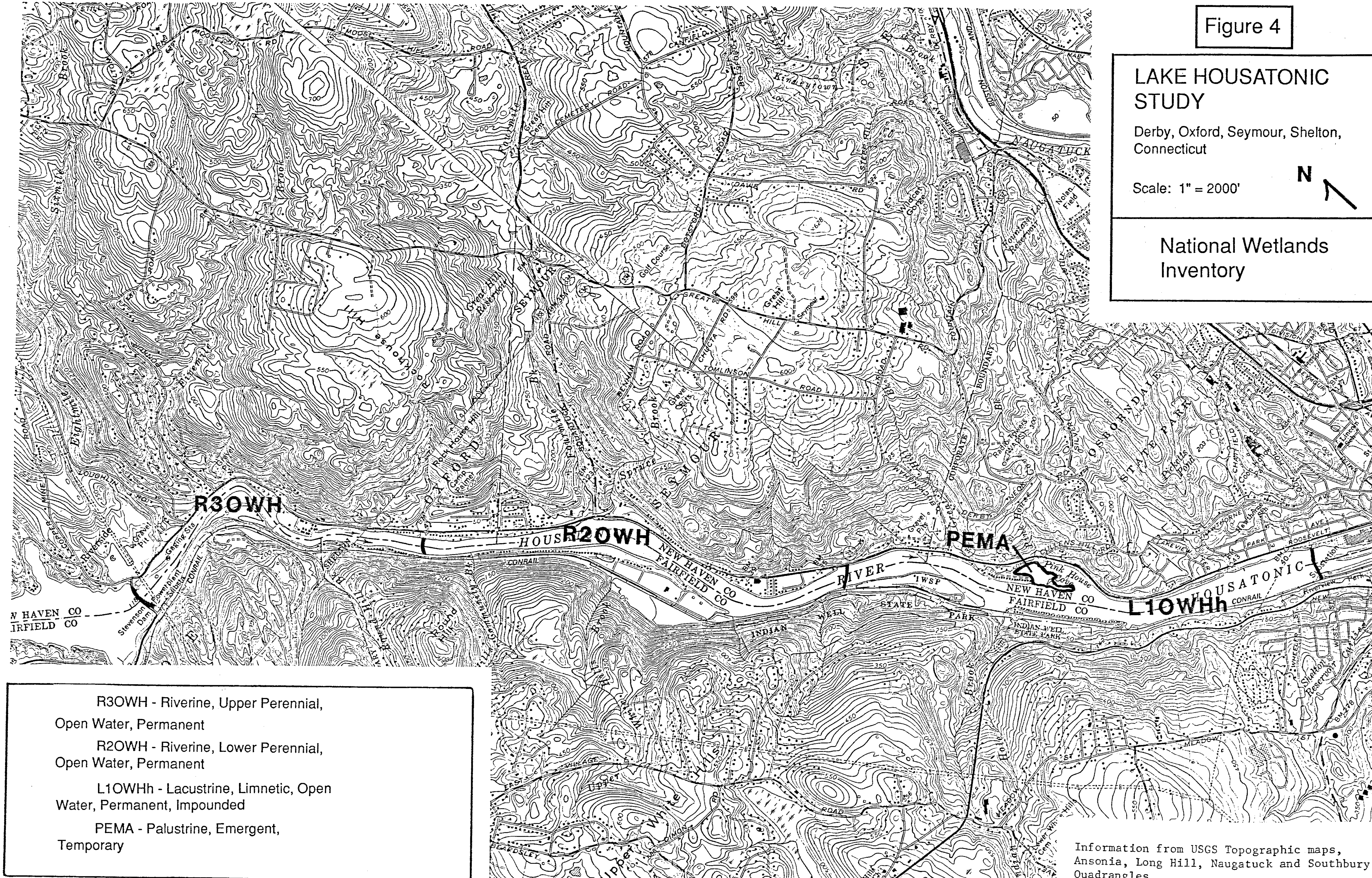
LAKE HOUSATONIC STUDY

Derby, Oxford, Seymour, Shelton, Connecticut

Scale: 1" = 2000'

N

National Wetlands Inventory



R3OWH - Riverine, Upper Perennial, Open Water, Permanent

R2OWH - Riverine, Lower Perennial, Open Water, Permanent

L1OWHh - Lacustrine, Limnetic, Open Water, Permanent, Impounded

PEMA - Palustrine, Emergent, Temporary

Information from USGS Topographic maps, Ansonia, Long Hill, Naugatuck and Southbury Quadrangles

Recommendations

Impacts to Lake Housatonic from dredging can be minimized. Suggestions include:

1) Dredging should be selective, limited to those areas around tributary mouths and shallow coves. The dredging of the entire lake system can be ecologically devastating. Shallow water areas are required for the balance and maintenance of the entire ecosystem. Ideally, the littoral zone should be approximately 40% of the lake surface area.

2) Dredging in shallow areas should not create depths greater that 10 feet. A depth of 10 feet is sufficient to prevent the growth of rooted plants by limiting light penetration and will not be deep enough to produce anoxic conditions. A depth of 10 feet is also adequate for the safe passage of boats.

3) Removed materials should be stored in such a manner as to prevent infiltration back into the lake.

4) The septic system leachate from cottages surrounding the lake contribute a significant amount of nutrients to the lake. Dredging will remove sediments, yet water quality will continue to be compromised by the leachate. It would benefit the entire lake ecosystem to have a sanitary sewer installed in place of the existing individual septic systems.

5) Limiting liming, fertilizing and the introduction of chemicals to lawns developed close to the lake will help abate the amount of additional nutrients entering into Lake Housatonic.

THREATENED AND ENDANGERED PLANT AND ANIMAL SPECIES

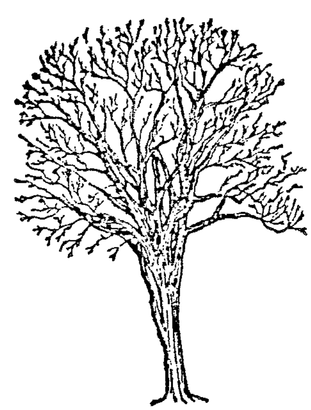
According to the National Diversity Data Base there are no Federal Endangered and Threatened Species or Connecticut "Species of Special Concern" that occur at or adjacent to the area in question.

The area is a Natural Areas Inventory site. In 1972 the Connecticut Forest and Park Association, Inc. prepared a Natural Area Inventory which included 459 sites. These were nominated as significant sites for one or more of the following attributes: geologic, hydrologic, biologic, archaeologic, cultural, aesthetic, research/educational. Being listed as a NAI site does not impart any restrictions or provide legal protection; it identifies areas that should receive consideration before any proposed development is approved.

In addition, there is invertebrate information from a member of the Connecticut Entomological Society. The locational information is about beetles (Coleoptera) considered rare in the state and collected during the late 1940's through 1987. These species are considered rare and included in a list put together by the Connecticut Entomological Society (Second Working Draft; March 1988).

Natural Diversity Data Base information includes all information regarding critical biologic 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. Consultation with the Data Base should not be substituted 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.

LAND USE AND PLANNING CONSIDERATIONS



PLANNING CONSIDERATIONS

Location

Lake Housatonic stretches approximately 31,000 linear centerline feet (5.85 miles) from the Stevenson Dam in the northwest at Monroe and Oxford to the other substation dam in a southeast direction at Derby and Shelton. Of this total distance, the Town of Oxford, located in the Central Naugatuck Valley Planning Region, fronts on approximately 10,000 linear centerline feet (1.9 miles).

Existing Land Use

The area from the Seymour Town Line northwestward along Route 34 to the Stevenson Dam is characterized by single-family homes probably of median value. Very few of the structures, in contrast to the Seymour area, are summer cottages converted to year-round use. There are a few structures clinging to the lake bank that are summer occupancy. No commercial or industrial uses were observed in the immediate area. There are several gravel mining areas which, according to the Town Planner and from observation, are not in operation or permitted by the Town of Oxford. Camp Palmer, now known as Oxford Glen, is one of the discontinued pits. Within the pit area three acres were to be donated to the Town for a softball field. However, there are still technical/legal questions concerning ownership which must be resolved. The Town of Oxford does not have frontage nor provide access to the lake.

Existing Zones

Route 34 (Roosevelt Drive) enters Oxford at the Seymour Town Line and follows the northern bank of the lake up to and across the Stevenson Dam into Monroe. From points 600 feet roughly north and easterly of this road to the lake front, the land is zoned Residence District D. This is the only area in the Town of Oxford which is so zoned. Property north and easterly of the 600-foot mark to Route 188 is zoned Residence District A. According to the Zoning Regulations for the Town of Oxford revised March 1, 1986 and amendments through March 31, 1988, the Residence District A is their basic single-family residence zone requiring 1 1/2 acres per single detached dwelling for one family. In addition, minimum square frontage is as follows:

1)	One story dwelling	1000 sq.ft.
2)	Split level, 1 1/2 story	1200 sq.ft.
3)	Two story dwelling	1400 sq.ft.

The strip of Residence District D paralleling the lake similarly requires 1 1/2 acres per single detached dwelling for one family. The minimum required square footage is as follows:

1)	One story dwelling	800 sq.ft.
2)	Split level, 1 1/2 story	960 sq.ft.
3)	Two story dwelling	1120 sq.ft.

There are other special provisions in District D by which the Planning and Zoning Commission may allow undersized lots recorded prior to a specific date to be built upon. The Town Planner noted that there is an old subdivision "Under the Rock Park" on the bank of the lake with 1/2-acre lots. Permits to build are carefully scrutinized in relation to the National Flood Insurance Program (NFIP) according to the zoning regulations.

Zoning along Lake Housatonic (from the dam going up the river) in the Valley Regional Planning Agency consists of:

Shelton: R-4 (Residential):	7,500 sq.ft. minimum lot area, 60 ft. minimum frontage, 40 ft. maximum building height. Permitted - 1, 2 and 3 family dwellings.
R-1 (Residential):	40,000 sq.ft. minimum lot area, 135 ft. minimum frontage, 40 ft. maximum building height. Permitted - Single-family dwellings.

Derby:	C-3 (Commercial):	Minimum lot area - none, minimum lot width - none, maximum building height - none. Permitted - Wholesale business, storage, limited industry.
	R-5 (Residential):	5,000 sq.ft. minimum lot area, 50 ft. minimum lot width, maximum building height - none. Permitted - 1 and 2 family dwellings.
	R-20 (Residential):	20,000 sq.ft. minimum lot area, 125 ft. minimum lot width, maximum building height - none. Permitted - Single-family dwellings.
Seymour:	RC-3 (Residential Commercial):	20,000 sq.ft. minimum lot area, 100 ft. minimum lot frontage, 40 ft. maximum building height. Permitted - Single-family dwellings, houseboats, retail establishment, taverns, day camps, boat repair, sales and boat rental.

