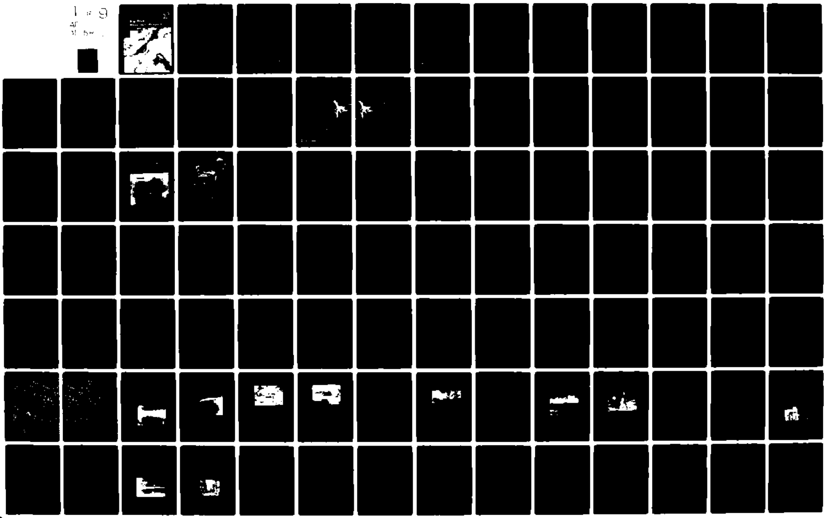
AD-A105 822   CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV   F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED   NL



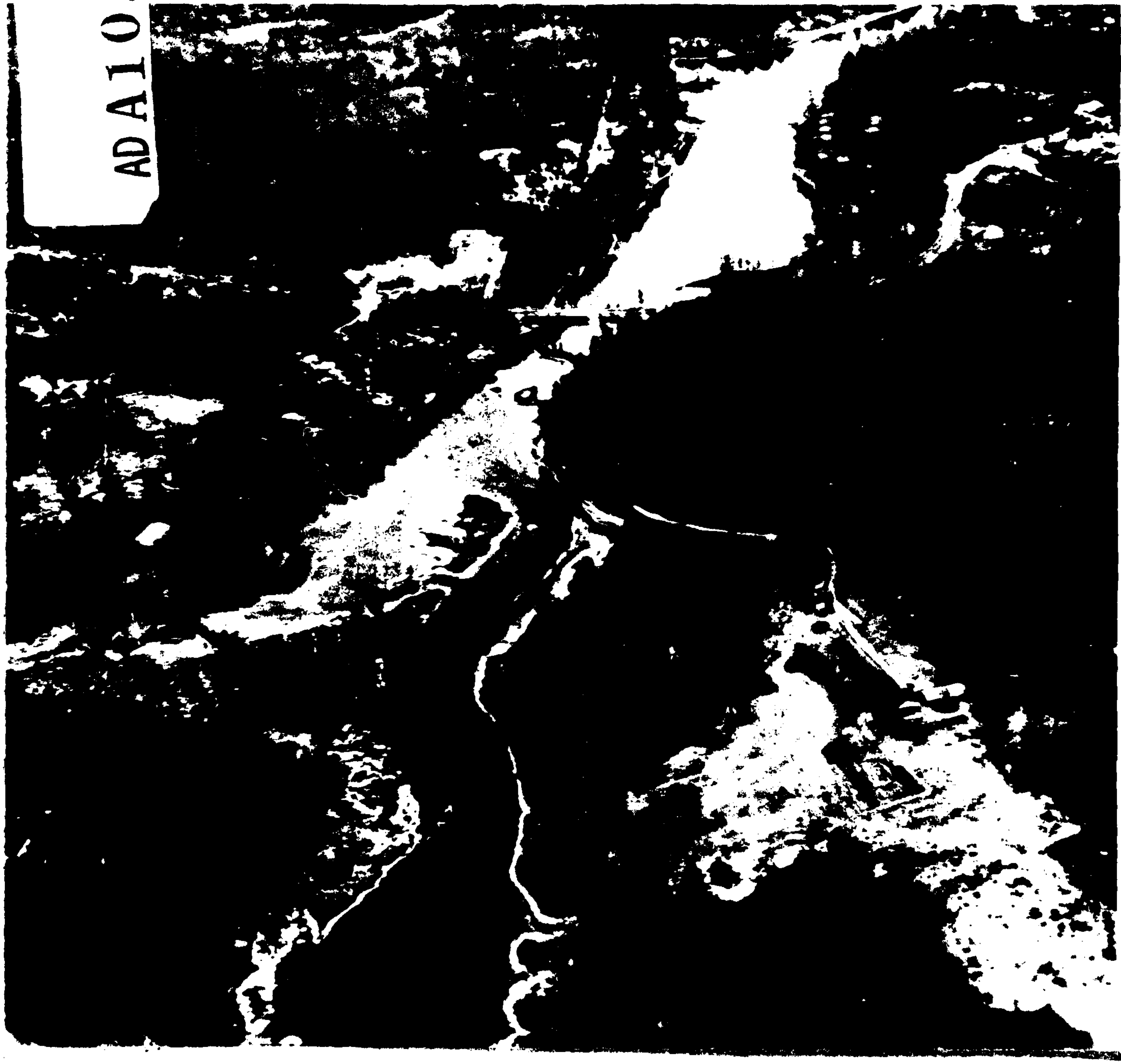
Interim Report

Volume III, July 1981

LEVEL

31

Big River Reservoir Project



SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) (9) Interim rept.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: (6) N/A
2. GOVT ACCESSION NO.: AD-A105822
3. RECIPIENT'S CATALOG NUMBER: n/a
4. TITLE (and Subtitle): Big River Reservoir Project - Pawcatuck River and Narragansett Bay Drainage Basins - Water and Related Land Resources Study - VOL. III Volume III. Appendices H-K.
5. TYPE OF REPORT & PERIOD COVERED: Interim - Appendices
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Department of the Army New England Division, Corps of Engineers Waltham, MA 02254
8. CONTRACT OR GRANT NUMBER(s): N/A
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Same as # 7
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (11)
11. CONTROLLING OFFICE NAME AND ADDRESS: NEDPL-BU John Craig (12) 826
12. REPORT DATE: Jul[redacted]981
13. NUMBER OF PAGES: 4 VOL. 2200
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Same as # 7
15. SECURITY CLASS. (of this report): Unclass.
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:
16. DISTRIBUTION STATEMENT (of this Report): Approved for public release; Distribution unlimited
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report): unlimited distribution
18. SUPPLEMENTARY NOTES:
19. KEY WORDS (Continue on reverse side if necessary and identify by block number): water supply, flood damage, recreation problems, flood prone areas, water resources, flood control, water conservation, groundwater development, surface water development, recreational development, water and related land resources study
20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

Volume III, Appendices H through K encompasses the aspects of Recreation and Natural Resources, (including a recreation impact analysis, aquatic and terrestrial ecosystems assessment and a fish and wildlife management plan), social and cultural resources, economics and an institutional analysis.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE 391651

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

INDEX OF VOLUMES

VOLUME I - MAIN REPORT

VOLUME II - APPENDIX A - PROBLEM IDENTIFICATION

APPENDIX B - PLAN FORMULATION

APPENDIX C - PUBLIC PARTICIPATION

APPENDIX D - HYDROLOGIC ANALYSIS

APPENDIX E - WATER QUALITY

APPENDIX F - GEOTECHNICAL INVESTIGATIONS

APPENDIX G - DESIGN AND COST ESTIMATES

VOLUME III - APPENDIX H - RECREATION AND NATURAL RESOURCES

Section 1 - Recreation Impact Analysis
Section 2 - Aquatic Ecosystem Assessment
Section 3 - Terrestrial Ecosystem Assessment
Section 4 - Fish and Wildlife Management Plan

APPENDIX I - SOCIAL AND CULTURAL RESOURCES

Section 1 - Social Resources
Section 2 - Cultrual Resource Reconnaissance

APPENDIX J - ECONOMICS

APPENDIX K - INSTITUTIONAL ANALYSIS

VOLUME IV - ATTACHMENT 1

ADDENDA AND ERRATA TO
Appendix H, "Recreation and Natural
Resources"

1. Letter of 19 May 1981 from Rhode Island Department of Environmental Management regarding fish and wildlife mitigation.

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Environmental Management
DIVISION OF FISH AND WILDLIFE
Washington County Government Center
Tower Hill Road
Wakefield, R. I. 02879

May 19, 1981

Mr. Joseph Ignazio
Chief of Planning
U.S. Army Corp of Engineers
424 Tupelo Road
Waltham, Mass. 02254

Attention: Bud Barrett

Dear Mr. Ignazio:

In response to a request from Bud Barrett and Sue Brown I wish to document estimated costs for on-site mitigations of Fish and Wildlife resources at the proposed Big River Reservoir. At the same time I want to make it clear that this letter does not in any way change our Department's stand with regard to supporting off-site mitigations.

On-site mitigation would involve three projects; the development of a cold water fishery in the reservoir, upland wildlife habitat improvement and the construction and maintenance of wildlife marshes.

Initial costs for the cold water fishery including a parking lot, sanitary facilities, check station, salaries for attendents and research surveys as well as fish would be $73,800. Annual costs to maintain the fishery and facilities would be $43,800 in 1981 dollars. Upland wildlife habitat management would be phased in year by year at an annual cost of $85,000 again in 1981 dollars. The marsh construction costs are the most difficult to estimate. If the material on the site and other factors were such that the dams could be constructed under force account using Division equipment the initial cost would be $90,000. If we had to go out to contract our estimate is $150,000. Annual maintenances would be $10,000 a year.

In summary initial first year costs would be $248,800 or $308,800 depending on the marsh construction costs and the annual costs thereafter in 1981 dollars would be $138,800.

Sincerely,

John M. Cronan
Chief

JMC/lg
CC: Bob Bendick

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX H

RECREATION AND NATURAL RESOURCES

Section 1 - Recreation Impact Analysis

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

BIG RIVER RESERVOIR
RECREATION IMPACT ANALYSIS

State of Rhode Island

Contract No. DACW33-78-C-0351
Work Order No. 1

December 1978

Prepared for

Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Prepared by

Schoenfeld Associates, Inc.
Engineers, Architects, and Planners
210 South Street
Boston, Massachusetts 02111

Robert S. Brustlin
Pamela Morey Okolita
Sandra E. Bazza

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

I. INTRODUCTION

A. Authority

Authority for the Pawcatuck-Narragansett Bay study, which includes the Big River Reservoir project, is contained in seven outstanding resolutions combined under one resolve adopted by the Committee on Public Works of the United States Senate. Following the heavy damages suffered in New England during the storms of March 1968 and February and April 1970, the Board of Engineers for Rivers and Harbors was requested to review the advisability of improvements for flood control, navigation, water supply, water quality control, recreation, low flow augmentation, and other allied water uses within the Pawcatuck River Basin, Rhode Island and Connecticut, and in the Narragansett Bay Drainage Basin, Massachusetts and Rhode Island.

B. Background

Although there are no existing reports or major studies on the proposed Big River Reservoir Site, two studies have been done which pertain to the site area. The most comprehensive study relevant to this report is the State Comprehensive Outdoor Recreation Plan (SCORP), which is a part of the Rhode Island State Guide Plan. The report, Plan for Recreation, Conservation and Open Spaces, dated January, 1976 (third edition), is prepared by the Rhode Island Statewide Planning Program and the Department of Natural Resources. The report inventories federal, state, local, and private recreation facilities on a community basis, assesses need according to supply and demand, and presents proposals for implementation.

The New England River Basins Commission, established to coordinate comprehensive, joint federal-state planning of water and related land resources of the region, has analyzed the short-term (1990) and long-term (2020) water resources needs in southeastern New England. The Report of the Southeastern New England (SENE) Study, issued December, 1975, presents a strategy for balanced development and protection of the resources in eastern Massachusetts and Rhode Island. Twenty-one recommendations for meeting 1990 recreation needs in economically, environmentally, and socially acceptable ways are made. In addition, planning reports were prepared which dealt specifically with the Narragansett Bay and the Pawcatuck, Blackstone, and Pawtuxet River Basins, which include the area surrounding the Big River Site.

C. Scope and Purpose

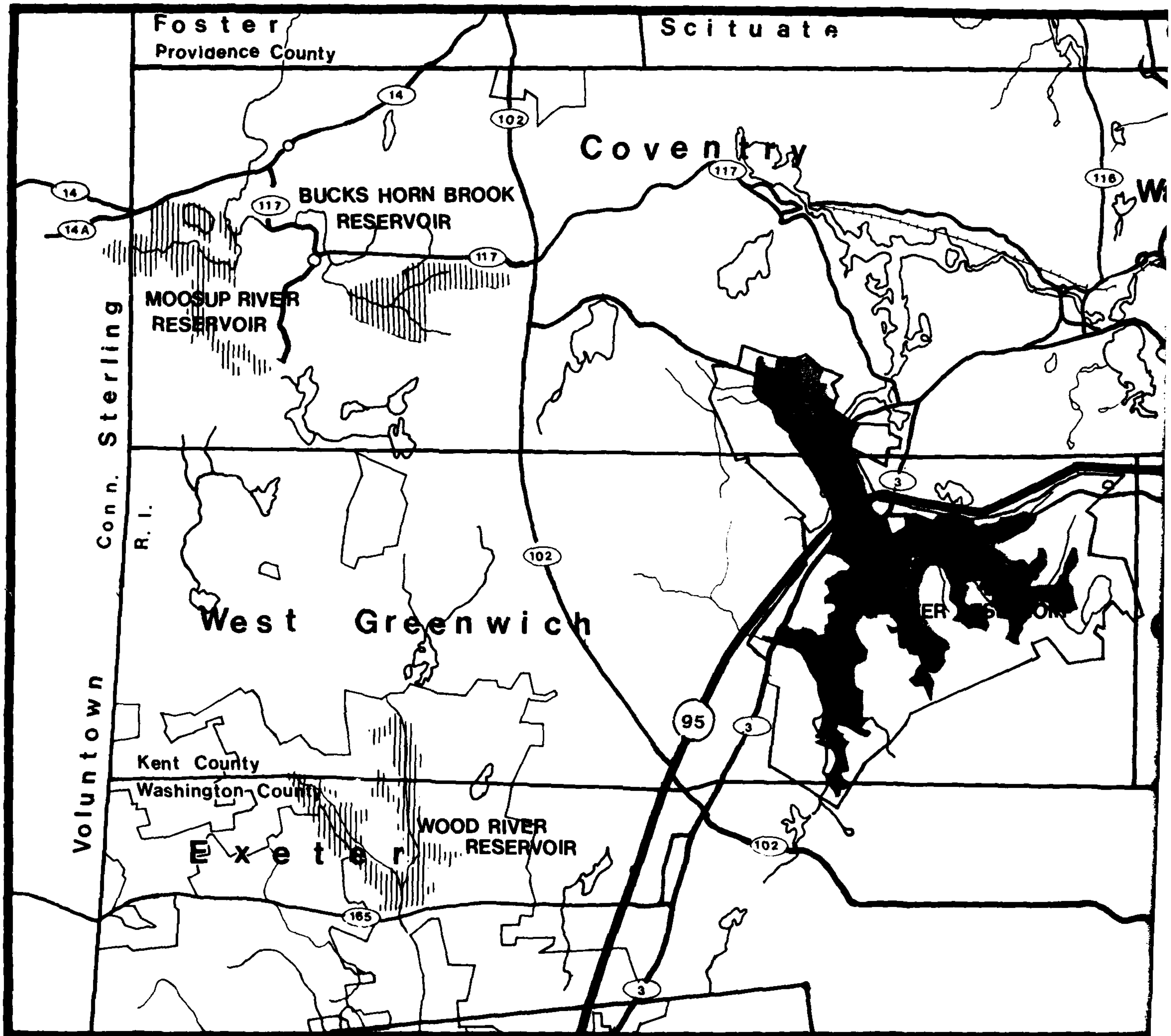
The purpose of this report is to describe the present recreational activities of the proposed Big River Reservoir Site and the surrounding area, and to evaluate the potential impacts that the proposed project may have. The study region that was analyzed includes the area which is within a one-hour's drive, or approximately 40 miles, from the proposed reservoir site.

The impact assessment primarily involves a comparison of the anticipated recreational activities both with and without the proposed project. The Big River Site is presently a popular local recreation area with considerable wetland and forest. Should the project be implemented, the region would be permanently altered. This report, therefore, includes the following:

- Identification of current recreational uses and trends onsite and in the total study region.
- Estimation of current and future demand for recreational facilities.
- Comparison of existing supply with future demand.
- Presentation of a recreation plan for the Big River Site should the project be implemented.

The Big River Site includes nearly 8,000 acres of land in the Towns of Coventry and West Greenwich, Rhode Island. The main rivers flowing through the area are the Big, Nooseneck, Congdon, and Carr Rivers. There are also a number of tributary streams and ponds in the area. The Big River, located mainly in West Greenwich, flows into the Flat River Reservoir (also known locally as Johnson's Pond), which becomes the South Branch of the Pawtuxet River.

The Big River Reservoir would provide a supplemental water supply for the Providence metropolitan area and the surrounding environs. The reservoir would have a surface area of approximately 5.9 square miles at an elevation of 302.5 feet msl (See Figure 1). Preliminary investigations indicate that the dam located in the vicinity of Harkney Hill Road would be about 2300 feet long and approximately 65 feet above stream bed. Water treatment facilities would be provided near the dam and a transmission main would convey furnished water to the West Warwick shaft of the existing Providence Water Supply Board aqueduct. It is estimated that approximately 2.5 feet of additional storage capacity would be required above the water supply pool for flood control purposes (elevation 305.0 feet msl). The storage capacity of the Big River Reservoir would be capable of accepting and storing water pumped from one or more diversion works and would be the central impoundment from which the water supply would be drawn.



LEGEND:

BIG RIVER RESERVOIR

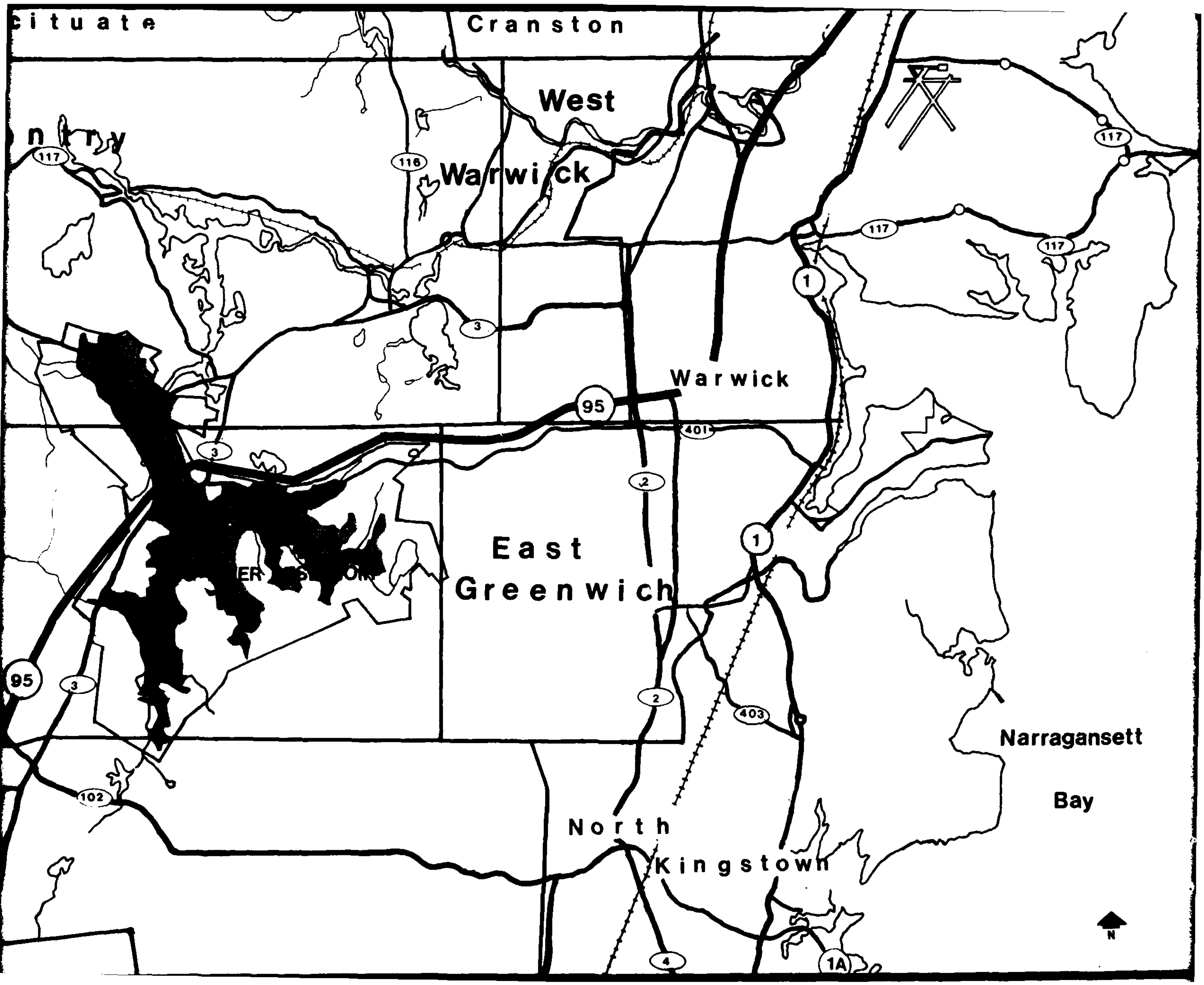
ALTERNATIVE IMPOUNDMENTS

BIG RIVER

BI

WATER SUPP

SCALE



ituate
Cranston
West
Warwick
Warwick
East
Greenwich
North
Kingstown
Narragansett
Bay
117
116
3
95
401
2
1
403
102
4
1A
N

The following paragraphs describe possible water supply diversions from adjacent watersheds that are being considered. The impoundment areas are shown on Figure 1.

Wood River Reservoir - The proposed reservoir and dam would be located in the towns of West Greenwich and Exeter, with the dam located in the vicinity of Ten Rod Road. The surface area of the reservoir pool would be approximately 1.4 square miles at an elevation of about 170.0 feet msl. The construction of diversion facilities or an impoundment on the Wood River sub-basin of the Pawcatuck River Basin would result in an out-of-basin transfer of water to the Big River Reservoir. Storage requirements of the impoundment would be limited since the major part of the flow would be pumped to Big River Reservoir storage.

Flat River Reservoir Diversion - Facilities to divert flood skimming operations from the Flat River Reservoir watershed would be constructed in the vicinity of the existing reservoir approximatley 2,000 feet downstream of the proposed Big River Reservoir. Flows would be pumped to storage in the Big River facilities.

Bucks Horn Brook Reservoir - The proposed reservoir and dam would be located in the Town of Coventry and would have a reservoir pool surface area of approximately 0.8 square miles at an elevation of about 450.0 feet msl. The facilities would result in an out-of-basin transfer of water from a sub-basin of the Thames River Basin as well as transfer of flow from an interstate waterway. Diversion flows would be pumped to storage provided in the Big River Reservoir.

Moosup River Reservoir - The proposed Moosup River diversion reservoir would be located in West Greenwich. The dam, located in the vicinity of Oneco, Connecticut would provide a water supply pool having a surface area of about 0.8 square miles at an elevation of about 350.0 feet msl. Water from the reservoir would be pumped to the Big River Reservoir. These facilities would result in an out-of-basin transfer of water from a sub-basin of the Thames River Basin as well as a transfer of flow from an interstate waterway.

D. Planning Considerations

The major planning objective of this report is to determine (a) whether there would be an impact on recreation activities in the Big River area should the proposed reservoir project be implemented, and (b) if so, how the impact could be lessened by allowing onsite recreation after the project is completed. There is, however, a great amount of disagreement in the State of Rhode Island as to the safety of recreation on primary water supply sources. It is not known at this time who will operate and maintain the proposed reservoir, or what their policies concerning recreation will be. The ultimate decision as to what kind of recreation, if any, will be allowed on the Big River Site remains with the Rhode Island General Assembly. Undoubtedly, various constraints would be placed on recreation in the project area to protect the reservoir water quality. A further discussion of these issues is presented below.

E. Recreational Use of Reservoirs

A controversal issue receiving more and more attention in Rhode Island is the concept of multiple use, particularly recreational use, of water supply areas. In the past, the single-purpose approach prevailed, and reservoirs were generally closed to public use. As recreation demands have grown, however, there has been more pressure to open reservoirs to some forms of recreation. In order to provide a background for the potential constraints associated with the project, this section presents a discussion of applicable laws, policies, and studies.

1. Laws and Regulations

In Rhode Island, water supplies, both public and private, are controlled and maintained by the water supplier. The Rhode Island Water Resources Board, however, plans and coordinates all programs for the development of water resources within the state, and prepares long-range plans for the development and utilization of these resources. The Board has the authority to review plans for new construction of water supply facilities or for additions to existing ones. They are also empowered to establish water supply facilities by acquiring land and water areas, or by entering into agreements with local or private agencies.

Under legal authority, the Water Resources Board has acquired the land required for the Big River Reservoir and has assumed managerial control. The Rhode Island General Assembly, however, has reserved the right to de' rmine the extent of recreational activity which would be permitted on the site (Chapter 133, Section 23 of the Rhode Island Acts and Resolves of 1964).

Rhode Island Law (Title 46, Chapter 14, Section 1), reprinted below, prohibits the discharge of refuse or other matter which may pollute a water supply source used for drinking purposes. Certain activities including swimming, bathing, and dumping are also prohibited. Other activities such as boating, hiking, camping, and fishing are not mentioned in state law.

> 46-14-1. Pollution or misuse of drinking water sources prohibited.
>
> --No person shall throw or discharge, or suffer to be thrown or discharged, into any well, spring, brook, lake, pond, reservoir or stream used as a source of water supply

> for drinking purposes by any city, town, district, institution or company, or into any known tributary or feeder of any such well, spring, brook, lake, pond, reservoir or stream, any sewage, drainage, refuse or other noxious matter or thing tending to pollute or corrupt, or impairing or tending to corrupt the purity of the waters of any such well, spring, brook, lake, pond, reservoir or stream, or any known tributary or feeder thereof, or render the same injurious to health. Nor shall any person bathe, swim, wash any animal, clothing or any other article in any of the above-mentioned waters; provided, however, that the provisions of this section shall not interfere with, nor prevent the enriching of land for agricultural purposes by the owner or occupant thereon, if no human excrement is used thereon, nor shall the prohibition against bathing apply to any camp or bathing resort located on a known tributary of any of the above-mentioned waters if such camp or bathing resort was licensed by the department of health prior to June 20, 1968. Any person violating any of the provisions of this section shall be punished for each offense by a fine of not exceeding fifty dollars ($50.00), or by imprisonment for a term not to exceed thirty (30) days, or both.