Municipal Plan of Development

The comprehensive plan for the Town of Oxford was prepared in December 1965 by E.W. Lord-Wood Associates. The plan is seriously outdated and does not represent present municipal policy. The comprehensive plan is in the process of extensive updating and is expected to be completed by the Oxford Town Planner in 1989. Given the gorge-like physical configuration and topography in the study area, it appears that no significant changes will be proposed. Accommodating the existing uses, maintaining above flood level construction/reconstruction and requiring at least the present 1 1/2-acre low density residential zoning seems logical.

Current zoning and land use on the Shelton shore of Lake Housatonic conforms to the Town's Plan of Development which allows for single-family residences, public recreation and open space.

Current zoning and land use on the Derby shore corresponds with the Town's Community Development Action Plan which recognizes the boating interests of Derby residents.

Current zoning and land use on the Seymour shore conforms to the Town's Comprehensive Plan of Development which recommends a mixed recreational-commercial zone along the entire shore.

Land use is consistent with the current Valley Regional Planning Agency Regional Plan of Development which recommends recreation/open space and single-family residences in the Lake Housatonic area.

Transportation/Utilities

Route 34 parallels the Housatonic through the east side of the study area. This two-lane asphalt highway had a 1987 ADT of 7500 vehicles as reported by ConnDOT. At that level, the highway functions at about one-half of its design capacity. Although monthly or seasonal counts are unknown, it is assumed that peak counts occur during the summer and boating months.

Land uses in Oxford depend entirely upon on-site well and sewage disposal systems. While extensions of these utilities from Seymour into this area of Oxford have been proposed by a developer, the Planning and Zoning Commission would not increase residential density to accommodate the economics of the proposal.

Flooding/Siltation

Other than culvert systems along and under Route 34, the principle sediment sources are Eight Mile Brook and Five Mile Brook to their confluence with Lake Housatonic. The Eight Mile Brook watershed is within the Housatonic Main Stem Regional Basin and extends 13 1/2 miles through Oxford to the northwest corner of Middlebury at Lake Quassapaug. The Five Mile Brook watershed has a significantly smaller area because its northern reach is only approximately 2 1/2 miles northeast of Lake Housatonic. In past years, the gravel mining operations conceivably could have been major contributors to lake sedimentation problems. There are still significant deposits of sand and gravel in this area of Oxford. Present mining and removal regulations, if carefully administered and enforced, should mitigate future problems. Much of the land area in the Lake Housatonic watershed, according to Central Naugatuck Valley Regional Planning Agency (CNVRPA) 208 studies, carries a soil erosion hazard rating of Severe - very easily erodible, emphasizing the necessity for strict enforcement. Erosion and sedimentation plans are required by state law for all developments including single-family home construction.

According to the Flood Insurance Study (1979), "Six major floods have occurred since 1900: in 1927, 1936, 1938, 1948 and two in 1955. The greatest flood took place in October 1955 on the Housatonic River (Lake) and had an estimated recurrence interval of 120 years." Given the physical configuration of the lake banks, no floodway is defined. The 100-year mapped flood boundary definition places an estimated 90% of all existing structures adjacent to Route 34 within that flood zone.

Observations

1) Given NFIP requirements and E&S controls presently in place and enforced by Oxford officials, deposition into the lake, especially from Eight Mile Brook and Five Mile Brook, should be greatly reduced at present and in the future. Any dredging at these points, therefore, should have a long lasting effect.

2) Since E&S control is a state development law, it is assumed that all municipalities bordering the lake are active participants and enforcers of those regulations. The key to a regulation is consistent enforcement. The Lake Housatonic Authority, as part of each annual work program, should consider appearing before the local land use commissions to remind them of the importance of E&S controls/ enforcement. It is the Commissions' responsibility to maintain the Lake Housatonic environment and water quality to the best of their interests.

3) The Lake Authority might consider recommending to abutting lake municipalities that the local zoning maps define the watershed boundary to Lake Housatonic. While E&S regulations should be equally enforced throughout each municipality, a single line on the zoning map could be a constant reminder to users of that document.

RECREATION CONSIDERATIONS

Existing Recreation Opportunities

The two major forms of recreation on Lake Housatonic are boating and swimming. The entire lake area experiences substantial boating traffic. Various access areas include the Yale Boat House in Derby, the Seymour "Beach" and Riverside Park and Indian Well State Park in Shelton. Indian Well State Park contains the primary swimming area.

Other Surrounding Land Uses

Most of the developed land adjacent to the lake contains single-family residences, primarily beach cottages. Many of these previously seasonal residences have been upgraded and are occupied year-round. There is limited commercial development (i.e., restaurants and inns) along the lake. Industrial uses such as water company facilities and gravel pits significantly affect water level and quality.

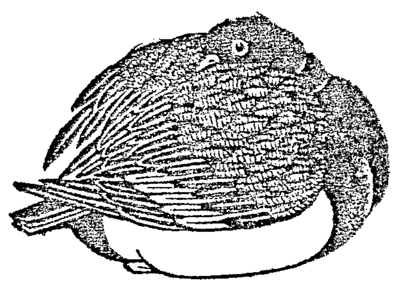
Recreational Hazards

The shallowness of Lake Housatonic is the primary recreational problem. Shallow water has caused several boating accidents in the past. Water use for hydroelectric power and industrial processing causes considerable fluctuation in water level. Many boaters are unaware of these shallow areas. Other known shallow areas contribute to boat traffic congestion. At Seymour's Spruce Brook outlet, for example, shallow water forces all boats to pass through a channel only one-third the width of the lake, creating an unsafe situation. Shallow water throughout the lake also encourages the rapid growth of aquatic weeds. Although the Lake Housatonic Authority operates a weed harvester daily, it is difficult to effectively control the weed growth. These weeds are a danger to boats and a nuisance to swimmers.

Future Recreational Impacts of Dredging

Dredging the lake in selected shallow areas of high boat traffic or high weed growth would create safer recreational situations. While dredging may not necessarily increase total boat traffic significantly, it may encourage the use of larger craft on the lake. This could create problems such as increased noise and an altered circulation pattern for smaller boats during periods of heavy use. However, the present safety needs of small boats outweigh the possible negative effects of larger boats in the future.

APPENDICES



Appendix A: "A Watershed Management Guide For Connecticut Lakes"

A WATERSHED MANAGEMENT GUIDE FOR CONNECTICUT LAKES

STATE OF CONNECTICUT
ENVIRONMENTAL PROTECTION

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER COMPLIANCE UNIT

Revised 1988

A WATERSHED MANAGEMENT GUIDE FOR CONNECTICUT LAKES

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER COMPLIANCE UNIT

REVISED 1988

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

INTRODUCTION

Connecticut's lakes and ponds are valuable natural resources which are used intensively for swimming, fishing, sailing, waterskiing, and many other forms of water based recreation. Lakes and ponds add diversity and aesthetic interest to the landscape and contribute immeasurably to the enjoyment of daily life in lakeside communities. They are important economic entities as well, with money spent in the pursuit of recreation contributing to local and regional economies. Lakes and ponds also enhance local property values, thereby augmenting the tax revenues of local communities.

Unfortunately, all lakes and ponds undergo the aging process called eutrophication, a form of water pollution which results in a decline in recreational utility and aesthetic appeal. Eutrophication is a gradual natural process which is accelerated by man's use of the lands which surround the waterbody. Through awareness and considerable effort and commitment, the eutrophication process is controllable and manageable. Every lake and pond in Connecticut will benefit from "preservation" oriented management which slows the eutrophication process and prolongs the useful life of the waterbody. Many lakes and ponds are also in need of "restoration" oriented management to correct or reverse undesirable conditions brought about in the absence of prudent management in past years.

This handbook has been developed to assist concerned citizens in understanding the process of eutrophication and the principles of eutrophication control through the management of the lake's surrounding watershed land. The handbook is a synthesis of information assimilated by the DEP through its eutrophication abatement activities in recent years. Material in the handbook was selected to fulfill basic information needs of the general public,as determined by our experiences with a variety of lake projects and our contact with numerous individuals and lake organizations. The handbook is intended to assist the layman in working more effectively with technical experts in government agencies and private industry to protect and restore Connecticut's lakes.

EUTROPHICATION

The Process of Eutrophication

Eutrophication is the process of lake aging, caused by enrichment of the lake with plant nutrients from its surrounding watershed land. During the aging process many lake characteristics undergo dramatic changes. To lake users, changes observed include algae blooms increasing in frequency, intensity, and duration; beds of aquatic plants becoming dense and more extensive in coverage of the lake bottom; sediment deposits accumulating, shoal areas developing, and the lake becoming shallower; and the oxygen content of bottom waters declining. As these conditions become pronounced, recreation opportunities become seriously impaired. During the latter stages of the eutrophication process, the lake evolves to a wetland - a swamp, marsh, or bog - and no longer can support its former recreation uses.

The Rate of Eutrophication

The rate at which eutrophication advances is determined by the rate at which the lake is fertilized by its watershed. Under natural conditions, nutrient inputs from a forested watershed are minimal and it may take many centuries for a lake to change in appearance. However, man's development and use of watershed land inevitably results in greater nutrient export from the watershed, and an acceleration in the rate of eutrophication. If man's watershed activities are not controlled, severe lake eutrophication can be brought about in a matter of decades.

Stages of Eutrophication

There are three basic stages of eutrophication which are used to describe the age of a lake. These stages are termed "oligotrophic", "mesotrophic" and "eutrophic". Oligotrophic refers to lakes in the early stages of the eutrophication process, while eutrophic refers to lakes in the late stages. Mesotrophic refers to middle-age lakes in transition between oligotrophic and eutrophic states. These stages are also referred to as trophic states or trophic classifications.

Each stage of eutrophication is characterized by a distinct set of lake conditions. Oligotrophic lakes are deep lakes with clear, infertile waters. They are low in biological productivity, having sparse amounts of algae and aquatic plants. They have minor accumulations of bottom sediments, and have well oxygenated bottom waters. Oligotrophic lakes are prime recreation lakes. Eutrophic lakes are relatively shallow lakes with fertile, turbid waters. They are high in biological productivity, having dense blooms of algae and dense beds of vascular aquatic plants. Eutrophic lakes have substantial accumulations of bottom sediments and have poorly oxygenated bottom waters. Eutrophic lakes have limited recreational utility. Mesotrophic lakes exhibit a mid-range of fertility, productivity, depth, and sedimentation.