2. Arguments For and Against Reservoir Recreation

The primary argument against the use of reservoirs for recreation is the problem of potential contamination of the water supply and the resulting danger to the health of the water users. Many health officials argue that human activity produces wastes which, should they come in contact with water sources, can cause contamination through disease-producing bacteria and viruses. Another concern is that costs for the water will increase due to the added capital and operating expenditures, as well as from litter, vandalism, and liability for disease traceable to the water.(1)

Generally, water contact sports are thought to be a more potential hazard. Swimming in particular is most often prohibited due to fear of waterborne diseases being introduced in the water supply. Boating for fishing and pleasure is often prohibited due to concern for increased turbidity and gas and lead pollution. Shoreline recreation is also opposed by many, for although there may be little direct effect on water quality, the indirect effects may be significant. The disruption of

(1) All sources are listed by number under References, found to the rear of the text.

soil and vegetation, for example, may cause erosion and contamination during periods of runoff in areas where camping is permitted. Hiking and use of off-road vehicles may also severely alter drainage patterns. In addition, for all of these activities, there is the major concern over the improper disposal of human wastes.(2)

On the other hand, Rhode Island is a small state with limited land and water resources. As more of these resources are committed to water supply purposes, the multiple use concept is becoming increasingly popular. Water-related sports are some of the most popular and fastest growing of all outdoor activities, and the demand on existing facilities is rapidly increasing. Moreover, actual data which have indicated recreation on existing reservoirs is harmful are limited, while a number of studies have presented evidence indicating that recreation does not have a significant impact on water quality (See Section I-5). In addition, modern water treatment systems have proven effective in removing contaminants which could be caused by recreational activity. The drinking water standards promulgated by the U.S. Environmental Protection Agency are stringent enough to provide adequate protection of public health.(2)

3. Roles of Agencies and Their Reservoir Recreation Policies

Historically, federal, state, and local governmental agencies have played a big role in the supervision and expansion of recreation programs. Various types of recreational facilities are generally supplied by different levels of government and, in some cases, by the private sector. In Rhode Island, the responsibility of administering outdoor recreation programs and facilities falls to various federal, state, regional, local, and private agencies. In instances where facilities have not adequately been provided, the responsibility of satisfying recreation demands falls to the state.

a. Federal

Various federal agencies administer outdoor recreation and open space programs under which state, local, and private agencies may qualify for assistance. This assistance includes credit, cost-sharing, technical aid, educational services, research, resource management, and regulation. Because the Big River Reservoir project has the potential of reducing flood damages in the Pawtuxet River Basin, the U.S. Army Corps of Engineers was requested by the State of Rhode Island to undertake a feasibility study for and serve as the lead developer of the reservoir project.

The President's Council on Environmental Quality has strongly advocated utilization of water supply reservoirs and surrounding environs for compatible uses, and recreation is stressed as being highly compatible.

It is the message of their handbook, Recreation on Water Supply Reservoirs (primarily directed to northeastern states), "...that with proper planning, management, and water treatment facilities, water supply reservoirs in these states and in other restricted areas throughout the country could provide both safe drinking water and greatly expanded outdoor recreation facilities."

This handbook expresses attitudes that past policies restricting public access to water supply reservoirs are bogus. Contemporary water treatment facilities make possible a wide range of compatible land uses in the watershed. In fact, they point out that recreation is becoming not only a compatible use, but a very practical way to insure the public support necessary for continued long-term protection of the watershed from encroachment of other more intensive and less compatible uses such as commercial, industrial, and residential development.

Under the 1975 Federal Water Project Recreation Act, recreation and fish and wildlife enhancement may be developed as part of any federal water resource project if economically justified and if non-federal public agencies agree to administer the project and to bear 50 percent of the costs. The Corps encourages the development of project areas, including Big River, for recreational purposes and fish and wildlife management. The New England Division has a full-time, active recreation-resources management program. An important goal of this program is to institute sound resource management practices at reservoirs, in cooperation with other governmental agencies.(3)

b. American Water Works Association

Although not connected with the Big River Reservoir project, the American Water Works Association (AWWA) is the chief representative of the water utilities in North America. The AWWA establishes broad policies concerning water supplies, although these policies are not followed consistently by local water suppliers. In a 1971 revision to their policy statement, the AWWA expresses concern for the growing demand for use of reservoirs for recreational purposes, and the resultant effect on water quality. They discourage the use of reservoirs for recreation, particularly if other surface waters are available, and oppose body contact sports such as swimming. The AWWA does, however, suggest that multiple use of metropolitan water supply areas be considered, and cites a study which concludes that recreational activities do not appear to significantly affect water quality.(1)

c. Regional

The New England River Basin Commission (NERBC) is the major regional agency concerned with recreation in the New England area. The NERBC is a federal-state partnership encompassing the six New England states and part of New York. Their main function is to assure coordination between the New England states and the federal government in the planning and management of water and related land resources. This includes the preparation of the SENE report, the comprehensive plan which identifies problems and recommends actions for providing adequate water supply, open space, and maximum use of existing resources. The NERBC recommends that water-contact recreational use of primary reservoirs in Rhode Island and Massachusetts be avoided until extensive research is done on potential contamination. They do note, however, that there is increasing evidence that the multiple use of domestic water supply lands is possible without significant effects on health and safety. For example, they suggest that secondary reservoirs could be used in a limited fashion for activities such as hiking and picnicking. Although they feel water treatment costs could increase, the NERBC recommends these costs be recouped through user-fees, permits, or the transfer of funds slated for acquisition. The NERBC concludes that limited recreational use of reservoirs can contribute significantly to filling the demand for open space.(4)

d. State/Municipal

(1) Rhode Island Department of Environmental Management

The Department of Environmental Management (DEM) has responsibility for proper development and utilization of all of the state's natural resources. The DEM consists of sixteen divisions, including the Divisions of Fish and Wildlife, Forest Environment, Land Resources, and Water Resources. Although the DEM does not have a specific policy on the issue of recreation in water supply areas, many within the department are in favor of reservoir recreation, and have proposed limited recreation plans for the Big River area.

(2) Rhode Island Water Resources Board

In their April 1978 statement of policy, the Water Resources Board (WRB) stated that the use of public reservoirs for recreational purposes should be permitted as long as the quality of the water supply is not jeopardized. The recreation program must be developed in cooperation with health authorities and with the administering agencies, and costs for the program must not be borne directly by the primary water users.(5) The working policy of the WRB adds additional restrictions, however. Following state law, swimming is prohibited on all public water supplies.

In addition, the WRB generally opposes all forms of recreation on primary reservoirs and within the site boundaries. On secondary reservoirs, however, recreational activities (other than swimming) may be permitted.(6)

(3) Rhode Island Office of State Planning

The Office of State Planning (OSP) supports the development of the Big River Reservoir as a multipurpose facility. They believe that the single-purpose approach which prevailed in the past may no longer be consistent with the increasing demands on the state's land and water resources. OSP recommends that a comprehensive study be conducted to provide an objective analysis of the actual impact of recreational activities on existing water supply areas.(7)

(4) Providence Water Supply Board

The Providence Water Supply Board (PWSB) has long contended that they have the capability to develop and operate the Big River Reservoir project.(8) In 1966, when the PWSB reported they could handle the financial aspects of the project, they stated they did not favor multiple use of the Big River Site since it would add to the water treatment costs and open the door to potential liability suits.(9)

The PWSB is still strongly opposed to all recreational activities on reservoirs and the surrounding environs under their jurisdiction, including secondary reservoirs. They maintain that as state law prohibits all activities which may pollute the water supply, then recreational activities would by law be prohibited. As a result, the PWSB generally forbids all trespassing in their reservoir areas. They feel this is necessary to maintain the exceptionally high water quality such as is found in Scituate Reservoir water. Should the PWSB become the developer of the proposed Big River Reservoir, this policy would prevail.(10)

e. Local

Although many of the more populated municipalities in Rhode Island have structured recreational programs, generally in the more rural areas the programs for recreation either are limited or fall to the private sector. Of the towns in the local area surrounding the Big River Site, only Coventry and West Warwick have separate recreation departments. None of the local area towns have official policies concerning recreation on the proposed reservoir site.

4. National Patterns of Reservoir Use

Recreational use of reservoirs in the United States appears to follow a regional pattern. In general, recreational activities are prohibited or limited at reservoirs in the northeast and in the three western states, California, Oregon and Washington, while the rest of the country is more lenient. Recreation is prohibited at 61 percent of the reservoirs in the northeast, and at 72 percent of those in the western states. For the nation as a whole, however, only 8 percent of the total is protected from recreational use. Of those reservoirs where recreation is allowed, 46 percent permit all water sports, including swimming.(1)

5. Reservoir Recreation Studies

Various studies on the effects of recreation on water quality have been conducted over the last twenty-five years. In 1974, the Rhode Island Statewide Planning Program conducted an extensive literature review of these studies.(1) In general, the results of these studies indicate that little or no increase in bacterial pollution results from recreational activity. Results of three major studies are described below.

Between 1959 and 1961, the California State Department of Public Health conducted a study of twelve reservoirs in the state that were used for recreation. Extensive physical, chemical, and bacteriological tests were conducted in order to assess the effect on water quality. The study revealed no serious degradation of water quality attributable to recreational activities. Although at two of the reservoirs, analysis showed more bacteria in the water where there was more recreational use, the increases in bacterial concentrations were not large.

Another study was conducted on Forrest Lake, the water supply source for Kirksville, Missouri. During the three-year study period (1958-1960), an average of 291,000 people visited the lake each year. Activities included swimming, fishing, motor boating, water-skiing, picnicking, and camping. Over 40,000 swimmer days per year were noted and over 700 boats were registered for use on the lake. Eight sampling stations were set up on the 702-acre lake to register the presence of bacteria. The study concluded that the high recreational use was not reflected by the bacterial counts, and that the pollution of Forrest Lake would need to increase considerably before there would be additional costs for water fi ation and treatment.

Three watershed areas were studied in the State of Washington to determine the effects of varying degrees of recreation. One area was closed to all activities; the second area permitted hunting, fishing, and camping; the third area permitted swimming, boating, camping, picnicking, hiking, trail riding, and hunting. The study concluded that the level of human use existing during this study had no measurable effect on chemical water quality.

II. REGIONAL SETTING

For purposes of this report, the Big River Site and the surrounding environs have been divided into four major regions (shown in Figure 2): (a) the study region (within 40 miles of the site); (b) the immediate study region (within 20 miles of the site); (c) the local area (the five towns surrounding the site, i.e., Coventry, West Greenwich, East Greenwich, Exeter, and West Warwick); and (d) the site itself.

The study region includes that area within approximately 40 miles, or a one-hour's drive, of the proposed Big River Site. This area includes all of Rhode Island, eastern Connecticut, and a portion of southeastern Massachusetts. Major recreational activities were inventoried in this area in order to assess the impact of loss of recreation in the Big River Site. The immediate study region and the local area were studied in more detail as any loss or alteration of recreational activities on the Big River Site would have a greater impact on this region.

The Big River Site includes nearly 8,000 acres of land in the Towns of Coventry and West Greenwich. Of this, approximately 3,400 acres will be flooded. The area covered by water is referred to as the impoundment area; the remaining dry land is referred to as the upland area (See Figure 3).

This section of the report concentrates on the features of the State of Rhode Island, as this area includes most of the study region, and yet is representative of the Big River Site. Information was taken from the Plan for Recreation, Conservation, and Open Space (referred to as the SCORP report), Rhode Island's major planning document for recreation activities and demands.(11)

A. Geographic Description

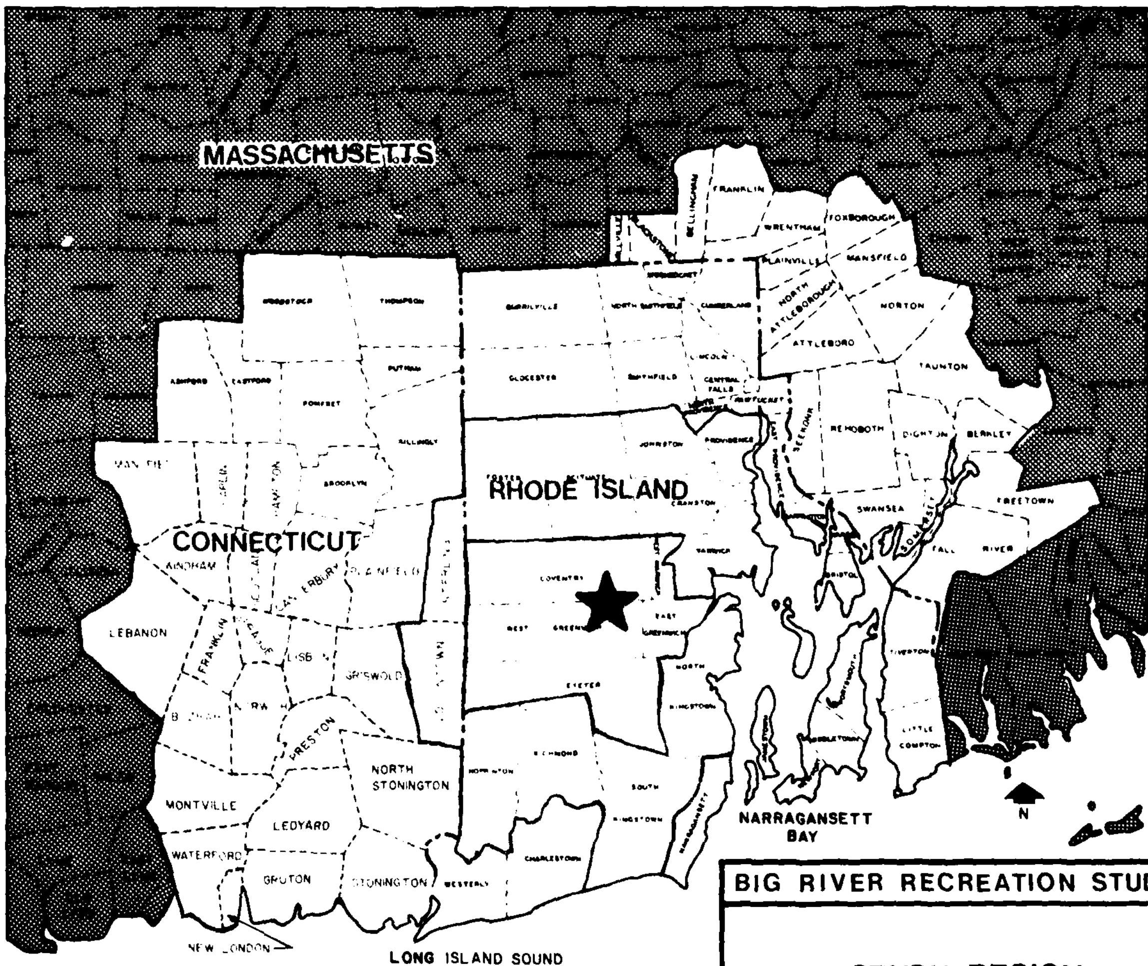
Rhode Island, the smallest state in the Union, is located within geographic coordinates of latitude 71° 05' W to 71° 50' W. It is bordered on the north and east by Massachusetts, on the west by Connecticut, and on the south by the Atlantic Ocean. The state encompasses approximately 1,214 square miles, 13 percent of which is the Narragansett Bay. In addition to the state's 136 miles of land boundaries, Rhode Island has approximately 420 miles of salt water coastline.

B. Topography

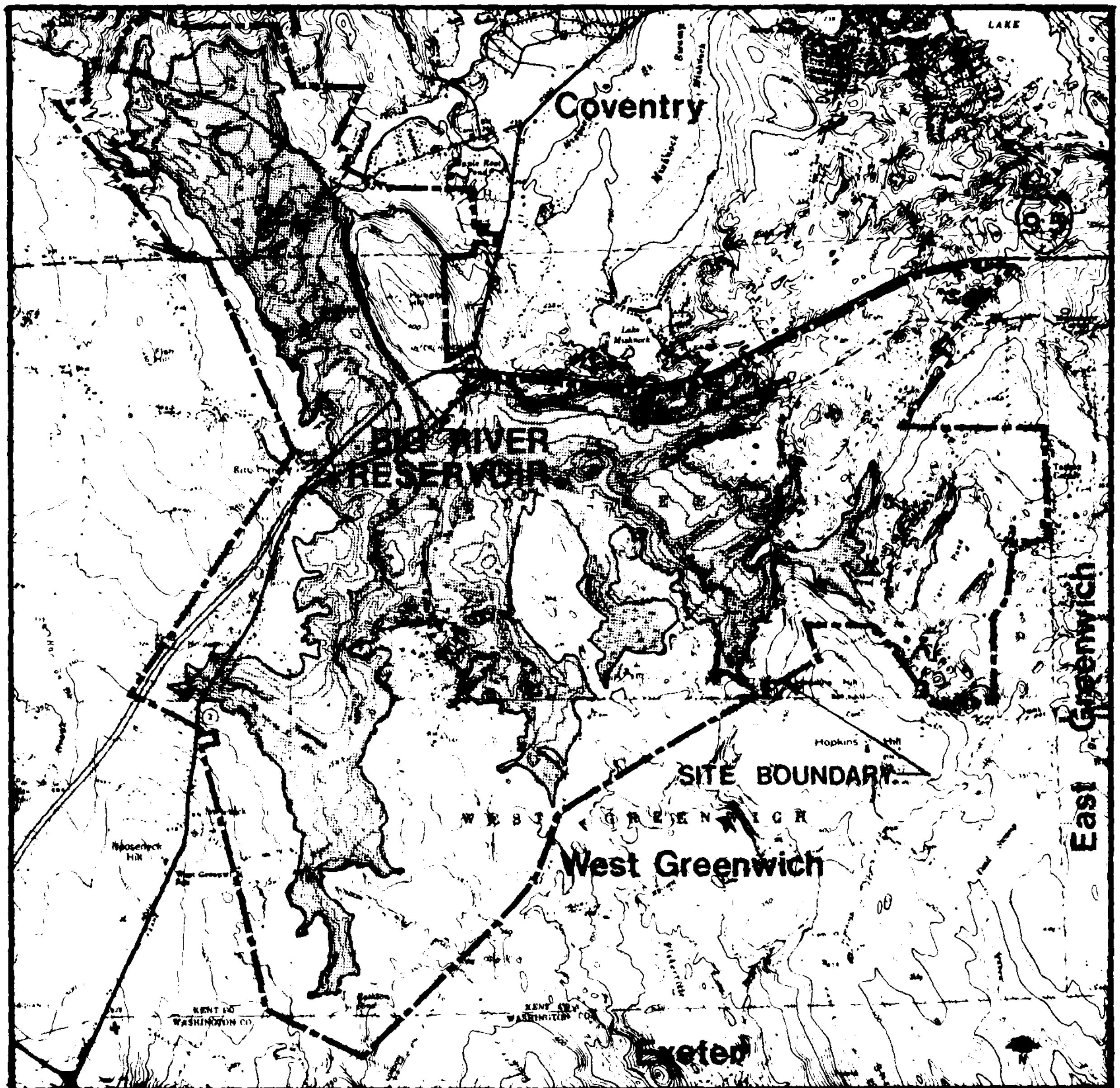
Rhode Island lies in two major physiographic sections of the New England province. The northwest third of the state lies within the New England Upland section, and consists of rounded steep hills and narrow valleys. The remainder of the state, which includes the Big River Site, lies in

LEGEND:

- ★ BIG RIVER SITE
- LOCAL AREA
- IMMEDIATE STUDY REGION
- STUDY REGION
- BEYOND STUDY REGION



BIG RIVER RECREATION STUDY	
STUDY REGION	
SCALE: 0 5 10 Miles	FIGURE: 2



BIG RIVER RECREATION STUDY

BIG RIVER RESERVOIR SITE

SCALE: 1" = 4000'	SCHOENFELD ASSOC., INC. - ENGINEERS, ARCHITECTS & PLANNERS U.S. ARMY CORPS OF ENGINEERS	FIGURE 3

the Seaboard Lowland section, and consists of rounded hills not as steep as those of the uplands. A large portion of this lowland has been submerged, forming the Narragansett Bay. The many islands of the bay are formed by the higher elevations of the submerged hills. In general, the lowland area has an altitude of less than 200 feet.

C. Climate

Rhode Island is a humid state with a variable climate, characterized by frequent though generally short periods of heavy precipitation. The mean annual precipitation is 43.57 inches (1965-74 data), and is fairly well distributed throughout the year. The greatest annual precipitation recorded was 65.03 inches in 1972; the minimum annual amount was 25.44 inches in 1965.

The temperature varies from summer highs slightly in excess of 100^{o} Faharenheit (F) to lows in the minus 20's which occur for short periods during the winter. The mean annual temperature is 50.5^{o}F, with the average monthly temperature varying from about 72^{o}F in July to near 29^{o}F in January and February.

Rhode Island is exposed to frequent periods of unsettled weather, due to the rapidly moving cyclonic storms or "lows" that move into New England from the north or southwest. The state is also subject to coastal storms that travel up the Atlantic Coast. The most severe storms usually occur during late summer and early autumn.

D. Water Resources

Rhode Island has a total of 357 fresh water lakes and ponds which comprise approximately 28.8 square miles, or 2.5 percent of the state's area. These impoundments provide a shoreline of approximately 464 miles. In addition, there are 26 inland salt ponds, covering approximately 10.7 square miles, with a shoreline of 96 miles. Of the total 39.5 square miles of the state's 383 impoundments, approximately 29 percent are used to provide drinking water.

In addition, Rhode Island has 272 streams that are grouped into seven major river basins which include the Blackstone, Moosup, Moshassuck, Pawcatuck, Pawtuxet, and Woonasquatucket Rivers. These rivers and their tributaries are divided into two groups, those that flow into Narragansett Bay (with a combined drainage area of 750 square miles) and those that drain into Long Island Sound (with a combined drainage area of 300 square miles). The Big River Site lies within the Pawtuxet River Basin. The Pawtuxet River and its two major tributaries, the North and South branches, form Rhode Island's second largest watershed.

The total withdrawal of groundwater is approximately 25 million gallons per day. Of this, approximately 12.3 million gallons are pumped for public supply, 10.4 million gallons for industry, and 2.3 million gallons for agricultural uses. This supply is continuously replenished by local precipitation.

E. Geology

The bedrock geology in the upland area is underlain mostly by granite rock, although the eastern part contains irregular patches of schist, quartzite, and greenstone. The lowland area is underlain by downfolded and downfaulted beds of conglomerate, sandstone, shale, and meta-anthracite, all of the Carboniferous age. The solid bedrock is exposed as ledges in many places, but it is generally covered by a layer of unconsolidated glacial drift material of varying thickness. These deposits are described as being either hardpan or till material, or as an outwash. The hardpan or till is generally unconsolidated, consisting of boulders, pebbles, silt, and clay, mixed together without sorting or bedding. Overlying the till and lying mainly in the valley areas are outwash deposits of bedded gravels, sands, silts, and clays that were deposited by meltwater from the glaciers that covered New England 15,000 years ago.

The soils of Rhode Island have developed largely from materials accumulated during the Ice Age as glaciers deposited soil as till or outwash. Most of the soils have developed from the extensive bedrock underlying most of the state. The upland soils, which cover the major part of the state, are very stony, the result of glacial action. Because of their basic structure and texture, these soils are conducive to good root penetration, water percolation, adequate drainage, and a high water-holding capacity. With proper care, these soils are favorable for growing forest, grasses, and various crops.

The soils that have developed on the terraces and outwash plains are relatively level and free of stones. They have good to excessive drainage and are variable in texture. These soils are less fertile since they were developed from coarser materials and have been leached to a great extent. Basically, the soils have good structure and, with adequate moisture and fertilization, would produce a fair yield of crops.

F. Flyways

A flyway is defined as an established air route of migratory birds. In the past, the terms "flyway" and "migration route" were generally considered synonymous. Today, however, a flyway is regarded as a vast geographic region with extensive breeding and wintering grounds, connected by an intricate system of migration routes. In 1935, the existence of four great flyways was discovered by analyses of several thousand records of bird banding data. These routes, referred to as the Atlantic, Mississippi, Central, and Pacific flyways, cover most of the width of the North American continent, and extend from the Arctic coast to South America. Many believe that all migratory birds follow these routes. Rhode Island lies within the Atlantic flyway, which roughly includes the Atlantic ocean routes and the routes over the eastern states. Although data are extremely limited, it is known that the Atlantic Coast is a regular route of travel for both waterfowl and land birds. Approximately 50 different kinds of land birds that breed in New England follow the coast southward to Florida and South America.(12)

G. Forests

Forest land is the dominant land-cover type in Rhode Island, comprising nearly 65 percent of the total area. Included are hardwood, softwood, and mixed forests. Of these, hardwood and mixed forests are most extensive (See Section II-I).

H. Transportation

Eleven major highways traverse the state, forming the major arteries of an integrated roadway system. Interstate Route 95, which traverses the Big River Site, runs from the western border of Connecticut through Providence to the Massachusetts line, bringing the total length to 43.3 miles. Route 3 also provides access to the site (See Figure 1). Interstate Route 195 is a branch route to southeastern Massachusetts, while Interstate Highway 295 circles the metropolitan Providence area to the west. Since 1956, $304 million have been spent for interstate highways alone. Except for the Newport and Mt. Hope bridges, highways in Rhode Island are free. The location of the Big River Site in the center of the state highway system makes it highly accessible from almost any part of the state.

Interstate bus service is provided by the Greyhound, Trailways, Almeida, and Bonanza bus companies. Intrastate transportation is provided by the Rhode Island Public Transit Authority and the ABC and Bonanza bus companies.

The Penn Central Railroad, which runs between New York and Boston, provides all the passenger and much of the freight rail service in Rhode Island. Additional freight lines owned by the Providence and Worcester, Moshassuck Valley, Narragansett Pier, Seaview, and Warwick rail companies carry cargo into Penn Central's main line at various points throughout the state. Passenger service is provided solely by Penn Central, which operates the Amtrak service (a federally assisted public corporation) between New York and Boston, and a commuter line from Westerly through Providence to Boston.

There are six state airports in Rhode Island which provide passenger and cargo service. The terminal facility at Green Airport in Warwick handled 807,931 airline passengers and 22 million pounds of air cargo in 1971. Direct flights are scheduled to New York, Washignton, Albany, Baltimore, Boston, Hartford, Miami, Philadelphia, and Cleveland.

The port of Providence is the third largest port in New England with respect to tonnage handled (approximately 8.5 million tons of goods in 1972). Many of southern New England's domestic and industrial petroleum products are unloaded at Providence for shipment to inland areas. Facilities are provided for handling bulk and general cargo at 27 private and public docks. In addition, there is a major shipping area centered around Tiverton, which handled one million tons of cargo in 1972. The state also operates piers at Pawtucket, Bristol, and Narragansett.