Studies of the trophic conditions of Connecticut lakes have resulted in the development of a formal classification system which defines trophic states on the basis of scientific measurements of water quality. A "highly eutrophic" stage was included in the eutrophic lakes. The mesotrophic state was subdivided into "early mesotrophic", "mid mesotrophic", and "late mesotrophic" conditions in order to further differentiate among lakes in this relatively broad category. A list of Connecticut lakes which have been formally classified is presented on pages 26 and 27 of this handbook.

These classification categories are useful tools for comparing the water quality of different lakes, for establishing benchmarks for short and long term trend comparisons, and for estimating the probable level of management required to meet lake use objectives. Trophic classifications are not rigid, and a lake may be eutrophic in some respects and mesotrophic in others. Also, the designation of a lake as eutrophic does not indicate that it is unsuitable or undesirable for all types of recreation, nor should it discourage efforts to manage the lake resource. Similarly, the classification of a lake as oligotrophic should not engender complacency towards management. In both instances, water quality can be maintained and improved through a management program.

Eutrophication of Artificial Lakes and Ponds - When initiating a lake study, it is important to recognize that many lakes and ponds in Connecticut were formed by the construction of a dam across a stream or across the outlet of a wetland. These artificial waterbodies often exhibit an advanced stage of eutrophication. They are relatively shallow waterbodies which are enriched by the nutrients accumulated by the predecessor wetland or terrestrial ecosystem. However, these water quality conditions do not evolve from the oligotrophic state - these lakes experience an advanced state of eutrophication from the time they are formed. Improvement of conditions in these lakes is exceptionally difficult because restoration does not involve the return to previous water quality conditions, but rather involves the creation of conditions which had never existed previously. Examples of this type of lake are Silver Lake in Berlin/Meriden, North Farms Reservoir in Wallingford, Mamanasco Lake in Ridgefield, Lake Winnemaug in Watertown, and Winchester Lake in Winchester.

Eutrophication as Water Pollution - Eutrophication is widely recognized as a form of water pollution which seriously impacts the recreational value of lakes and ponds. Programs to address eutrophication problems are mandated by both state and federal legislation.

Section 314 of the Federal Clean Water Act (P.L. 95-217) requires that each State submit to the Environmental Protection Agency an identification of publicly owned freshwater lakes and a classification of those lakes according to trophic condition. The statute further requires states to submit to the EPA procedures, processes, and methods to control sources of pollution to lakes, and methods and procedures to restore the quality of lakes.

Recreational Lakes Grant Program

Public Act #87-492 established a State grant program to improve the water quality of recreational lakes. This legislation allows DEP to make cost sharing grants to towns and lake associations for studies and implementation measures necessary for the abatement of lake eutrophication. The grant program is administered in accordance with procedures described in DEP regulations entitled: "Grants to Municipalities and Lake Associations to improve the Water Quality of Recreational Lakes". In 1987, The Connecticut General Assembly authorized bonds of the State of one million dollars to begin the grant program.

The Limiting Nutrient, The Key to Controlling Eutrophication

In order for any form of life to grow and multiply, the basic building blocks of life must be available in the environment. Those essential substances are commonly referred to as nutrients. In a lake, algae depend on nutrients in the water column to satisfy their growth. The larger rooted aquatic plants also depend on nutrients in the water column, although to a lesser extent since many species can also extract nutrients from lake sediments.

The term "limiting nutrient" refers to that particular nutrient which is in shortest supply relative to the growth needs of an organism grows. When the limiting nutrient becomes depleted, growth stops even though other nutrients are still available in surplus. Any increase in the supply of the limiting nutrient will result in a corresponding increase in growth. Conversely, any decrease in the supply of the limiting nutrient will result in a corresponding decrease in growth. The key to controlling the growth of algae and vascular plants in a lake - the key to controlling eutrophication - is to reduce the supply of the growth limiting nutrient.

Carbon, nitrogen, and phosphorus are the three basic plant nutrients which could hypothetically be limiting to the growth of algae and aquatic plants in a lake. Surface waters have an abundant supply of carbon because carbon dioxide gas (CO_2) readily dissolves in lake waters from the atmosphere. Similarly, nitrogen gas (N_2) readily dissolves in lake waters from the atmosphere and is present in abundance. There are many forms of common nuisance blue-green algae which are physiologically capable of "fixing" N_2 and utilizing this form of nitrogen for growth. These algae thrive even when dissolved mineral nitrogen forms (ammonia, nitrate) are scarce. Thus, carbon and nitrogen are not generally limiting to the eutrophication process.

Phosphorus, the third basic plant nutrient, has been found to be the growth limiting nutrient in the eutrophication process of most lakes and ponds. Phosphorus is not readily available as a gas from the atmosphere, and it is usually present in relatively scarce quantities in lake waters. Lake water quality studies have found that most lakes have a scarce supply of phosphorus relative to other nutrients and are phosphorus limited. Some highly eutrophic lakes have been found to be nitrogen limited, although this is not due to a low nitrogen supply but rather to an excessive phosphorus supply. In these lakes, restoration strategies focus on phosphorus control to reduce the supply to a level where it becomes limiting.

The key to controlling the eutrophication process, therefore is controlling phosphorus enrichment.

WATERSHED MANAGEMENT OVERVIEW

Objectives

The watershed of a lake is that land area which drains to the lake. The watershed is therefore the source of water for the lake. Water quality of a lake, to a large extent, is determined by qualities imparted to water by watershed land as the water drains to the lake.

Watershed management is aimed at identifying and controlling existing and potential watershed characteristics which ultimately influence a lake's trophic condition. Since phosphorus is the nutrient which governs the productivity of algae and aquatic plants, watershed management is first and foremost concerned with reducing phosphorus enrichment. An important secondary consideration is the reduction of sediment inputs which contribute to physical lake filling and the development of shallow shoal areas where tributaries and storm waters enter the lake.

Watershed management is imperative for each and every lake, regardless of the lake's trophic condition. If a lake is oligotrophic, watershed management will serve to preserve its superior quality and prolong its useful life for recreation. If a lake is eutrophic, watershed management will serve to temper the eutrophication process and enhance the effectiveness of restoration measures within the lake. Watershed management must be the foundation for all lake preservation and lake restoration programs.

Sources of Water Pollutants

Sources of phosphorus and sediment are divided into two broad categories, point sources and non-point sources. Point sources are concentrated, localized discharges such as outfalls from sewage treatment plants. Non-point sources are diffuse and are not easily identified because they do not enter a watercourse at a single point. Rainstorm runoff from a residential area and drainage from a cornfield are examples of non-point sources.

Point Sources

In Connecticut, Water Quality Standards prohibit point source discharges to Class A waters which include natural lakes and ponds and many artificial impoundments (including their tributary watercourses). In a relatively few cases, Class B river impoundments are significantly enriched with point sources of phosphorus. State and federal wastewater discharge permit programs are responsible for implementing advanced waste treatment to control point sources contributing to eutrophication in these lakes. Thus, the primary concern for management of eutrophication in lakes and ponds in Connecticut is the identification and control of non-point sources.

Non-Point Sources

Connecticut's program for controlling non-point sources of pollution involves numerous agencies at all government levels. DEP has NPS planning and enforcement responsibilities through its Water Compliance Unit, Water Resources Unit, Hazardous Materials Management Unit and Office of Solid Waste Management. The Connecticut Council on Soil and Water Conservation prepares guidance related to minimizing NPS at construction sites and from agricultural activities. Several Federal agencies, Conservation Districts, and the State Department of Agriculture provide technical and financial aid to farmers to improve NPS controls. Municipalities, however, are the key government agency where improved NPS management must occur with DEP overview and assistance. Efforts to minimize the impacts of land development to the State's vulnerable water resources depends in large part on effective municipal programs. Planning and Zoning, Inland-Wetland regulation, Public Health and other local authorities can be used to minimize impacts. Under the Federal Clean Water Act, Section 319, the DEP is re-examining its non-point source management strategies. During 1988, a plan for distribution of resources and a time frame for dealing with these issues will be developed.

WATERSHED RESOURCE MAPS

The first step in developing a lake management program is to obtain information about the lake watershed which is pertinent to existing and potential non-point sources of phosphorus and sediment. Several recent statewide natural resource and land use inventories have produced valuable baseline information which is portrayed on maps at 1/24,000 scale (USGS topographical guadrangle scale). This baseline information can be used to construct various lake watershed maps which show features related to eutrophication.

Lake Watershed Boundary Map

The Natural Resources Center of DEP has delineated watershed boundaries on mylar overlays which are on file at the State Office Building in Hartford. A boundary map for a lake watershed can be traced from the mylar onto USGS topographical maps. This serves as a base map on which various watershed characteristics can be portrayed.

Land Use Map

The Connecticut 208 Program developed maps of predominant land use in 5.7 acre grids. Fifteen land use categories were considered - low density residential, moderate density residential, high density residential, institutional, commercial, industrial, open land, cropland, orchard land, dairy production, forest production, resource extraction, wetland, water, and woodland. This information is on file at Regional Planning Agency offices on mylar overlays. A watershed land use map can be constructed by tracing this information onto a lake watershed boundary map.

Wetlands Map

The Connecticut 208 Program developed "water quality sensitive areas" maps which portray legally defined wetlands as well as flood prone areas of environmental or historic interest. This information is on file at Regional Planning Agency offices on mylar overlays. A map of wetlands and other sensitive areas in a lake watershed can be constructed by tracing this information onto a watershed boundary map.

Erosion and Sediment Source Map

The Connecticut 208 Program conducted a statewide inventory of active erosion and sediment sources in 1977 and 1978. The inventory considered cultivated cropland sites greater than two acres, construction sites greater than two acres, surface mines, stream banks, road banks, gravel roads, and unpaved driveways. Active sites were mapped on mylar overlays which are on file at Regional Planning Agency offices and at Soil and Water Conservation District offices. An erosion and sediment source map for the lake watershed can be developed by tracing sites onto a watershed boundary map. This map can serve as a baseline for developing an updated erosion and sediment source maps based on field observations. It is possible that some sites identified in the 1977-78 inventory have stabilized and no longer are active sources. It is also possible that new sites developed in the lake watershed since the 1977-78 inventory.

Areas of High Erosion Potential Map

The Connecticut 208 Program conducted a statewide inventory of high erosion potential areas based on slope of the land and soil type. This information is portrayed on mylar overlays on file at Regional Planning Agency offices. A map of high erosion potential areas for the lake watershed can be constructed by tracing this information onto a watershed boundary map.

Detailed Soils Group Map

The U. S. Department of Agriculture Soil Conservation Service has developed a statewide mapping of detailed soils groups in cooperation with the Natural Resources Center of DEP. This information is on file at the Natural Resource Center in Hartford as mylar overlays. A map of soils groups for a lake watershed can be constructed by transferring this information onto a watershed boundary map. This information can be used to evaluate the suitability of watershed land for on-site sewage disposal (septic systems), and to evaluate erosion potential of watershed land. Technical assistance may be needed to properly interpret the soils information.