I. Land Use and Management

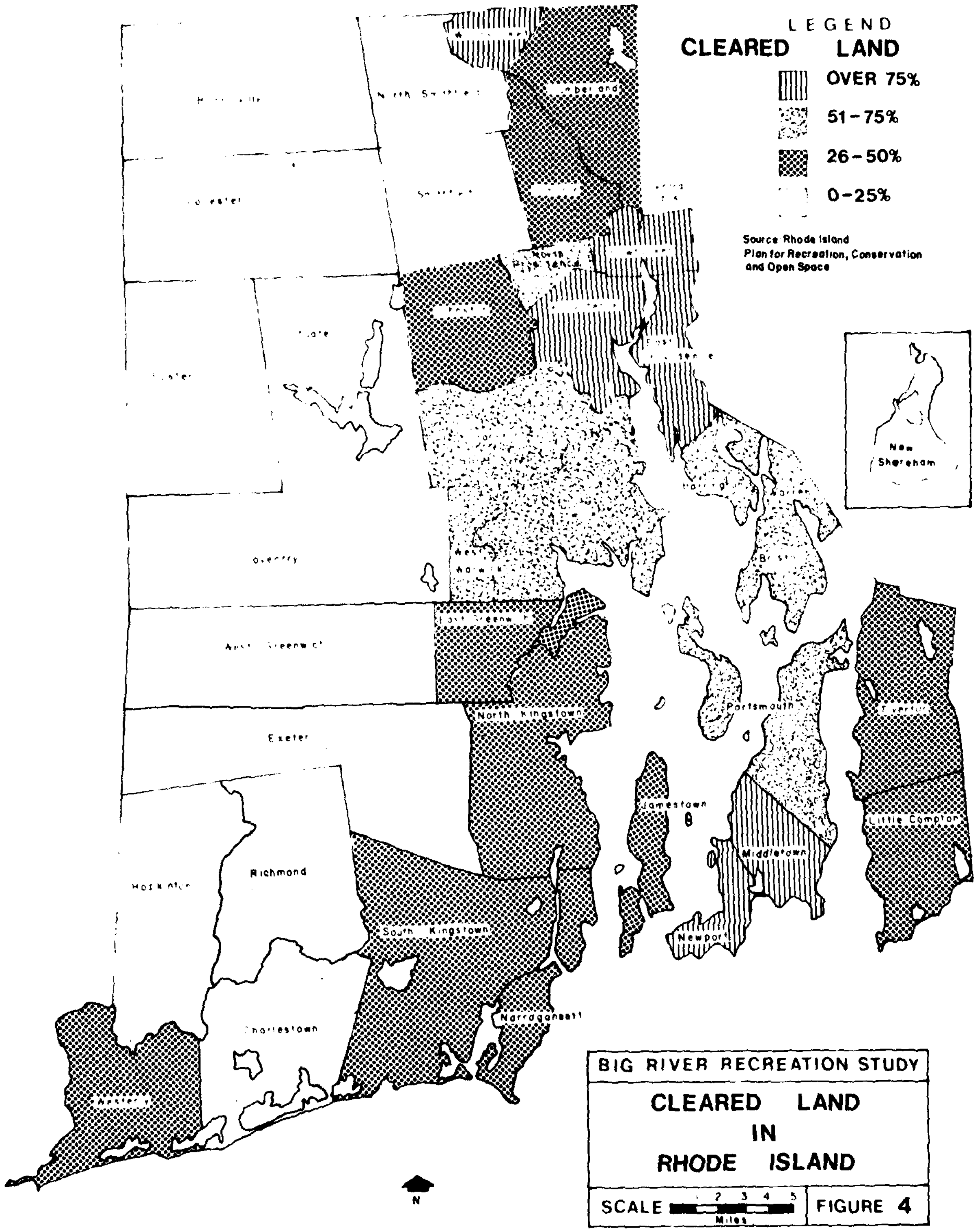
Only about 30 percent of Rhode Island's land has been cleared of natural vegetation. Forest land is the dominant cover type, representing nearly 65 percent of the state's area. Abandoned fields, abandoned orchards, and shrub types have a wide distribution throughout the state, although they comprise only 5 percent of the land area. Wetlands, which include fresh and salt water marshes and shrub swamps, cover only 1.5 percent of the land area, although practically every city and town has wetland areas.

Approximately one-third of Rhode Island's land is cleared for urban and agricultural uses. Approximately 18 percent of the total land is committed to urban (i.e., residential, commercial, and industrial) development. The majority of these usages are concentrated at the head of Narragansett Bay. Approximately 11.6 percent of the land area is used for active agricultural purposes, and includes farms, pastures, orchards, and land covered with grasses or the remains of a crop. Agriculture has been declining since 1850, and the land has been replaced first by forest area, then by urban, usually residential, development. (All numbers were taken from the Rhode Island SCORP report.)

Figure 4 indicates the land which has been cleared in Rhode Island.

J. Education

There are 40 school districts in Rhode Island, with an average daily attendance of 172,582 in 1973. According to the 1970 census, 46.4 percent of the population 25 years and older have completed four years of high school or more. General supervision of the school system is the responsibility of the State Board of Regents.



BIG RIVER RECREATION STUDY

CLEARED LAND IN RHODE ISLAND

FIGURE 4

Rhode Island has seven vocational schools, one operated by the state and six by local school districts with state support. There is also one state-operated school for the blind, and two privately operated schools for the handicapped.

Rhode Island has three state institutions, the University of Rhode Island, Rhode Island College, and Rhode Island Junior College. In addition, there are eleven private colleges and universities. The total enrollment in 1973 for these institutions was 48,555.

III. REGIONAL ASSESSMENT

A. Socio-Economic Characteristics of the Market Region Population

Several socio-economic factors have been taken into account in the development of the projections of future recreation demand in the Big River area. These projections are discussed later in Section III. The most significant characteristics employed in the methodology used for projecting future recreation demand, both in the Rhode Island SCORP report and in that adapted for use in this study, are population change and income. Other factors which help to broaden the recreation demand picture include the changing pattern of age distribution, and, to a lesser extent, education and automobile availability.

Federal census data from 1970 are presented for Rhode Island and sections of Connecticut and Massachusetts within 40 miles of the Big River Site. Projections have been made for these communities in 1995. Statewide population projections are also detailed for Rhode Island, Connecticut, and Massachusetts in 1995 and 2020. Recreation demand has been assessed later in this section for the years 1995 and 2020.

In 1970, 1,631,363 people lived within 40 miles of the Big River Site. By 1995, this figure is estimated to increase to 1,992,650. Due to various socio-economic considerations and the availability of a wide range of recreation activities in Connecticut and Massachusetts, the primary market area for the Big River Site is limited to Rhode Island. All cities and towns in Rhode Island are within one hour's driving time of the proposed Big River Reservoir.

1. Rhode Island

Both stabilization and suburbanization have been significant factors in Rhode Island population trends. Rhode Island, with the second highest population per square mile of any state, is generally typified as belonging to the metropolitan area extending along the east coast between Boston and Washington. Urbanization is a trend which began during the eighteenth and nineteenth centuries when rapid economic expansion was due to the growth of the textile industry. In the twentieth century, however, the rate of growth has stabilized and the populations of central cities have declined while surrounding suburban communities have grown.(13)

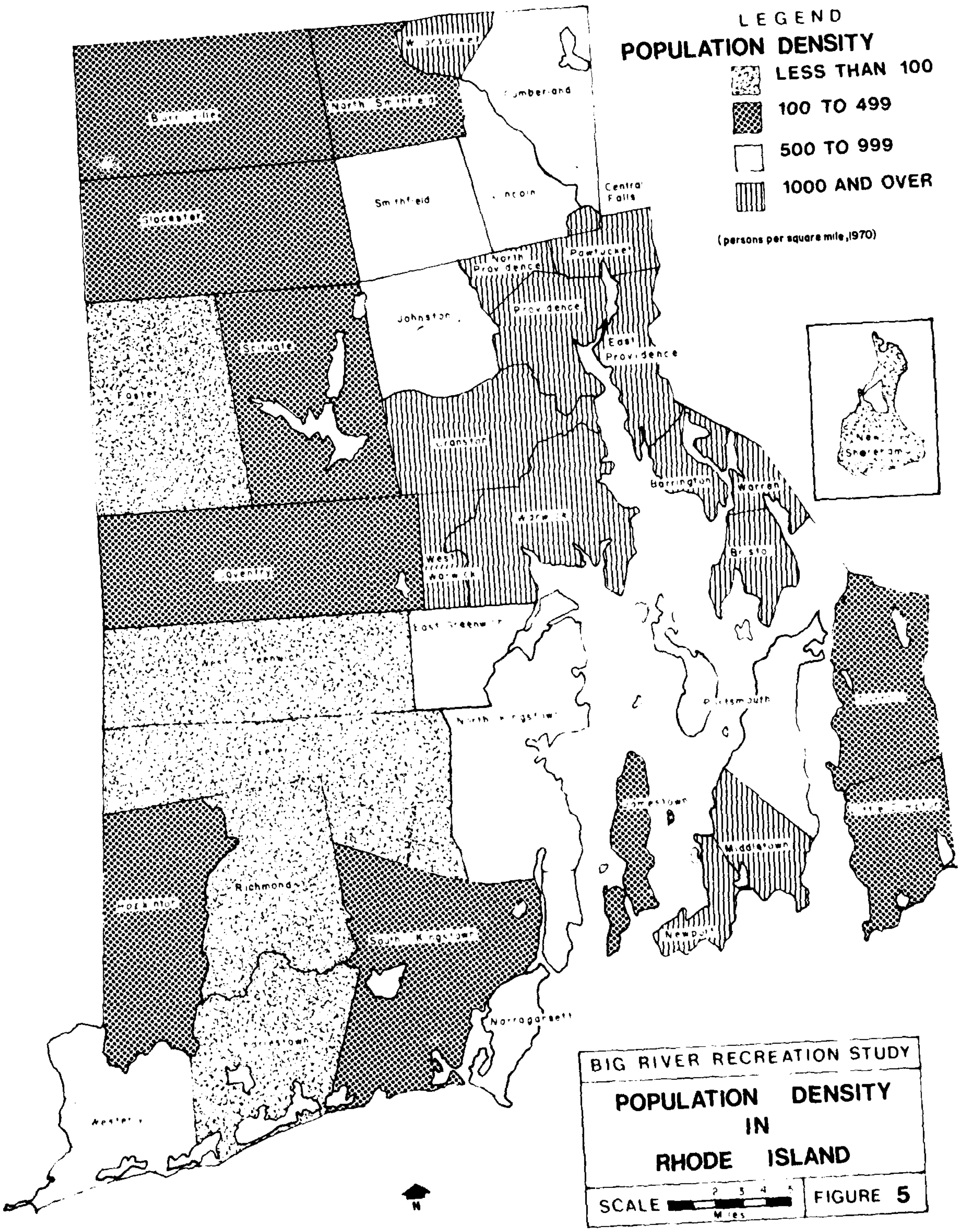
Population growth and urban development have centered on the northern and western shores of Narragansett Bay. The Providence metropolitan area, located at the head of the bay, includes the cities of Central Falls, Cranston, East Providence, Pawtucket and Warwick. Urbanized towns in the metropolitan area include Barrington, Bristol, North Providence, Warren and West Warwick. Both Woonsocket, located to the north, and Newport, located to the south of the Providence-Pawtucket metropolitan area are incorporated cities exhibiting urban characteristics. Other towns which are becoming increasingly urban include Coventry, Johnston, Smithfield, South Kingstown and Tiverton. Despite the high overall residential density of Rhode Island, other communities remain essentially rural. Figure 5 illustrates the population density pattern of Rhode Island communities.