Accessory Land Use Maps

The Connecticut 208 Program conducted two additional statewide inventories which can be used to construct useful lake watershed maps. The "Open Space and Dedicated Lands" inventory portrays land in public ownership, quasi-public ownership, and non-profit organization ownership. These lands include water utility property, land trust property, golf courses, recreation areas, nature preserves, and institutional property. This information is portrayed on mylar overlays at Regional Planning Agency offices. A map of open space and dedicated lands in the lake watershed can be constructed by tracing this information onto a watershed boundary map.

A statewide inventory of "lands Unavailable for Development" portrays flood hazard areas, wetlands, watercourses, waterbodies, urban areas, and dedicated lands. This information is available on mylar overlays at Regional Planning Agency offices. A map of property in the lake watershed which is unavailable for development can be constructed by tracing this information onto a watershed boundary map.

NON-POINT SOURCES AND CONTROLS

Erosion and Sedimentation

Erosion is a natural process whereby soil is worn away from the land by running water. Sedimentation is the deposition of eroded material in a watercourse. The severity of erosion and sedimentation is influenced by soil type, slope of the land, type of vegetative cover, intensity and duration of precipitation, and proximity to a watercourse. Some erosion and sedimentation from a lake watershed is inevitable, since this occurs as a natural process. Erosion and sedimentation can be greatly increased by activities of man which disturb the land, remove vegetation, and expose soil to the direct forces of rainfall and surface runoff.

The transport of eroded soil to a lake contributes to eutrophication in several ways. Most importantly, phosphorus and other plant nutrients associated with soil particles are introduced into the lake. Erosion and sedimentation is a dominant cause of phosphorus enrichment of lake waters. Another important effect is the physical presence of solid particles in the lake. Sedimentation reduces water depths, creating shoals which are conducive to the growth of aquatic plants. In addition, organic matter associated with soil particles is decomposed by micro organisms, contributing to the depletion of oxygen in waters overlying the lake sediments.

Serious natural erosion can occur on land with steep slopes, along streambanks, and along lake shorelines. Common man-made sites of erosion are cultivated fields, roadway embankments, roadway drainage ditches, timber harvesting, and construction sites. Erosion associated with specific land features or specific land uses can be controlled by utilizing the "best management practices" which are addressed in subsequent sections of this report. Erosion associated with construction activities is a serious source of erosion which is not restricted to any particular land use of land feature, but rather can occur anywhere in the lake watershed. Special consideration of this erosion source follows:

Construction Site Erosion - Research has shown that soil erosion from construction sites may be 10 to 100 times greater than erosion from agricultural land of the same size, slope, and soil type. The demand to develop lake watershed land, especially land near the lake, is exceptionally strong Construction site erosion must therefore be regarded as a major causative factor in the lake eutrophication process.

Methods for controlling construction site erosion and sedimentation are described in Guidelines for Soil Erosion and Sediment Control, CT Council on Soil Water Conservation, January 1985. This document can be obtained from the DEP Natural Resources Center. This publication is a technical handbook which was developed to assist government officials, developed, engineers, contractors, and others to minimize erosion and sedimentation from sites undergoing development. Among the erosion control topics which are discussed in detail are site planning; vegetative controls such as seeding, sodding, and tree planting; non-structural controls such as hay bale checks, mulching, land grading, and traffic control; and structural controls such as diversions, rip rap, and sediment basins. This handbook should be used as the basic guidance manual for controlling construction site erosion in lake watersheds.

Erosion and Sediment Control Regulations - Excessive sedimentation from construction activities can be reduced when erosion and sedimentation (E & S) control needs are recognized and BMP's are employed. In Connecticut, E & S control management roles are well defined and E & S control management is a shared responsibility. Municipal government through its Inland Wetlands Agency, Zoning Commission, or General Site Plan Review procedures, are required by State Statues to evaluate E & S control needs. The Connecticut Council on Soil and Water Conservation, the Soil and Water Conservation Districts, and Regional Planning Agencies routinely promote the need for thorough municipal E & S control programs and are available to provide technical assistance.

Similarly, DEP's role is to encourage the development of municipal programs. Furthermore, DEP - Water Resources Unit is the E & S control plan reviewer and regulator for State sponsored projects requiring Inland Wetlands Permits and manager of local Inland Wetland Permit Programs where municipalities have not assumed such authority.

In 1983, major E & S control legislation was passed (P. A. 83-388) to strengthen this program in Connecticut. Key provisions of this statute require:

- development of E & S control guidelines and model regulations for municipalities by the Connecticut Council on Soil and Water Conservation (completed in 1985); and

- mandatory adoption of municipal E & S control programs by July 1, 1985.

This law was amended in 1985 to defer mandatory municipal adoption to June 30, 1986.

Residential Land

An acre of residential land will contribute much more phosphorus to a lake than an acre of woodland in the same location. Residential land adjacent to the lake will contribute more to eutrophication than residential land in distant areas of the watershed. The importance of residential land in the eutrophication of a lake is readily appreciated when one observes the amount of land adjacent to any particular lake which is occupied by seasonal or permanent residences.

Sources of phosphorus associated with residential land include construction site erosion, failing septic systems, properly functioning septic systems, fertilization of lawns and gardens, disposal of vegetation from yard upkeep, and stormwater runoff. Construction site erosion has been discussed in the preceding section, and stormwater runoff will be addressed in a later section. The remaining sources and their controls will be discussed below.

Failing Septic Systems - Sewage disposal in residential areas not serviced by sanitary sewers is accomplished with on-lot subsurface disposal systems commonly referred to as septic systems. When functioning properly, septic systems provide for the sanitary breakdown of wastewaters into simple chemical substances including soluble phosphorus compounds. The basic components of the system include a house sewer, septic tank, distribution system, and leaching field. Sewage is delivered to the septic tank via the house sewer. In the septic tank, solids are physically separated from liquids (primary treatment) by the sedimentation of heavy solids to form a sludge blanket, and the flotation of light solids to form a scum layer. The distribution system delivers the liquids to the leaching field. The liquid effluent is decomposed biologically (secondary treatment) in the leaching system.

A septic system can fail if it is not properly designed, installed, or maintained. A failing system will either result in the backflow of wastewaters into the house, or the breakout of wastewaters on the surface of the ground. A failing septic system can contribute phosphorus and other pollutants to lake waters. A far more important consideration, however, is that a failing septic system is a public health hazard. The public health threat is an overriding concern which demands correction of the problem, irrespective of the lake eutrophication issue.

The correction of individual or scattered failing septic systems in a residential area is the responsibility of town health official. The correction of widespread failures within a residential community is initiated by facility planning as provided by state and federal water pollution control statutes. A community sewage disposal system is a likely outcome in these cases.

Prevention of Failing Septic Systems - The first safeguard against septic system failure is the proper design and installation of the system. The DEP has published a document entitled Septic System Manual to guide local land use officials on the legal and technical aspects of the design and installation of on-site subsurface sewage disposal systems. The manual provides a brief explanation of the actual process of sewage treatment that takes place in a septic tank, leachfield and surrounding soil. It is intended to enhance the knowledge of local officials and provide for a more informed review of development proposals. This manual should be consulted by local commissions when reviewing applications for planning, zoning, and wetlands permits which involve the installation of new septic systems in the lake watershed.

Proper operation and maintenance practices will serve to prevent the premature failure of existing septic systems in the lake watershed. The septic system should not be used for the disposal of garbage, solvents, paints, household chemicals, and medicines because these materials can cause clogging or can interfere with biological treatment processes. Water conservation should be practiced in the household since heavy water use can hydraulically overload a septic system and cause failure. A poster detailing water conservation practices is available from the DEP: Water Compliance Unit. For maintenance, a septic tank should be pumped routinely every 3-5 years to remove accumulated scum and sludge which would otherwise move into the distribution system and leaching system, causing clogging and eventual failure.

The Connecticut 208 Program has developed three reports which can guide a lake organization in the development of a community wide septic system management program. Theses are "A Proposed Septic System Inspection and Maintenance Program for Killingworth, Connecticut" by the Connecticut River Estuary Regional Planning Agency; "Voluntary Septic System Management Program for the Towns of Canterbury, Killingly, and Woodstock" by the Northeastern Connecticut Regional Planning Agency; and "Voluntary Septic System Management Program For Quaddick Lake, Thompson" by the Northeastern Connecticut Regional Planning Agency.

A simple and effective means of educating lakeside residents about the proper operation and maintenance of septic systems is an information pamphlet distributed by a lake organization to property owners. The pamphlet should advise homeowners about the consequences of failures, list materials which should not be disposed of in a septic system, explain water conservation measures, and stress the need for routine septic tank pumping. An excellent pamphlet for these purposes was developed by the Northeastern Connecticut Regional Planning Agency and the Northeast District Department of Health entitled "Homeowners Guide to Septic System Maintenance - Or How To Save Thousands of Dollars."

Non-failing Septic Systems as Phosphorus Sources - The liquid effluent which flows from the leaching field of a septic system passes into the surrounding soil and enters the ground water system. This leachate has a high concentration of soluble phosphorus. The ground water flow is generally in the direction of the lake, where it enters the lake as springs. Whether phosphorus travels with the ground water to the lake depends on interactions between soil particles and phosphorus. Many factors are involved, including the proximity of the septic system to the lake, the age of the septic system, the soil type and its capacity to attenuate phosphorus, the path of travel of leachate, the time of travel of leachate, and the elevation of the ground water table.

At present, the incomplete scientific understanding of the interactions between soil particles and ground water phosphorus makes it difficult to predict if or when a septic system will become a source of phosphorus to lake waters. Some soil studies in Connecticut have suggested that soils have an enormous capacity to adsorb and retain phosphorus. More recent Connecticut studies have suggested that leachate may travel in preferential channels through the soil, limiting the exposure of phosphorus to soil adsorption sites. The studies also found that soils will release phosphorus to the ground water when the water table is high and the soils are flooded for several weeks.

In view of this information, it is apparent that the likelihood of a septic system contributing phosphorus to lake waters is enhanced if the septic system is located in thin soils on ledgerock, or if the septic system is located in an area which experiences a seasonally high water table which saturates soils with water. If many lakeside septic systems fall into these categories, it is probable that septic systems are an important factor in the eutrophication of the lake.

In homes with laundry facilities, the phosphorus passing through the septic system can be reduced 30-40 percent by the use of nonphosphate laundry detergents. Concerned lakeside residents should adopt a "better safe than sorry" attitude towards phosphate detergents. The use of nonphosphate laundry detergents by lakeside residents would constitute a sincere personal commitment to taking every available step to abate eutrophication of the lake.

Section 25-5400 of the Connecticut General Statutes enables the DEP to an the use of phosphate detergents in a lake watershed to protect lake water quality. Originally, this authority was developed to enable the DEP to control eutrophication in cases where community-wide septic system failures had been identified but the construction of community sewers was not imminent. The exercise of this authority to control phosphorus from non-failing septic systems is a new concept which warrants consideration as lake diagnostic studies develop detailed information about septic systems and soils in lake watersheds.

Cottage Conversions - In many lakeside communities, seasonal cottages have been winterized and converted to permanent homes. If a septic system is not expanded and upgraded when a conversion occurs, it may not conform to minimum requirements of the Public Health Code. Local health officials must evaluate the adequacy of septic systems serving converted cottages, and oversee the timely correction of inadequate systems. Cottage conversions are usually subject to local building permits and zoning approval.

Lawn and Garden Fertilizers - Lawns and gardens are generally very efficient at utilizing soil nutrients and preventing their loss through runoff and leaching. However, recent research suggest that fertilizers applied in the fall are not utilized by plants and therefore contribute to runoff and leaching. Excess nutrient runoff can also occur if fertilizer applications exceed nutrient requirements, or if fertilizers are applied prior to storm events which cause runoff. These situations can be avoided by applying fertilizers only in the Spring, matching fertilizers to soil requirements, and timing applications to avoid periods of runoff. Soil test kits can be purchased at a nominal charge from the University of Connecticut Cooperative Extension Service county offices. The samples are analyzed at the Extension Service Laboratory, and the results identify soil nutrient deficiencies.

Yard and Garden Vegetation Disposal - Leaves, grass clippings, and other vegetative material from yard and garden maintenance should not be deposited in a location where the material may be washed into the lake. Vegetative material will add to the sediment in the lake and will provide plant nutrients upon decomposition. Each property owner should select a suitable site away from the lake and its watercourses for the composting of vegetative material.

Agricultural Land

An acre of agricultural land will contribute less phosphorus to a lake than an acre of residential land in the same location, but more phosphorus than an acre of woodland in the same location. Agricultural sources of phosphorus and sediment are associated with cropland, with pasture land and feed lots, and with manure storage and handling.

The Connecticut 208 Program, through the Connecticut Council on Soil and Water Conservation, conducted a statewide study of agricultural non-point sources of pollution and developed a program for the implementation of Best Management Practice (BMP) controls. The most effective agricultural BMP's identified by the Connecticut 208 Program are cover crops, field border filter strips, critical area planting, diversions, grassed waterways, streambank protection, animal waste management, optimum manure and fertilizer application rates, and changing from cultivated crops to permanent vegetation. Additional effective practices, very effective in some areas, are contour farming, contour strip cropping, no-till planting, conservation cropping, pasture and hayland management, planned grazing, protection of heavy use areas, subsurface drainage, roof gutters in barn areas, mulching, fencing to keep livestock from streams and stream banks, proper manure spreading and fertilization techniques, and prompt incorporation of manure into soils.

Implementation of the statewide agricultural BMP Program is being managed by the Connecticut Council on Soil and Water Conservation. The program relies on voluntary participation through education and incentives, resorting to regulatory authority only in major problem areas where voluntary initiative is unsuccessful. Technical expertise is provided by the USDA Soil Conservation Service and State Soil and Water Conservation Districts. A primary source of federal cost sharing for BMP's is the USDA Agricultural Stabilization and Conservation Service, which can provide up to 75% funding for erosion and sedimentation controls, and soil and water conservation.

A basis goal of the statewide program is to promote accelerated implementation of BMP's in watersheds designated "high priority" by the 208 Program agricultural study. Several lakes will benefit from this strategy. The watersheds of Roseland Lake and Wappaquassett Lake are designated "Highest Priority" by the 208 study. The impact of agricultural activity on the water quality of Roseland Lake was estimated to be highly significant. The impact on Wappaquassett Lake was estimated to be moderately significant. The Watersheds of Lake Wononpakook, Mudge Pond, Beardsley Pond, and Fitchville Pond were designated as "High Priority" by the 208 study. The impact of agricultural activity on water quality was estimated to be highly significant for Mudge Pond and moderately significant for Wononpakook, Beardsley, and Fitchville.

The agricultural BMP Program also includes the implementation of several statewide objectives over the next 15-20 years. These consist of the implementation of erosion controls on sites with high calculated soil loss; the implementation of BMP's for retention of soils on critical sites near watercourses; the establishment of vegetated buffer strips between cultivated fields and watercourses, and between barnyards and watercourses; the establishment of winter cover crops on cultivated fields; and the development of farm waste management systems with routine review and follow-up inspections.

A lake organization should consult with the local Soil and Water Conservation District to obtain information on the status of agricultural activities in its particular lake watershed. The lake organization should establish cooperative, working relationships with District personnel, Soil Conservation Service personnel, and local farmers in order to develop a strategy for the timely implementation of agricultural BMP's needed to protect lake water quality.

Woodland and Timber Harvesting

An acre of properly managed woodland in a lake watershed contributes much less phosphorus to the lake than an acre of residential land in the same location. However, harvesting of timber for firewood or lumber is a land disturbance activity which has the potential to cause serious erosion and sedimentation. Under the Connecticut 208 Program, a Forestry Advisory Committee undertook a statewide study of the impacts of timber harvesting on water quality. A field study and analysis of 80 logging sites was conducted by the committee in 1979. In general, it was found that harvesting practices in Connecticut are limited in scope and intensity, and rarely involve types of timber, slopes, harvesting equipment, or management practices which lead to severe water quality degradation. The committee concluded that harvesting operations did not affect nutrient export levels, but could cause site specific problems with sedimentation.

The Forestry Advisory Committee has adopted a policy of advocating voluntary compliance with best management practices to control erosion and sedimentation by timber harvesting. Appropriate practices are described in the Committees' handbook entitled "Logging and Water Quality in Connecticut - A Practical Guide for Protecting Water Quality While Harvesting Forest Products". This document is available from the

Connecticut 208 Program or the Connecticut Forest and Park Association, Inc. The handbook describes effective and practical erosion and sedimentation controls related to haul roads, skid trails, stream crossings, harvesting practices, and job termination practices. A lake organization should develop cooperative working relationships with landowners, loggers, and foresters to ensure that these best management practices are employed in the lake watershed.

Wetlands

Scientific research has demonstrated that wetlands in a lake watershed play a vital role in regulating the timing of transport of phosphorus to the lake. During the spring and summer biological growth period, wetlands remove significant amounts of phosphorus from overlying waters and effectively withhold that phosphorus from transport downstream. Mechanisms by which wetlands retain phosphorus include physical entrapment of particulate phosphorus, chemical sorption by organic matter and soil particles, uptake by aquatic plants and attached algae, and utilization by bacteria and other microorganisms. During the fall and winter, wetlands release phosphorus as decomposition of wetland vegetation takes place. Consequently, transport of this phosphorus to downstream waters and to the lake occurs at a time of the year when the phosphorus is least likely to contribute to nuisance algae blooms and weed growth.

Thus, although little phosphorus is permanently withheld by wetlands on an annual basis, the "spring and summer storage; fall and winter release" pattern of phosphorus flux through a wetland serves to minimize summer algae blooms and weed problems in a downstream lake. Wetlands in a lake watershed should be appreciated for this valuable service provided to lake water quality.

The perpetuation of a wetland's phosphorus regulatory function involves, quite simply, maintaining the wetland in a natural state. Alteration or elimination of the wetland reduces or eliminates the effectiveness of this regulatory role and contributes to the degradation of the trophic condition of a downstream lake.

Another important function of wetlands relevant to lake water quality is the control of flooding and associated erosion. Wetlands retain water during periods of high runoff and gradually release water at moderate rates of flow. This flow regulation reduces flooding and erosion which could contribute sediment and phosphorus to a lake. The importance of this function for a particular wetland depends on the topography of the surrounding land, the location within the lake drainage basin, and the size of wetland area relative to the size of its drainage area. Alteration or elimination of wetlands would impair the regulation of runoff, and sediment and phosphorus loads to a downstream lake would increase.

It is recommended that the appropriate wetlands regulatory agency utilize the authorities of Connecticut's Inland Wetlands and Watercourses Act (Sections 22a-36 through 22a-45 Connecticut General Statutes) to maintain the wetlands in a lake watershed in their natural states. This is particularly important for wetlands which are contiguous with the lake or its tributary watercourses. Maintaining wetlands in their natural states will protect lake water quality by providing for continued regulation of seasonal phosphorus loads, and continued control of flooding which could cause erosion.

Specifically, a wetlands agency should give due consideration to wetlands functions which enhance lake water quality when acting on permit application for regulated activities in legally defined wetlands. This consideration is appropriate since the review of application must, by statute, weigh environmental impacts of proposed actions, and weigh irreversible and irretrievable commitments of resources associated with proposed actions. In order to facilitate the implementation of this recommendation, a wetlands agency should make special recognition of lake watershed wetlands on working maps used by agency members.

Stormwater Runoff

Stormwater runoff is the overland flow of water associated with precipitation events of periods of snowmelt. Runoff from residential areas and roadways in a lake results in the transport of sediments, phosphorus, and other pollutants to lake waters. A watershed management program should include measures for minimizing the impacts of stormwater runoff. The following measures should be considered:

Preservation of Wetlands - Wetlands provide for the temporary storage and gradual release of stormwater runoff, and provide for the retention of phosphorus, sediments, and other pollutants. Preservation of wetlands in accordance with Sections 22a-36 through 22a-45 of the Connecticut General Statutes is an important way to control stormwater runoff.

Existing Residential Areas - Stormwater transport of sediment from residential areas to a lake can be controlled by the installation of storm sewers with sediment traps at catch basins and points of discharge. Sediment traps must be cleaned of sand, leaves, and other debris on a regular basis to maintain their effectiveness. Routine street sweeping in the early spring should be conducted in lakeside residential areas to minimize the amount of sand and debris susceptible to stormwater transport. The rate of stormwater runoff can be reduced by employing artificial stormwater detention ponds and by minimizing the amount of impervious and semipervious pavements and surfaces.

New Residential Areas - Stormwater runoff from planned residential areas can be controlled by including stormwater management as part of the overall site development plan. Stormwater control measures should be incorporated into the site plan so that the runoff rate from the developed site is the same as it had been prior to development. Methods of stormwater control which can be considered include preservation of wetlands, installation of artificial stormwater detention ponds, temporary storage in open spaces, temporary storage in underground tanks, and the use of permeable pavements.

An effective means of implementing stormwater management is through town planning and zoning regulations which require Stormwater Runoff

Control Plans for the detention and controlled release of stormwater runoff from new developments. Generally, plans should be required for sites where impervious surfaces exceed 60 percent of the total area. The Guidelines for Soil Erosion and Sediment Control can be used as a guide for local regulations.