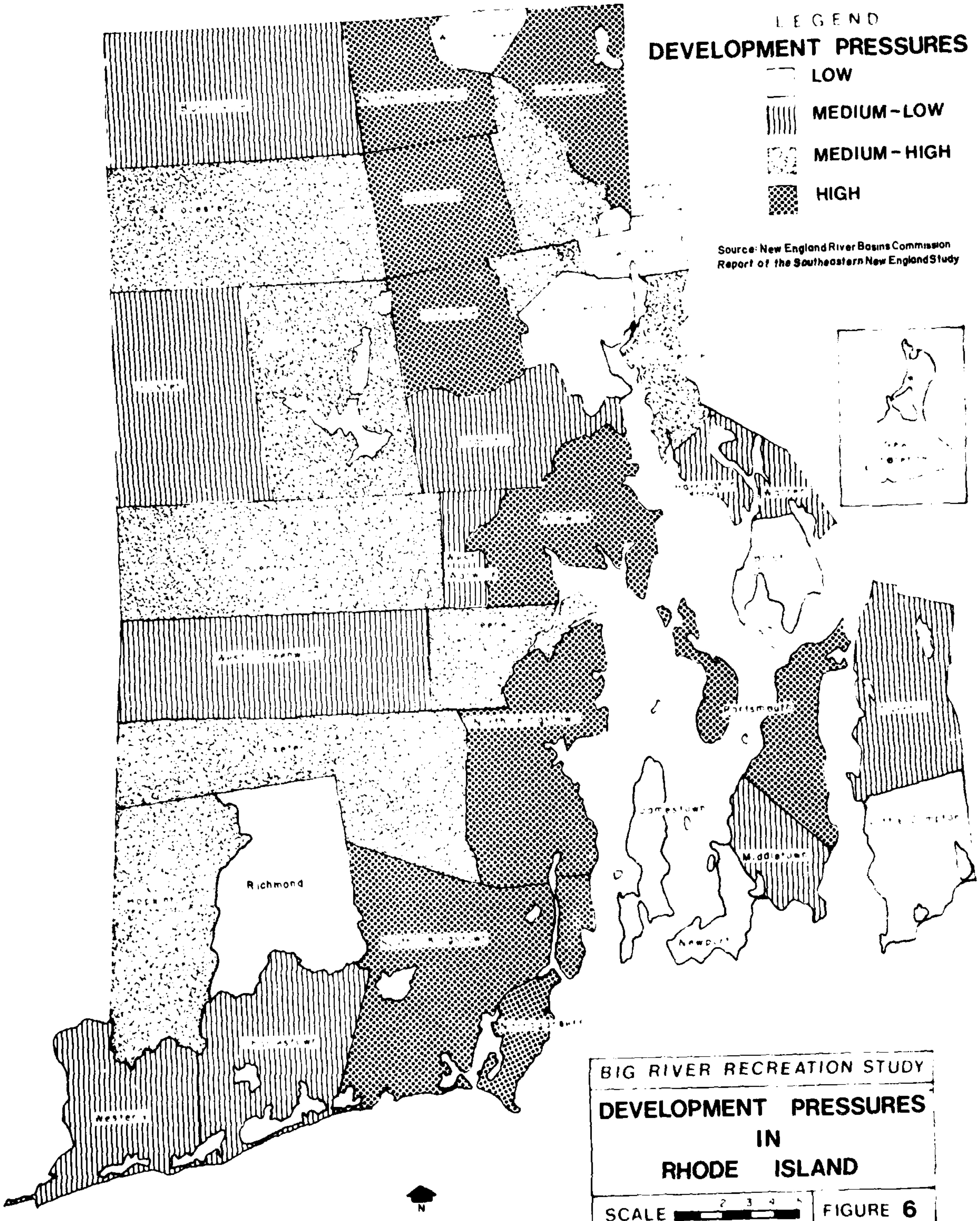
Of the five towns in the local area, both Exeter and West Greenwich had less than 100 persons per square mile in 1970. Coventry had 384 persons per square mile while East Greenwich had 582 per square mile. West Warwick, an urban town, had 3052 persons per square mile in 1970.(14)

Several studies prepared by the Rhode Island Statewide Planning Program (SPP), the New England River Basins Commission (NERBC), and the U.S. Departments of Commerce and Agriculture (1972-E OBERS) have made population projections for Rhode Island.(15,4,16) According to the SPP, the total population of the five-town local area is projected to increase over 50 percent from the 1970 population of 61,933 to 93,900 in 1995. Both Coventry and West Greenwich are expected to nearly double in population over this time period -- Coventry to a total of 41,000 and West Greenwich to a total of 3,400. Other communities will experience more modest growth with increases between 30 and 51 percent. Between 1995 and 2020, the population of the five-town area is expected to grow 20 percent to 112,300.(15)

Anticipated growth in Rhode Island has been projected by the NERBC according to development pressures relative to all southeastern New England communities. These communities extend from the North Shore of Boston southward through Rhode Island, and include several towns in southeastern Connecticut. Development pressure has been rated low, medium-low, medium-high, or high according to factors which make a town attractive for growth. Factors considered include rate of growth of residential, commercial, and other uses, the relative accessibility of the area to employment and population centers, and the amount of easily developed land. As indicated in Figure 6, development pressure is highest along Narragansett Bay and in northeast Rhode Island. Medium pressure may be anticipated in western Rhode Island. Central cities and several other isolated communities may expect little future growth.(4)

As indicated in Table 1, the population of the ten Rhode Island towns located within the immediate study region was 423,972 in 1970. A 21 percent population increase is expected by 1995 when the total is projected to be 511,300. A more modest 17 percent increase is projected between 1995 and 2020 when the total will be 595,700. The 1970 population of the twenty-four Rhode Island communities within the study region, located over 20 miles from the Big River Site, was 463,818. This total


LEGEND
POPULATION DENSITY
LESS THAN 100
100 TO 499
500 TO 999
1000 AND OVER
(persons per square mile,1970)
North Smithfield
Smithfield
Central Falls
North Providence
Pawtucket
Providence
Johnston
East Providence
Scituate
Glocester
Foster
Cranston
Barrington
Warren
Bristol
West Warwick
Coventry
East Greenwich
Richmond
South Kingstown
Narragansett
Middletown
Newport
New Shoreham
BIG RIVER RECREATION STUDY
POPULATION DENSITY IN RHODE ISLAND
SCALE
Miles
FIGURE 5



BIG RIVER RECREATION STUDY

DEVELOPMENT PRESSURES IN RHODE ISLAND

SCALE

FIGURE 6

TABLE 1

Rhode Island Population by Community
1970, 1995 and 2020

	1970	1995	2020
Local Area			
Coventry	22,947	41,000	52,400
East Greenwich	9,577	13,100	16,300
Exeter	3,245	4,900	5,400
West Greenwich	1,841	3,400	4,400
West Warwick	24,323	31,500	33,800
Immediate Study Region - 20 Miles			
Cranston	74,287	91,200	104,200
Foster	2,626	4,000	5,100
Hopkinton	5,392	7,300	9,400
Johnston	22,037	32,300	37,200
North Kingstown	29,793	45,500	57,500
Providence	179,116	186,000	209,000
Richmond	2,625	4,200	5,200
Scituate	7,489	9,300	9,800
South Kingstown	16,913	23,800	28,700
Warwick	83,694	107,700	129,600
Study Region - 40 Miles			
B[illegible]ington	17,554	18,300	19,400
Bristol	17,860	21,900	22,900
Burrillville	10,087	13,100	16,600
Central Falls	18,716	17,300	17,100
Charlestown	2,863	4,700	6,000
Cumberland	26,605	33,700	44,200
East Providence	48,207	64,000	74,200
Glocester	5,160	7,400	8,400
Jamestown	2,911	3,900	4,800
Lincoln	16,182	19,700	23,600
Little Compton	2,385	4,200	4,900
Middletown	29,290	19,000	26,200
Narragansett	7,138	11,200	13,200
Newport	34,562	33,500	38,500
New Shoreham	489	500	600

TABLE 1 (continued)

Rhode Island Population by Community
1970, 1995 and 2020

	1970	1995	2020
North Providence	24,337	32,900	39,400
North Smithfield	9,349	12,700	18,800
Pawtucket	76,984	76,700	77,200
Portsmouth	12,521	15,600	19,400
Smithfield	13,468	18,500	23,500
Tiverton	12,559	16,100	21,200
Warren	10,523	12,600	14,600
Westerly	17,248	22,000	29,000
Woonsocket	46,820	50,600	52,500
Rhode Island	949,723	1,135,300	1,324,500

Source: "Rhode Island Population Projections by County, City and Town."(15)

is projected to increase 14 percent by 1995 to 530,100. An additional 16 percent increase is anticipated by the year 2020 when a total population of 616,200 is expected.(15)

The Statewide Planning Program in Rhode Island has projected that the 1970 state population of 949,723 will increase 16 percent to 1,135,300 in 1995. An additional 16 percent increase is expected statewide to bring the total population to 1,324,500 in the year 2020.(15) According to the 1972-E OBERS Projections, the population of Rhode Island is expected to increase 25.2 percent from the 1970 figure to 1,340,800 in the year 2020.(16) The 1972-E OBERS population projections for Rhode Island, Connecticut, and Massachusetts are presented in Table 2.

An important demographic consideration for recreation planning is the age distribution of the population. Outdoor sports such as hiking, swimming, canoeing, bicycling, outdoor games and sports, and horseback riding are typically engaged in by people below age 40. These recreation activities are more active and generally less organized in nature than those preferred by very young children or by persons over 40.(17) The table below illustrates the 1970 Rhode Island population distribution by age groups.

Age Distribution in Rhode Island
1970, 1995, and 2020

Age Group	1970		1995		2020	
	Population	Percent	Population	Percent	Population	Percent
0-14	250,937	26.4	267,425	23.6	274,676	20.7
15-24	174,199	18.4	172,711	15.2	184,158	13.9
25-39	154,620	16.3	248,003	21.8	276,319	20.9
40-64	265,766	28.0	283,930	25.0	393,506	29.7
65+	104,201	10.9	163,205	14.4	196,061	14.8
TOTAL	949,723	100%	1,135,274	100%	1,324,720	100%

Source: "Rhode Island Population Projections by County, City and Town."(15)

Projections have also been made for 1995 and 2020.(15) As indicated, age segments of the population are expected to shift in future years. The percentage of people below age 25 will decrease both in 1995 and 2020 while the 25-39 year bracket will peak in dominance in 1995.

TABLE 2

Statewide Population Projections

	Federal Census	1972-E OBERS Projections[16]		State Projections	
	1970	2000	2020	1995	2020
Rhode Island[15]	949,723	1,191,000	1,340,800	1,135,300[15]	1,324,500[15]
Connecticut	3,032,217	4,030,000	4,647,600	3,674,200[60]	*
Massachusetts	5,689,170	7,456,700	8,582,400	6,542,000[27]	**

*Not available, Connecticut Department of Planning and Energy Policy.

**Not available, Massachusetts Office of State Planning.

Activities enjoyed by the 25-39 year bracket include fishing, boating, picnicking, hiking, horseback riding, and other family activities. Accordingly, motorcycle riding, which is enjoyed by younger people, will decrease in popularity. By the year 2020, the segment of the population above age 40 will increase significantly. Again, fishing, boating, and organized recreational opportunities will again increase in popularity as the demand for activities appealing primarily to those below age 25 decreases.

Projections have been made for the total number of automobiles available in Rhode Island in the year 2000.(18) This figure is an indication of how able the general population will be to travel to various recreational opportunities. In Rhode Island, 520,409 automobiles, or one automobile for every 1.8 persons, were available in 1970. By the year 2000, this number is expected to increase to 745,998 or one automobile for every 1.6 persons. Automobiles are even more available in the five-town local area. In the year 2000, there will be one automobile available for every 1.4 persons.

According to the Connecticut State Comprehensive Outdoor Recreation Plan (Ct. SCORP), family income is also indicative of the amount of personal resources available for recreation.(17) A person with an income higher than average will participate more frequently in more diverse activities than one with a lower income. He will also travel further and participate more often. Preferred activities include hiking, nature study, swimming, golfing, and boating. A person with a limited income prefers more developed recreation settings such as picnic areas, playgrounds, and game fields close to home. People from both income levels walk for pleasure, hunt, fish, and attend local parks.

In the Report of the Southeastern New England (SENE) Study, the NERBC reported the 1969 per capita income for four planning areas within 40 miles of the Big River Site. This information (in 1967 dollars) was then compared to the per capita income in southeastern New England and to the national average. In the Pawtuxet planning area, including Providence, Pawtucket, and Warwick as well as Coventry, West Greenwich, and West Warwick in the local area, the per capita annual income was just over $3,500. This figure is over the national average but 5 percent below the SENE average.(19) The per capita income for communities along the Rhode Island coastline in the Pawtucket planning area, including Exeter, was $3,127, about 8 percent less than the national average and over 15 percent less than the SENE average.(20) Figures compiled for Narragansett Bay indicate that the per capita income was $3,100 in 1969, one of the lowest income levels in the SENE region.(21) In the Blackstone planning area which extends northwest of Providence and into Massachusetts, the per capita income was $3,400, close to the national average but below the average for the SENE region.(22) Although the government sector provided a large segment of employment opportunities at that time, with the closing of several military bases in Rhode Island manufacturing has become a more significant source of jobs. Due to the lower than average income levels in the Rhode Island area (compared to all of southeastern New England), residents typically are less willing to travel distances for recreation and prefer more organized settings than in adjacent states where income levels are higher.

According to the 1972-E OBERS Projections, the per capita personal income of residents in Rhode Island and eastern Massachusetts (Worcester County and eastward) was 10 percent higher than the national average in 1970. Although personal income will continue to be above the national average in future years, the percentage will decrease to 8 percent in the year 2000 and 6 percent in 2020.(16) In future years it is estimated, therefore, that residents will become less willing to travel to recreation facilities than they were in 1970. They will also prefer more organized and developed recreation opportunities by the year 2020. Preferred recreational opportunities will include activities similar to those currently available at Rhode Island state parks.

2. Connecticut

In Connecticut, the population of central cities also declined after World War II as surrounding suburban communities grew. About 74 percent of the state's population is contained in 50 of the 169 towns on 26 percent of the land area. Although population density and development pressures are the highest in southwestern Connecticut and in the Connecticut River valley, substantial growth has also occurred in the New London-Groton-Norwich area, located within 40 miles of the Big River Site.(17)

Both Sterling and Voluntown, located within the immediate study region, have under 100 persons per square mile. Of the thirty Connecticut communities within 20 to 40 miles of Big River, eleven have less than 100 persons per square mile and fourteen have between 100 and 499 persons per square mile. Waterford and Windham have population densities between 500 to 999. New London, Groton and Norwich have densities in excess of 1000 people per square mile.(17)

Three regional planning commissions encompass communities within the Big River study region in Connecticut. Northeastern Connecticut includes ten towns with a total 1970 population of 58,961. By the year 1995, the population is expected to increase 40 percent to 82,750. Southeastern Connecticut encompasses eighteen communities, all but three of which are within 40 miles of the Big River Site. In this regional planning district, the population is expected to increase 30 percent, from a 1970 total of 220,402 to a total of 286,950 in the year 1995. The Windham region encompasses ten communities, all but three of which are within the study region. The population of this region is expected to increase 27 percent from a 1970 total of 64,376 to 81,500 by the year 1995. The total population of these three regional planning districts is expected to increase from 343,739 in 1970 to 451,200 in 1995. The population of the 30 Connecticut towns within 40 miles of the Big River Site (excluding Sterling and Voluntown) is expected to increase 29.1 percent from 305,955 recorded in 1970 to 395,000 projected in 1995. The population of Sterling and Voluntown, located within the immediate study region, is expected to increase 39 percent from the 3,305 recorded in 1970 to 4,600 in 1995. The population of the state as a whole is anticipated to increase from 3,032,217 in 1970 to 3,674,200 in 1995, a 21 percent increase.(60)

Other statewide projections for Connecticut are 4,030,000 for the year 2000 and 4,647,600 for the year 2020.(16) The population of the Long Island Sound Water Resources Region, including three of the easternmost counties, has also been projected in the 1972-E OBERS Series. The 1970 population of this region was 2,254,820. This total is expected to increase to 2,959,600 in 2000 and 3,401,200 in 2020.