Roadway Runoff - State highways, town streets, and unpaved roads can be significant sources of sediments in lake watersheds. Under the Connecticut 208 Program, the Northwestern Connecticut Regional Planning Agency developed a report entitled "Best Road Maintenance Practices for Critical Watersheds" which should be used as a guide to minimizing erosion and sedimentation from roadways in lake watersheds. The report presents detailed information on the design of roadway drainage systems; the management of paved roadways, including sanding operations and early spring street cleaning; the stabilization of road banks with vegetation and proper grading; and the grading and surfacing of unpaved roads. A lake organization should establish cooperative working relationships with appropriate town and/or state maintenance officials in order to implement a sound management program for lake watershed roads.

Waterfowl

Ducks and geese are generally considered attractive wildlife assets which enhance the aesthetic appeal of a lake. However, large numbers of migratory waterfowl which spend considerable periods of time on a lake can contribute appreciable loadings of phosphorus and nitrogen to lake waters. In a study of one Connecticut Lake, it was estimated that the phosphorus in the excrement of four geese in one month was equivalent to the total annual loading of phosphorus from 2.5 acres of watershed land. In order to quantify the impact of waterfowl on a lake, it is necessary to develop accurate information on waterfowl population numbers, feeding habits, resting areas, and periods of occupancy. In the absence of detailed information, it should be recognized that large flocks of migratory waterfowl which stop at a lake for many weeks can be an important factor in the eutrophication process.

Waterfowl can be controlled by methods which discourage large flocks from frequenting the lake. The U. S. Fish and Wildlife Service regulates all migratory bird activities that involve handling the birds, such as trapping, banding, and hunting. This agency also provides information on methods of harassment. These activities include mechanical barriers, landscaping techniques, scarecrows and other foreign objects, automatic exploders, flashing lights, balloons, and chase dogs. Information on these methods can be obtained from U. S. Fish and Wildlife Service, 4 Whalley Street, Hadley, Massachusetts 01035.

The DEP Wildlife Bureau lends assistance and cooperation in controlling nuisance waterfowl whenever possible. The DEP is studying the potential of special goose hunting by certified, competent hunters to control nuisance populations in areas where safety considerations are not prohibitive. Assistance regarding special goose hunting can be obtained from the DEP Wildlife Bureau in Hartford.

Streambanks and Shorelines

Streambanks and shorelines are sites where erosion can cause serious cause sedimentation which immediately impacts a lake. Activities which disturb the land surface should be avoided in these areas, and maintenance of a zone of natural vegetation, or a greenbelt, should be encouraged. Construction activities in these areas should employ erosion and sediment controls as described in Guidelines for Soil Erosion and Sediment Control.

General guidance for stabilizing streambanks and protecting streambanks and protecting streambanks against scour and erosion is presented in the Guidelines for Soil Erosion and Sediment Control. Measures to be considered for critical streambank sites include bank sloping, riprap, vegetation, jetties, fencing, and removal of obstructions. Each streambank site is unique, and implementation of controls should be done under the guidance of the federal Soil Conservation Service and/or the county State Soil and Water Conservation District.

It is a common practice for lakeside property owners to construct masonry retaining walls along shorelines which are vulnerable to erosion. Retaining walls absorb the shock of waves, and prevent soil from moving off the land and into the lake. General guidance on the construction of retaining walls is provided in the Guidelines for Soil Erosion and Sediment Control. Additional guidance should be obtained from professional builders.

Erosion and sediment control measures undertaken along streambanks and shorelines may require approval of the Inland Wetland Agency and/or the U. S. Army Corps of Engineers.

Atmosphere

Recent eutrophication studies have shown that measurable amounts of phosphorus may enter a lake through precipitation and dry atmospheric fallout. Precipitation data at one Connecticut lake suggested that atmospheric phosphorus was associated with pollen dispersion. Other research has suggested that atmospheric phosphorus emanates from local and distant sources of air pollution. Although atmospheric phosphorus is a factor in lake eutrophication, control of atmospheric loadings is not within the scope of a local lake management program.

Lake Sediments

Under certain conditions, sediments on the lake bottom can release phosphorus and nitrogen to overlying waters. Depending on lake mixing characteristics and algae bloom sequences, these recycled nutrients may contribute to nuisance algae blooms. The identification of internal enrichment can only be made through detailed lake water quality monitoring. Control of this source involves in-lake technology which is outside the scope of this handbook. However, it is important to recognize that for some Connecticut lakes, lake sediments are a significant source of enrichment of lake waters.

Resource Agencies

State and Federal

Department of Environmental Protection
Natural Resources, Water Compliance, Water Resources, Wildlife & Forestry Units
165 Capitol Avenue
Hartford, Connecticut 06106

Connecticut 208 Program
c/o Connecticut DEP Water Compliance Unit
165 Capitol Avenue
Hartford, Connecticut 06106

Connecticut Council on Soil & Water Conservation
State Office Building
165 Capitol Avenue
Hartford, Connecticut 06106

USDA Soil Conservation Service
Mansfield Professional Park
Storrs, Connecticut 06268

Connecticut Agricultural Experiment Station
123 Huntington Street
New Haven, Connecticut 06054

U. S. Geological Survey
450 Main Street
Hartford, Connecticut 06103

U. S. Fish and Wildlife Service
4 Whalley Street
Hadley, Massachusetts 01035

Connecticut Forest and Park Association, Inc.
1010 Main Street
P. O. Box 389
East Hartford, Connecticut 06108

U. S. Army Corps of Engineers
Regulatory Branch
424 Trapelo Road
Waltham, Massachusetts 02254

AGENCIES RESPONSIBLE FOR REGIONAL PLANNING IN CONNECTICUT

Revised: April 13, 1988

Mr. Dana S. Hanson, Exec. Dir.
Capitol's Region Council of Govts
221 Main Street
Hartford, CT 06106
Tel. (203) 522-2217

Ms. Beverly P. Paul, Exec. Dir.
Central Ct. Regional Planning Agy
225 North Main Street
P. O. Box 1880
Bristol, CT 06010
Tel. (203) 589-7820

Mr. Duncan M. Graham, Exec. Dir.
Council of Governments of Central
Naugatuck Valley
20 East Main Street
Waterbury, Conn. 06702
Tel. (203) 757-0535

Mr. Stanley V. Greimann, Plng Dir.
CT River Estuary Reg'l Planning Agy
455 Boston Post Road
P. O. Box 778
Old Saybrook, CT 06475
Tel. (203) 388-3497

Mr. James T. Wang, Exec. Dir.
Greater Bridgeport Regional
Planning Agency
Bridgeport Trans. Center
525 Water St., Bridgeport, CT 06604
Tel. (203) 366-5405

Mr. Jonathan Chew, Exec. Dir.
Housatonic Valley Coucil of
Elected Officials
Old Town Hall - Rte #25
Brookfield Center, CT 06805
Tel. (203) 775-6256

Mr. Geoffrey K, Colgrove, Exec. Dir.
Midstate Regional Planning Agency
100 DeKoven Drive
P. O. Box 139
Middletown, CT 06457
Tel. (203) 347-7214 or 347-7215

Mr. Gerald McCarthy, Exec. Dir.
Northeastern Ct. Reg'l Planning Agy
Rte #205, Regional Building
P. O. Box 198
Brooklyn, CT 06234
Tel. (203) 774-1253

Ms. Linda Cardini, Director
Northwestern Ct. Council of Govts
Sackett Hill Road
Warren, CT 06754
Tel. (203) 868-7341

Mr. James A. Butler, Exec. Dir.
South Central Regional Council of
Governments
23 Peck Street
North Haven, Conn. 06473
Tel. (203) 234-7555

Mr. Richard B. Erickson, Exec. Dir.
Southeastern CT Reg. Planning 455
139 Boswell Ave.
Norwich, CT 06360
Tel. (203) 889-2324

Mr. Richard Carpenter, Exec. Dir.
South Western Regional Planning Agy
213 Liberty Square
East Norwalk, CT 06855
Tel. (203) 866-5543

Mr. Richard Eigen, Exec. Dir.
Valley Regional Planning Agency
Derby Station, Main Street
Derby, CT 06418
Tel. (203) 735-8688 or 735-8689

Ms. Meg Reich, Planning Director
Windham Regional Planning Agency
968 Main Street
Willimantic, CT 06226
Tel. (203) 456-2221 or 456-2222

Mr. Richard M. Lynn, Jr.
Planning Director
Litchfield Hills Council of Elected
Officials
42 North St., P. O. Box 187
Goshen, CT 06756-9723

STATE COORDINATOR OF REGIONAL PLANNING ORGANIZATIONS:

Theron A. Schnure, Assistant Director
Conn. Office of Policy and Management
80 Washington Street
Hartford, Conn. 06106-4459
Tel. (203) 566-8398

County Offices

USDA Soil Conservation Service District Conservationist (SCS)
Soil and Water Conservation Districts (S&WCD's)
UConn Cooperative Extension Service Extension Agents (UCONN)

Fairfield County SCS, S&WCD
UConn Agricultural Center
Route 6 Stony Hill
Bethel, Connecticut 06801
744-6108

Hartford County, SCS, S&WCD
Agricultural Center
1101 Kennedy Road
Windsor, Connecticut 06095
688-7125

Litchfield County SCS, S&WCD
UConn Agricultural Center
Litchfield, Connecticut 06759
567-9019

Middlesex County SCS, S&WCD
UConn Extension Center
Route 9-A
Haddam, Connecticut 06438
873-8808

New Haven County SCS, S&WCD
UConn Extension Service
322 North Main Street
Wallingford, Connecticut 06492
269-7509

New London County SCS, S&WCD
UConn Extension Service
562 New London Turnpike
Norwich, Conn. 06360
887-4163

Tolland County SCS, S&WCD
UConn Agricultural Center
24 Hyde Avenue
Vernon, Connecticut 06066
875-3331

Univ. of Connecticut
Storrs, Conn. 06268
486-3334

Hartford County UCONN
Extension Service
Carriage House
Hartford, Connecticut 06105
241-4940

Windham County SCS, S&WCD
UConn Extension Center
P. O. Box 112
Wolf Den Road
Brooklyn, Conn. 06234
774-9600

Resource Maps

Title	Prepared by*	Scale
Watershed Boundary (Drainage Basins)	RPA's, DEP NRC	1:24,000
Land Use	RPA's	1:24,000
Water Quality Sensitive Areas	RPA's	1:24,000
Erosion & Sediment Source Inventory	RPA's, S&WCD's	1:24,000
Areas of High Erosion Potential	RPA's	1:24,000
Open Space & Dedicated Lands	RPA's	1:24,000
Detailed Soils Groups	SCS DEP NRC	1:24,000

* RPA - Regional Planning Agency
S&WCD's - Soil & Water Conservation Districts
SCS - Soil Conservation Service
DEP NRC - Department of Environmental Protection Natural Resources Center

Resource Publications

Title	Source
"Erosion & Sediment Source Inventory"	CCSWC, RPA's, S&WCD's
"Guidelines for Soil Erosion and Sediment Control"	CCSWC
"Septic System Manual"	DEP Water Compliance Unit
"A Proposed Septic System Inspection & Maintenance Program for Killingworth, Ct."	CRERPA
"Voluntary Septic System Management Program for Canterbury, Killingly, and Woodstock"	NERPA
"A Voluntary Septic System Management Program for Quaddick Lake, Thompson"	NERPA
"A Homeowners Guide to Septic System Maintenance"	NERPA, NDDH
"Logging & Water Quality In Connecticut - A Practical Guide for Harvesting Forest Products & Protecting Water Quality"	Ct. 208 Forestry Advisory Committee
"Best Road Maintenance Practices for Critical Watersheds	NWRPA
"Connecticut AG 208 Project"	CCSWC
"Inventory of the Trophic Classifications of Seventy Connecticut Lakes"	DEP Natural Resources Center
"Lake Management Handbook - A Guide To Quantifying Phosphorus Inputs to Lakes"	DEP Water Compliance Unit, Windham RPA
"Lake Waramaug Watershed Management Plan"	DEP Water Compliance Unit, Northwestern CT RPA
"State of Connecticut Regulations for Grants to Improve the Water Quality of Recreational Lakes"	DEP Water Compliance Unit
"Mirrors of the Landscape, An Introduction to Lake Management" R. W. Kortmann, D. D. Henry	Univ. of Conn.
"The Lake and Reservoir Restoration Guide" E. P. A.	DEP Water Compliance Unit

Connecticut Lake Trophic Conditions

Trophic Condition	Lake	Town(s)	Surface Area (Acres)
Oligotrophic	Alexander	Killingly	190.4
	Bashan	East Haddam	276.3
	Beach Pond	Voluntown	394.3
	Billings	North Stonington	105.1
	Highland	Winchester	444
	Mashapaug	Union	297.1
	Uncas	Lyme	69
	West Hill	New Hartford	263
Early Mesotrophic	Bigelow Pond	Union	18.5
	Candlewood	New Fairfield Sherman New Milford Danbury Brookfield	5,542.0
	Columbia	Columbia	277.2
	Crystal	Ellington, Stafford	200.9
	Dodge Pond	East Lyme	33
	Long Pond	Ledyard, North Stonington	98.6
	Mount Tom Pond	Litchfield, Morris Goshen	61.5
	Norwich Pond	Lyme	27.5
	Rogers	Lyme, Old Lyme	264.9
	Quassapaug	Middlebury	271
	Waumgumbaug	Coventry	378
	West Side Pond	Goshen	42.4
	Wyassup	No. Stonington	92.4
Mesotrophic	Amos	Preston	105.1
	Black Pond	Woodstock	73.4
	Burr Pond	Torrington	85
	Cedar	Chester	68
	Cream Hill	Cornwall	72
	East Twin	Salisbury	562.2
	Gardner	Salem, Montville Bozrah	486.8
	Glasgo Pond	Griswold	184.2
	Gorton Pond	East Lyme	53
	Hayward	East Haddam	198.9
	Little School House Pond	Thompson	68.4

(continued)

Trophic Condition	Lake	Town(s)	Surface Area (Acres)
Mesotrophic	Lower Bolton	Bolton, Vernon	178.4
	Pachaug Pond	Griswold	830.9
	Pattagansett	East Lyme	123
	Pocotopaug	East Hampton	511.6
	Powers	East Lyme	152.6
	Quaddick Res.	Thompson	466.8
	Quonnipaug	Guilford	111.6
	Shenipist	Vernon, Ellington	52.8
		Tolland	
	Squantz Pond	New Fairfield	288
		Sherman	
	Terramuggus	Marlborough	83
	Tyler	Goshen	182
Late Mesotrophic	Ball Pond	New Fairfield	89.9
	Black Pond	Meriden	75.6
		Middlefield	
	Hitchcock	Wolcott	118.4
	Middle Bolton	Vernon	114.9
	Moodus Res.	East Haddam	451
	Mudge Pond	Sharon	201
	Taunton Pond	Newtown	126
	Waramaug	Warren, Washington	680.2
		Kent	
Eutrophic	Bantam	Litchfield, Morris	916
	Batterson Park Pond	Farmington	162.7
		New Britain	
	Beseck	Middlefield	119.6
	Eagleville	Mansfield	80
	Housatonic	Shelton	382.2
	Kenosia	Danbury	56
	Linsley Pond	No. Branford	23.3
		Branford	
	Long Meadow Pond	Bethlehem	110.5
	Mamanasco	Ridgefield	95
	Roseland	Woodstock	88
	Wononpakook	Salisbury	164
	Wononscopomuc	Salisbury	352.6

(continued)

Trophic Condition	Lake	Town(s)	Surface Area (Acres)
Highly Eutrophic	Cedar	North Branford	21.8
	1860 Reservoir	Wethersfield	35
	Lillinonah	Southbury Bridgewater Brookfield, Newton	1900
	North Farms	Wallingford	62.5
	Silver	Berlin, Meriden	151
	Winnemaug	Watertown	120
	Zoar	Newtown, Monroe Oxford, Southbury	975

Appendix B: "The Trophic Classifications of Seventy Connecticut Lakes"

I. Name: LAKE HOUSATONIC

II. Location:

Town -Shelton

U.S.G.S. Quadrangle - Southbury, Long Hill, Ansonia

U.S.G.S. Quadrangle Number - 78 (105), 93 (125), 94 (126)

Basin Identification : Major - Housatonic; Subregional #6000

Longitude - 73^{o} 8' 36"

Latitude - 41^{o} 19' 36"

III. Physical Characteristics:

Surface Area - 328.2 acres

Maximum Depth - 26 feet

Mean Depth - 9.4 feet

Volume - 134,386,084.8 cu. ft. (3,201, 076.54m^3)

Retention Time - 15 hours

Bathymetry - Available

Watershed Area - 1,574 sq. mi. (407,671.6 ha)

IV. National Eutrophication Survey: Yes. Working Paper No. 181

V. National Pollution Discharge Elimination System Permits (NPDES): Bridgeport Hydraulic Company and all Lake Zoar permits

VI. Public Access: State swimming area and town access for residents.

VII. Biological/Chemical Data:

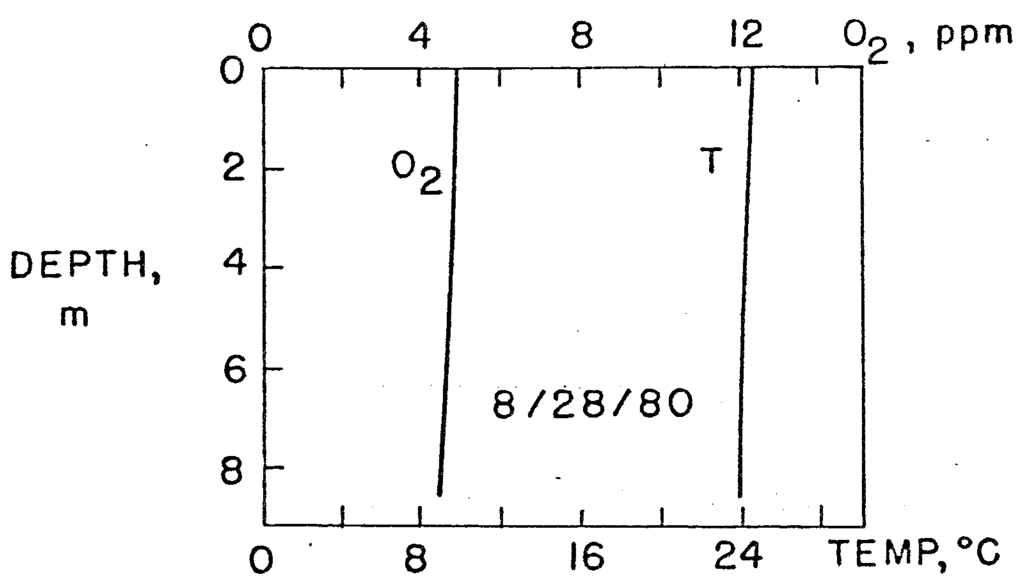
Trophic Classification - eutrophic

Aquatic Weeds - intermediate/dense

LAKE HOUSATONIC
(Oxford, Seymour, Derby, Monroe, Shelton, CT)

Date	Transparency	Sample depth	Alkalinity	Chlorophyll-a	Soluble P	Total P	NH_4-N	NO_3-N	Soluble N	Total N
	m		meq/l	ppb						
5/5/80	2.1	comp	1.36	-	15	41	50	412	602	747
8/28/80	2.0	0-8	1.90	22	10	51	100	105	475	700

Water Chemistry Data



Temperature and Dissolved Oxygen Profile

Depth	Temperature	Oxygen
m	^{o}C	ppm
0	24.8	4.9
1	24.3	4.8
2	24.2	4.8
3	24.2	4.7
4	24.0	4.7
5	24.0	4.7
6	24.0	4.7
7	24.0	4.7
8	24.0	4.6

Temperature and Dissolved Oxygen Data, 8/28/80

Aquatic Macrophyte Notes

Aquatic weeds were very abundant in water up to about 3 m in depth. A wide variety of weeds were present in major amounts, including *Elodea* (Common Elodea), *Myriophyllum* (Water Milfoil) and *Vallisneria* (Wild Celery). Various *Potamogetons* (Pondweeds) and *Ceratophyllum* (Coontail) occurred less frequently. *Sagittaria* (Arrowhead and Duck Potato), *Pontederia* (Pickerelweed) and *Typha* (Cattail) were found in some marshy areas along the shore.

VIII AND IX.
Land Use and Erosion and Sedimentation

The acreage of each land use as well as their respective percentages of the total area and sources of erosion and sedimentation were not compiled for the Lake Housatonic watershed because of its large area of 1,574 square miles.

X. Topography

Lake Housatonic was formed by the construction of a concrete dam across the Housatonic River. Water from the impoundment is used for hydro-electric power and industrial processing. A very large watershed area of 1,574 square miles feeds the lake.

XI. Surficial Geology

The area immediately adjacent to Lake Housatonic is composed entirely of glacial till.

Appendix C: "A Short History of the Derby Dam" and "Shelton Canal Company" and an attempt to revive it in 1838 failed again. As explained by Dr. Shelton in 1870, "the requisite legislation was obtained, but as the shad interest was so important, and science has not yet discovered that fish like individuals could climb ladders and go over dams, the company were not permitted to build a high dam like the one (now at Derby), but a low dam, with tumbling rapid over it for the shad. This required the location of the dam near Zoar bridge and the water to be brought down in a canal to the present location or below. The surveys made at the time made the expense so great that it was abandoned."