In Connecticut, the communities where the percentage of families below the poverty level exceed the state-wide average are generally central cities and rural towns in the northeastern corner of the state.(17) In New London and Groton, 10 percent or more of the families are below the poverty level. Of the 28 remaining Connecticut towns in the Big River study region, 5 to 9.9 percent of the families in twelve of the towns have incomes below the poverty level. Manufacturing and other blue-collar occupations employ over 40 percent of the workers in nine of the towns. In ten of these communities, 30 to 39.9 percent of the employed persons are engaged in manufacturing.(17) Based upon income, residents in this region are typically less willing to travel distances. They also prefer more regulated activities like picnicking and swimming than do those in higher income brackets.

3. Massachusetts

Twenty Massachusetts communities are located within 40 miles of the Big River Site. The total 1970 population of this area was 337,901. Although these towns are generally not very intensively developed, Fall River, Taunton, Attleboro, North Attleboro and Somerset are urbanized. The 1970 population of these five communities was 62 percent of the total population of the towns within the Big River study region in Massachusetts. Of the remaining fifteen communities, twelve are "less dense" and three are "open" or rural, as classified by the Massachusetts SCORP.(22)

According to the NERBC's study of southeastern New England previously described for Rhode Island, development pressures are high in five communities, medium-high in nine communities, medium-low in three communities, and low in three communities. Many of the growing communities are in the area served by the interstate highway network including I-495, I-95, and I-295. The population of the twenty-town area is expected to increase 22 percent between 1970 and 1995 to a total of 413,250.(24-26)

Population projections have also been made on a statewide basis in Massachusetts. By the year 2000 the population of Massachusetts is projected to be 6,668,000 according to the Massachusetts Office of State Planning.(27) This is a 17 percent increase over the 1970 population, 5,689,170. According to the 1972-E OBERS Projections, the Massachusetts population will be 7,456,700 in the year 2000 and 8,582,400 in the year 2020.(16)

B. Inventory of Recreational Activities

The purpose of this section is to describe the outdoor recreation activities in the 40-mile study region, which includes all of Rhode Island, eastern Connecticut, and part of southern Massachusetts. Major activities were inventoried if the activity or a potential for the activity exists on the proposed Big River Site. Information utilized in the inventory was obtained from federal and state governmental agencies, as well as from regional commissions, private organizations, and personal observations of staff members.

The inventory data are divided by the Big River Site area, local area (the five towns surrounding the site), the immediate study region (within 20 miles), and the study region (within 40 miles). These data are provided for the following activities: boating, camping, fishing, golf, hunting, picnicking, swimming, and trails for hiking, horseback riding, recreational vehicles, and snowmobiles.

1. Recreational Activities in the Study Region

The activities inventoried for this report are shown in Tables 3 through 11. The recreational areas and facilities vary greatly in location and size, and provide a wide range of activities.

There are over 30,000 acres of state-owned land in Rhode Island that are utilized for recreation, conservation, and open space. State management areas make up most of this acreage. The state operates both multi-use areas, such as management areas and parks, and specific facilities such as campgrounds, boat launches, and beaches. Also owned by the state, but not included in this inventory, are the large tracts of school land which provide open space and various recreational facilities.

TABLE 3

Major Recreation Areas

NAME	LOCATION	CAMPSITES	PICNICKING	SWIMMING	FISHING	BOATING	HUNTING	HIKING	WINTER SPORTS
LOCAL AREA	Rhode Island[28]								
Arcadia State Park	Exeter, Richmond								
Beach Pond State Park	Exeter, W. Greenwich	x	x	x	x			x	x
IMMEDIATE STUDY REGION - 20 Miles	Rhode Island[28]								
Dawley State Park	Richmond								
East Matunick State Beach	South Kingston		x	*	*				
Goddard State Park	Warwick		x	*	*	*		x	x
	Connecticut[29]								
Pachaug State Forest	Voluntown	x	x	x	x	x	x	x	x
STUDY REGION - 40 Miles	Rhode Island[28]								
Burlingame State Park	Charlestown	x	x	x	x	x			x
Charlestown Breachway	Charlestown	x			*	*		x	
Colt State Park	Bristol		x		*	*		x	x
Diamond Hill State Park	Cumberland		x		x			x	x
Fisherman's Memorial St. Pk.	Narragansett	x	x						
George Washington Area	Glocester	x	x	x	x	x		x	
Haines Memorial Park	Barrington		x			*			
Lincoln Woods State Park	Lincoln		x		x	x		x	x
Misquamicut State Beach	Westerly		x	*	*				
Ninigret Conservation Area	Charlestown	x		*				x	
Ocean Drive Area	Newport				*	*			
Pulaski State Park	Glocester		x	x	x			x	x
R. Wheeler Memorial State Pk.	Narragansett		x	*	*				
Scarborough Beach	Narragansett		x	*	*				
W.W. II Memorial State Park	Woonsocket		x	x					
	Connecticut[29]								
Bluff Point State Park	Groton								
Fort Griswold State Park	Groton								
Fort Shantok State Park	Montville		x						
Harkness Memorial State Park	Waterford		x		x				
Hopeville Pond State Park	Griswold	x	x	x	x	x		x	
Mansfield Hollow State Park	Mansfield		x		x	x		x	
Mashamoquet Brook State Park	Pomfret	x	x	x	x			x	x
Old Furnace State Park	Killingly		x		x			x	
Pomeroy State Park	Lebanon								
Quaddick State Park	Thompson		x	x	x	x			
Stoddard Hill State Park	Ledyard		x		x	x			
James L. Goodwin S. Forest	Hampton				x			x	
Quaddick State Forest	Thompson				x		x	x	
Mohegan State Forest	Scotland						x	x	x
Natchaug State Forest	Ashford		x		x		x	x	x
	Massachusetts[30]								
F. Gilbert Hills S. Forest	Foxboro						x	x	x
Watson Pond State Park	Taunton		x	x	x				
Dighton Rock State Park	Berkley		x		x				
Freetown State Forest	Assonet		x				x	x	x
Massasoit State Park	Taunton	x		x	x		x		x

* Salt Water Activity

TABLE 4

Fresh Water Boat Launches

WATER BODY	LOCATION	JURISDICTION	NOTES
BIG RIVER			
	Rhode Island(31)		
Zekes Bridge, Big River and Flat River Reservoir	Coventry	State	
Big River off Weaver Hill Road	West Greenwich	State	
Big River off Burnt Sawmill Road	West Greenwich	State	
Tarbox Pond	West Greenwich	State	
LOCAL AREA			
	Rhode Island(11,28,31)		
Carbuncle Pond	Coventry	State	No outboard motors
Tiogue Lake	Coventry	State	
Upper Dam Pond	Coventry	Town	
Breakheart Pond	Exeter	Arcadia Mgmt. Area	
Beach Pond	Exeter	State	
IMMEDIATE STUDY REGION - 20 Miles			
	Rhode Island(28,31)		
Fiskeville Reservoir	Cranston	Curren Public Fishing Area	
Shippee Saw Mill Pond	Foster	State	No outboard motors
Alton Pond/Wood River	Hopkinton	State	
Ashville Pond	Hopkinton	State	10 hp. limit
Locustville Pond	Hopkinton	State	
Moscow Pond	Hopkinton	State	Unimproved
Wood River	Hopkinton	State	
Grantville-Hope Valley Road	Hopkinton	State	
Silver Spring Lake	No. Kingstown	State	No outboards
Mashapaug Pond	Providence	State	
Biscuit City-Pawcatuck River	Richmond	State	
Richmond Landing-Pawcatuck R.	Richmond	State	
Wyoming Pond	Richmond	State	
Hope Landing-Upper Pawtuxet River	Scituate	State	Electric trolling motors only
Barber's Pond	So. Kingstown	State	
Indian Lake	So. Kingstown	State	
Taylor's Landing	So. Kingstown	State	
Tucker's Pond	So. Kingstown	State	
Worden's Pond	So. Kingstown	State	
Potowomut Pond	Warwick	State	
	Connecticut(29)		
Beach Pond	Voluntown	State	
Beachdale Pond	Voluntown	State	
Green Falls Reservoir	Voluntown	State	
STUDY REGION - 40 Miles			
	Rhode Island(28,31)		
Clear River-Harrisville Pond	Burrillville	State	
Pascoag Reservoir-Echo Lake	Burrillville	State	No outboard motors
Spring Lake	Burrillville	State	No outboard motors
Wakefield Pond	Burrillville	State	No outboard motors
Wilson Pond	Burrillville	State	10 hp. limit
Deep Pond	Charlestown	State	
Watchaug Pond	Charlestown	State	
School House Pond	Charlestown	State	
Bowdish Reservoir	Glocester	State	

TABLE 4 (Continued)

WATERBODY	LOCATION	JURISDICTION	NOTES
Clarkville Pond	Glocester	State	No outboard motors
Keech Pond	Glocester	State	10 hp. limit
Lake Washington	Glocester	State	No outboard motors
Smith and Sayles Reservoir	Glocester	State	10 hp. limit
Olney Pond	Lincoln	State	
Upper Slattersville Reservoir	No. Smithfield	State	
Melville Public Fishing Area	Portsmouth	State	Car top
Stafford Pond	Tiverton	State	
Bradford Landing-Pawcatuck R.	Westerly	State	
Chapman's Pond	Westerly	State	
	Connecticut[29]		
Amos Lake	Preston	State	
Anderson Pond	No. Stonington	State	
Avery Pond	Preston	State	
Beaver Brook Pond	Windham	State	
Billings Lake	No. Stonington	State	
Black Pond	Woodstock	State	
Glasgo Pond	Griswold	State	
Halls Pond	Eastford	State	
Hopeville Pond	Griswold	State	
Lake of Isles	No. Stonington	State	
Lantern Hill Pond	Ledyard	State	
Little Pond	Thompson	State	
Long Pond	No. Stonington	State	
Naubesatuck Lake	Mansfield	State	
Quaddick Reservoir	Thompson	State	
Roseland Lake	Woodstock	State	
Stoddard Hill, Thames River	Ledyard	State	
Thames River	New London	State	
Wyassup Lake	No. Stonington	State	
	Massachusetts[32]		
South Watuppa Pond	Fall River	State	
Long Pond	Freetown	State	
Sabbatia Lake	Taunton	State	
Falls Pond	North Attleborough	State	
Coles River	Swansea	State	