Renewed interest in damming the river came in 1864. By this time there was no interest in water transportation since the railroad, by 1848, had already made existing Connecticut canals obsolete. Rather, the site of the proposed dam was looked upon as the last available source of industrial water power in close proximity to navigable tide water in all of New England, and the industrial prosperity that resulted from the close of the Civil War gave promoters and investors the wherewithal to develop this resource to their own advantage. Purchase of the land for the dam and canals began in 1863. An expert was brought from Maine to show a committee of the legislature a model of a fish weir, by means of which fish could go over a high dam. On the basis of this evidence, "the committee were satisfied that they could grant a charter and preserve their respect for the right of the shad eaters at the same time." Following this favorable report the Legislature in 1864 granted a charter for the high dam at Derby, notwithstanding the continuing objections of the New Milford shad fishing industry. Funds were obtained in 1866 and the company was organized in November of that year. Plans and specifications were made by Wm. E. Worthen of New York. Henry T. Potter, who had built several dams in the Norwich area (e.g. Ponemah Mills on the Shetucket) was engaged as Engineer and Superintendent. The first stone was laid July 17, 1867.

The construction of the dam was a laborious affair which tried the patience of Henry Potter so much so that after its completion in October, 1870, he declined to have any further involvement with the project. From the description of the construction of this dam given by James Leffel in 1874 it would appear as if, at the time of construction the discovery was made that rock at the site dipped too sharply to be used as a foundation for the dam, a fact that may not have been known earlier by Mr. Worthen when he first made the original plans and specifications for the dam. The layering of a foundation in gravel for a masonry dam, with current from the river above the dam and a three-foot rise and fall of the tide on the downstream side, proved to be a very difficult operation, requiring coffer dams on either side and water pumps to keep the construction area dry. On numerous occasions in 1867, 1868 and 1869 the work was interrupted by freshets breaking through the project's cofferdams. The worst disaster occurred on October 4, 1869, when the center portion of the dam, then under construction, was fully overturned, and 160 feet of the dam was swept away. "The removal of water from the immense coffer below the dam was a work of such magnitude that the Engineer, Mr. Potter, devised a pump expressly for the purpose, 48 feet long, 4 feet wide and 12 inches high, with buckets and elevators attached to belts...When the water had all been removed from the coffer, it was found the full extent of the damage done by the October freshet has not been realized. It had not only swept away the center portion of the dam but cut down the riverbed south of the dam, making a hole more than half an acre in extent and 20 feet deep below the apron. This immense cavity was filled with rock and stones, the foundations laid upon it, and on the fifth of October, 1870, the last coping stone was laid." The final structure, estimated to contain 451,000 cubic feet of masonry, was 637 feet long, measure along the arc from abutment to abutment, the arc having a mid-ordinate of 50 feet. The abutments were 175 feet long. The dam was built of large blocks of ashla masonry. The height varied from 25 feet to 32 feet. Its width was 20 feet at the base, with an 8 foot wide cap of Maine granite blocks each 8 feet long and 1 foot thick. On the downstream side was a horizontal apron, 24 feet wide, of southern pine logs, one foot square, resting on two feet of timber and masonry, with 10 inch sills anchored 8 feet deep into the masonry of the dam. The dam's capability at the time was estimated at 2500 horsepower 12 hours a day, assuming a head of 22 feet and 500 cubic feet per second minimum average flow. On account of the large amount of industrial water power that could be derived from the dam, and the perservance required for its construction, its completion was locally hailed as one of the major achievements of that time. There were no flashboards until 1883.

Mr. Potter's success in completing the dam was not destined to last. The dam failed in the spring of 1891, probably due to a large amount of ice which had become piled upon the dam during a freshet at the breaking up of the river. A large breach, estimated to be 210 feet wide, was made at the easterly end of the dam. The repair which took place that summer, was under the direction of Engineer D.S. Brimsmade, cost $130,000 and consisted of: (1) lengthening the dam by another 38 feet, to its present 675 feet; (2) reconstructing the breached and new section with a different, substantially wider cross-section, such as to have a sloping back in place of old horizontal apron; and (3) adding a triangular section above the old apron of the remaining portions of the old dam and increasing the width of the apron from 24 feet to approximately 43 feet-6 inches. The downstream portion of this apron was supported by a rock filled timber cribbing. The toe was protected by 3" plank sheeting just upstream from the last foot-square horizontal waters, which in turn, were laterally supported by piles driven 24" on centers. The entire surface of the apron was then covered with timbers and 2 layers of planking well anchored to masonry, starting just under the capstone and extending at a 1-1/3 to 1 slope, approximately 23 feet and thence through an arc of about 38 feet radius for another 31 feet, to the toe. The new portion apparently built monolithically and of larger stone than the old one, had also vertical upstream face. The chosen method of strengthening the old dam, i.e., by adding a sloping, planked triangular section which would serve at the same time soften the fall of the water, was not original. A very similar approach was used between 1868 and 1870 to strengthen the Holyoke dam. The dam that existed there at the time was a timber crib dam, 1,017 feet long and 30 feet high, that, like the Derby Dam, was built on an erodible base.

There do not appear to have been further modifications to the Derby Dam until 1948. An inspection of the toe of the dam was made in 1943. By 1948, because of the daily operation of the Stevenson Hydroelectric plant which had been constructed in 1920, about six miles upstream, and because of local pond levels from Memorial Day to Labor Day each year, and the extensive worn condition of the subplanking due to erosion, it was found very difficult and expensive to maintain the repairs on the wooden apron of the dam. That year, under the direction of Hydraulic Engineer D.M. MacWilliam, the Connecticut Light and Power patched with concrete 3,183 square feet of the apron. In addition, on the Derby end of the apron, a 2,290 square-foot experimental strip was laid down, removing both layers of planking and replacing them with 9" of concrete. Additional concrete patches were made in subsequent years. Then, in 1952, C.W. Blakeslee & Sons was awarded the contract for removing all the remaining planking replacing it with nine inches of concrete.

In 1929 the Connecticut legislature released the then Ousatonic Water Power Company of the obligation to maintain a fish weir at the dam. There had been no shad run in the Housatonic River since the turn of the century. Inspectors for the State Fish Commissioners noted shrinking shad runs in the early 1870s. The fish weir as built was not as successful as had originally been anticipated. Samuel Orcutt, in his 1880 History of Derby, describes it as follows: "a weir of fish through which an occasional June shad with a sprinkling of youthful lamprey eels are allowed to go up for the special benefit of the up country people."

SHELTON CANAL COMPANY

History and General Description

During the period 1867 to 1870 the Ousatonic Water Company constructed the Derby Dam and two canals - one 2100 ft. long on the Derby side and the other approximately 5400 ft. long on the Shelton side. The Shelton Canal included one upper lock and two lower locks to permit passage of boats.

The objective of the construction was to sell the land between the river and canal for construction of factories. The factories would use the canal for water power and process purposes thus producing income for the water company.

The original water leases covered a period of 90 years bringing the expiration dates to about 1985 to 1995 with the privilege of renewal for a like period. Over the years, and for various reasons including bankruptcy, most of these old leases have been dropped.

Around 1920 to 1930 the Ousatonic Water Company was purchased by the Shelton Canal Company, a subsidiary of Connecticut Light and Power Company (CL&P). The purchase was made to secure water rights to ensure the continued operation of the recently constructed Stevenson Station located about 6 miles upstream.

In 1944 there were still a dozen mills using canal water (including the Derby Gas and Electric Co. which ran a steam condenser and two 400KW water wheels).

During the period from purchase of the Ousatonic Water Co. to 1960 the Shelton Canal Co. and Stevenson Hydro were operated and maintained by the CL&P Co. Waterbury District.

In 1960, CL&P Co. purchased the gas properties owned and operated by the Derby Gas and Electric Co. (United Illuminating puchased the electric facilities).

CL&P Co., of course, manned the Derby/Shelton area to provide O & M capabilities for its newly purchased gas properties. Because the Shelton Gas Division was a next door neighbor, they inherited the O & M of the Shelton Canal Co. The Hydro Production office assumed responsibility for the Shelton Canal Company in 1979.

Condition of Structures and Equipment

The 675 ft. long Derby Dam is in fair to good condition - no major expenditure should be required for 5 years or more.

Both the Shelton and Derby Canals are in poor to fair condition. Canal walls (masonry block construction) require maintenance, fencing is required in many areas for security and safety, equipment is antiquated and head gates need replacement. Two Shelton lock gates must be replaced if boat passage is to be restored. (Shelton locks have been out of service since 1974.)

NOTES

ABOUT THE TEAM

The King's Mark Environmental Review Team (ERT) is a group of environmental professionals drawn together from a variety of federal, state, and regional agencies. Specialists on the Team include geologists, biologists, soil scientists, foresters, climatologists, landscape architects, recreational specialists, engineers, and planners. The ERT operates with state funding under the aegis of the King's Mark Resource Conservation and Development (RC & D) Area - a 83 town area serving western Connecticut.

As a public service activity, the Team is available to serve towns and/or developers within the King's Mark RC & D Area - free of charge.

PURPOSE OF THE ENVIRONMENTAL REVIEW TEAM

The Environmental Review Team is available to assist towns and/or developers in the review of sites proposed for major land use activities. For example, the ERT has been involved in the review of a wide range of significant land use activities including subdivisions, sanitary landfills, commercial and industrial developments, and recreational/open space projects.

Reviews are conducted in the interest of providing information and analysis that will assist towns and developers in environmentally sound decision-making. This is done through identifying the natural resource base of the site, and highlighting opportunities and limitations for the proposed land use.

REQUESTING AN ENVIRONMENTAL REVIEW

Environmental Reviews may be requested by the chief elected official of a municipality, or the chairman of an administrative agency such as planning and zoning, conservation, or inland wetlands. Environmental Review Request Forms are available at your local Soil and Water Conservation District, and the King's Mark ERT Coordinator. This request form must include a summary of the proposed project, a location map of the project site, written permission from the landowner/developer allowing the Team to enter the property for purposes of review, and a statement identifying the specific areas of concern the Team should investigate. When this request is approved by the local Soil and Water Conservation District and King's Mark RC & D Executive Committee, the Team will undertake the review. At present, the ERT can undertake two (2) reviews per month.

For additional information regarding the Environmental Review Team, please contact your local Soil and Water Conservation District or Nancy Ferlow, ERT Coordinator, King's Mark Environmental Review Team, King's Mark Resource Conservation and Development Area, 322 North Main Street, Wallingford, Connecticut 06492. King's Mark ERT phone number is 265-6695.