TABLE 5

Camping

CAMP	LOCATION	JURISDICTION	SEASON	CAMP SITES	MINIMUM RATE/NIGHT
LOCAL AREA					
	Rhode Island(11,33)				
Arcadia State Park	Exeter	State	4/15-10/31	25	$3.00
Beach Pond Camps	Exeter	State	4/15-6/20 9/1-10/31	48	$2/person
Frosty Hollow Area	Exeter	State	All year	2	$3.00
Horsemen's Camping Area	Exeter	State	4/15-10/31	30	$3.00
Colwell's Campground	Coventry	Private	4/15-10/15	75	$4.00
Hickory Ridge Family Camp.	Coventry	Private	4/15-10/15	200	$4.50
Mishnock Rec. Vehicle Park	W. Greenwich	Private	All year	35	$4.50
Ca[illegible]bers Campground	W. Greenwich	Private	All year	130	$4.00
Little Rhody Campground	Exeter	Private	All year	30	$4.50
Camp Ayoho	Coventry	W. Warwick	N/A	13	N/A
Palmer Grove	Exeter	Private	N/A	3	N/A
Yagoo Valley Ski	Exeter	Private	N/A	75	N/A
Camp Westwood	Coventry	YMCA	5/30-9/10	50	$8.00
IMMEDIATE STUDY REGION - 20 Miles					
	Rhode Island(11,33)				
Dyer Woods Nudist Camp	Foster	Private	5/1-10/1	14 1 Cabin	$11.00
Frontier Camper Park	Hopkinton	Private	2/1-12/1	135	$5.50
Ginny B. Family Campground	Foster	Private	5/1-9/30	150	$5.50
Greenwood Hill Family Camp.	Hopkinton	Private	2/1-12/1	Variable	$4.00
Holly Tree Camper Park	Hopkinton	Private	5/1-9/30	38	$4.00
Steadman's Campground	So. Kingstown	Private	5/1-10/30	150	$5.00
Wawaloam Reservation Camp.	Richmond	Private	All year	225	$5.00
Whippoorwill Hill Camp.	Foster	Private	4/15-10/15	150	$4.00
Whispering Pines Campground	Hopkinton	Private	2/1-12/1	130	$5.00
Worden's Pond Family Camp.	So. Kingstown	Private	All year	200	$4.00
Camp Yagoo	Hopkinton	BSA	N/A	35	N/A
Nokewa Camp	*No. Kingstown*	GSA	N/A	15	N/A
Dawley Management Area	Richmond	State	N/A	75	N/A
	Connecticut(34,35)				
Pachaug State Forest	Voluntown	State	N/A	54	N/A
Nature's Campsites	N. Voluntown	Private	5/1-10/15	150	$4.50
River Bend	Oneco	Private	5/1-11/1	100	$4.75
Ye Olde Countryside	Voluntown	Private	5/1-10/30	30	$3.50
Purola Farm	Voluntown	Private	4/15-10/31	74	$4.00
STUDY REGION - 40 Miles					
	Rhode Island(11,33)				
Burlingame State Park	Charlestown	State	4/15-10/31	755	$3.00
Canoe Camp Sites	Charlestown	State	All year	2	no charge
Canoe Camp Sites	Richmond	State	All year	2	no charge
Charlestown Breachway	Charlestown	State	4/15-10/31	75	$3.00
Fisherman's Memorial S.P.	Narragansett	State	4/15-10/31	182	$3.00
George Washington Mgmt. Area	Glocester	State	4/15-10/31	74	$3.00
Ninigret Conservation Area	Charlestown	State	4/15-10/31	50	$3.00
Fort Getty Rec. Area	Jamestown	Town	5/1-10/30	115	$5.00
Bowdish Lake Camping Area	Glocester	Private	N/A	200	$4.00
Camp Ponagansett	Glocester	Private	5/31-9/1	40	$5.00
Echo Lake Campground	Burrillville	Private	5/1-10/15	170	$5.00
Holiday Acres Campground	Glocester	Private	5/1-10/15	200	$5.00
Long Cove Marina Camp Sites	Narragansett	Private	4/29-11/1	100	$4.50
Melville Park	Portsmouth	Private	5/1-10/1	40	$6.00
Second Beach Family Camp.	Middletown	Town	5/1-10/1	28	$7.00
Forest Park	Middletown	Private	5/1-10/30	20	$6.00
Meadowlark Rec. Vehicle Park	Middletown	Private	4/1-11/15	40	$6.00
Paradise Trailer Park	Middletown	Private	5/1-11/1	22	$9.00

TABLE 5 (Continued)

CAMP	LOCATION	JURISDICTION	SEASON	CAMP SITES	MINIMUM RATE/NIGHT
Sakonnet Oaks	Tiverton	Private	5/1-10/30	150	$5.50
Camp Cookie	Glocester	GSA	N/A	18	N/A
Camp Russell	Glocester	Private	N/A	67	N/A
Oak Leaf Camp	Glocester	Private	N/A	50	N/A
Round Meadows	Little Compton	Private	N/A	76	N/A
Camp Aquidneck	Little Compton	Private	N/A	50	N/A
Manville Rod & Gun	Lincoln	Private	N/A	20	N/A
Camp Shepard	Smithfield	Private	N/A	6	N/A
Aquapaug Camp	So. Kingstown	BSA	N/A	25	N/A
Camp Fuller	So. Kingstown	YMCA	N/A	16	N/A
Camp Hoffman	So. Kingstown	GSA	N/A	40	N/A
Card's Camp	So. Kingstown	Private	N/A	200	N/A
M.A. Carpenter's	So. Kingstown	Private	N/A	285	N/A
Dune's Parking Lot	Westerly	Private	N/A	50	N/A
Jim's Trailer Park	Westerly	Private	N/A	60	N/A
Pucci's Trailer Park	Westerly	Private	N/A	30	N/A
	Connecticut[34,35]				
Acorn Acres	Colchester	Private	5/1-10/1	150	$5.75
Beaupres'	Pomfret	Private	All year	125	$5.50
Big Valley	Brooklyn	Private	4/15-10/30	250	$5.75
Brialee	Ashford-Warrenville	Private	All year	120	$5.75
Buck Meadows	Canterbury	Private	4/15-10/15	120	$5.00
Fox Tail	Brooklyn	Private	5/1-9/30	100	$4.50
Hidden Acres	Preston	Private	4/1-11/1	130	$4.00
Highland	Scotland	Private	4/15-10/15	170	$6.00
Highland Orchards	No. Stonington	Private	All year	200	$5.25
Hill'n Dale Acres	Lisbon	Private	4/1-11/1	80	$3.50
Indianfield	Salem	Private	5/1-10/30	125	$6.00
Laurel Lock	Colchester	Private	4/15-10/23	130	$6.50
Meadowside	Woodstock	Private	5/1-9/15	100	$6.00
Nickerson Park	Chaplin	Private	4/15-10/31	100	$4.00
Pachaug Park	Norwich	Private	4/15-10/15	35	$6.00
Ponderosa	East Lyme	Private	All year	146	$6.00
Rockin D	Danielson	Private	5/15-10/15	50	$4.00
Ross Hill Park	Lisbon	Private	All year	200	$5.00
Salt Rock	Baltic	Private	All year	111	$5.00
Seaport KOA	Old Mystic	Private	4/1-10/31	130	$6.00
State Line	E. Killingly	Private	5/1-10/15	200	$5.50
Strawberry Park KOA	Norwich	Private	All year	100	$6.25
Travel Trailer Haven	Groton	Private	All year	35	$6.50
Wilderness Park	Pomfret Center	Private	5/1-10/15	75	$5.00
Witch Meadow	Salem	Private	5/1-10/31	170	$6.50
Hide-a-way Cove	E. Killingly	Private	5/15-10/15	200	$6.25
Chamberlain Lake	Woodstock	Private	N/A	New	N/A
Mashamoquet Brook State Park	Pomfret	State	4/15-9/30	32	$2.00
	Massachusetts[36,37]				
Circle C.G. Farm	Bellingham	Private	4/15-10/15	110	$5.00
Dighton Rock	Berkley	Private	5/1-10/1	75	$5.00
Massassoit State Park	Taunton	State	7/1-9/4	N/A	N/A
Amy's Hideaway	Freetown	Private	4/15-10/15	58	$4.50
Forge Pond	Assonet	Private	4/1-9/30	65	$5.50
Normandy Farm	Foxboro	Private	All year	175	$6.50
Boston Hub KOA	Wrentham	Private	5/15-10/15	100	$5.50
Canoe River Campground	E. Mansfield	Private	All year	120	$6.00

N/A - Not Available

TABLE 6

Fresh Water Fishing

WATER BODY	LOCATION	STOCKED TROUT
BIG RIVER SITE		
	Rhode Island[39]	
Big River	West Greenwich	B
LOCAL AREA		
	Rhode Island[28,38,39]	
Beach Pond	Exeter	A
Boone Lake	Exeter	
Breakheart Pond	West Greenwich	A
Browning Mill Pond	Exeter	
Carbuncle Pond	Coventry	B
Dawley Pond	Exeter	
Deep Pond	Exeter	A
Flat River Reservoir	Coventry	
Loutitt Pond	West Greenwich	
Mishnock Pond	West Greenwich	
Quidnick Reservoir	Coventry	
Tiogue Lake	Coventry	
Bradley Pond	West Greenwich	C
Breakheart Brook	Exeter	A
Bucks Horn Brook	Coventry	B
Flat River	Exeter	A
Frosty Hollow Pond	Exeter	A
Hunt River	East Greenwich	C
Moosup River	Coventry	B
Parris Brook	Exeter	A
Roaring Brook	Exeter	B
Sodum Brook	Exeter	B
Wood River	Exeter	A
IMMEDIATE STUDY REGION - 20 Miles		
	Rhode Island[28,38,39]	
Alton Pond/Wood River	Hopkinton	A
Ashaway	Hopkinton	B
Ashville Pond	Hopkinton	
Belleville Pond	North Kingstown	
Blackamore Pond	Cranston	
Blue Pond	Hopkinton	
Canob Lake	Richmond	
Cranberry Bog	Warwick	
Dyer Pond	Cranston	
Fenner Pond	Cranston	
Glenn Rock Reservoir	South Kingstown	
Gorton Pond	Warwick	
Hundred Acre Pond	South Kingstown	
Indian Lake	South Kingstown	
Curren Upper Reservoir	Cranston	
Larkin Pond	South Kingstown	
Locustville Pond	Hopkinton	
Long Pond	Hopkinton	
Lower Simmons Reservoir	Johnston	
Mashapaug Pond	Cranston	
Meshanticut Pond	Cranston	C
Moscow Pond	Hopkinton	
Oak Swamp Reservoir	Johnston	
Pausacaco Pond	North Kingstown	
Printworks Pond	Cranston	
Ralph Pond	Cranston	
Randall Pond	Cranston	
Sandy Pond	Richmond	
Shippee Saw Mill Pond	Foster	A

A, B and C - Rhode Island trout fishing areas have been classified[39] into three categories according to fishing intensity and suitability of environment.

TABLE 6 (Continued)

WATER BODY	LOCATION	STOCKED TROUT
Silver Spring Lake	North Kingstown	A
Spectacle Pond	Cranston	
Thrity Acre Pond	South Kingstown	
Tongue Pond	Cranston	
Tucker Pond	South Kingstown	C
Upper Canada Pond	Providence	
Upper Simmons Pond	Johnston	
Wanskuck Pond	Providence	
Warwick Pond	Warwick	
Wenscott Reservoir	Providence	
Westconnaug Reservoir	Foster	
Wincheck Pond	Hopkinton	
Worden Pond	South Kingstown	
Yawgoo Pond	South Kingstown	
Yawgoog Pond	Hopkinton	B
Barber's Pond	South Kingstown	A
Beaver River	Richmond	C
Biscuit City Pond	South Kingstown	B
Brushy Brook	Hopkinton	A
Carolina Trout Pond	Richmond	B
Chickasheen Brook	South Kingstown	C
Dexter Pond	Scituate	B
Dolly Cole Brook	Foster	B
Hopkins Mill Pond	Foster	B
Log House Brook	Hopkinton	A
Meadow Brook	Richmond	A
Pawcatuck River	Hopkinton	A
Pawtuxet River	Scituate	C
Peacedale Reservoir	South Kingston	A
Ponagansett River	Foster	C
Seidels Pond	Cranston	
Turkey Meadow	Foster	B
Windsor Brook	Foster	A
Wyoming Pond	Richmond	
	Connecticut[40]	
Beachdale Pond	Voluntown	
Green Falls Reservoir	Voluntown	
Hodge Pond	Voluntown	
Great Meadow Brook	Voluntown	
Mount Misery Brook	Voluntown	
Myron Kinnie Brook	Voluntown	
Pachaug River	Voluntown	
Quanduck Brook	Sterling	
STUDY REGION - 40 Miles		
	Rhode Island[28,38,39]	
Barney Pond	Lincoln	
Brickyard Pond	Barrington	
Butterfly Pond	Lincoln	
Chapman Pond	Westerly	
Clarkville Pond	Glocester	
Deep Pond	Charlestown	A
East Providence Reservoir	East Providence	
Fresh Pond	New Shoreham	
Georgiaville Pond	Smithfield	
Herring Pond	Burrillville	
Howard Pond	Cumberland	
Keech Pond	Glocester	
Lily Pond	Newport	
Lower Slatersville Reservoir	North Smithfield	
Mellville Pond	Portsmouth	A
Middle Pond	New Shoreham	
Mowry Meadow Pond	Glocester	B

TABLE 6 (Continued)

WATER BODY	LOCATION	STOCKED TROUT
Olney Pond	Lincoln	A
Poscoag Reservoir	Charlestown	
Peck Pond	Burrillville	A
Ponagansett Reservoir	Glocester	
Sachem Pond	New Shoreham	
Sands Pond	New Shoreham	
Schoolhouse Pond	Charlestown	
Slack's Reservoir	Smithfield	
Smith and Sayles Reservoir	Glocester	
Spring Grove Pond	Glocester	A
Sylvesters Pond	Woonsocket	B
Sucker Pond	Burrillville	
Tarklin Pond	Burrillville	B
Upper Slatersville Reservoir	North Smithfield	
Wakefield Pond	Burrillville	
Wallum Lake	Burrillville	A
Watchaug Pond	Charlestown	
Waterman Reservoir	Glocester	
Wilbur Pond	Burrillville	
Wilson Reservoir	Burrillville	
Woonasquatucket Reservoir	Smithfield	
Woonsocket Reservoir	Smithfield	
Abbots Run	Cumberland	C
Adamsville Brook	Tiverton	B
Aldrich Brook	Tiverton	B
Brandy Brook	Glocester	C
Cass Pond	Woonsocket	C
Chepachet River	Glocester	B
Chockalog Brook	Burrillville	C
Clear Brook	Burrillville	B
Crook's Falls Brook	North Smithfield	C
Dunderry Brook	Little Compton	C
Geneva Brook	North Providence	C
Heritage Park	Glocester	
Lapham Pond	Burrillville	C
Mowry A. L. Pond	Smithfield	B
Nine Foot Brook	Glocester	B
North Branch	Smithfield	C
Perry Healy Brook	Charlestown	B
Round Top Brook and Pond	Burrillville	A
Saint Mary's Pond	Portsmouth	B
Silvys Brook	Cumberland	C
Silveys Pond	Cumberland	C
Sin and Flesh Brook	Tiverton	
Slater Park	Pawtucket	C
Stafford Pond	Tiverton	A
Tiffany Pond	Barrington	B
Tiverton Pond	Tiverton	B
Upper Rochambeau Pond	Lincoln	B
Watchaug Pond	Charlestown	
	Connecticut(40)	
Alexander Lake	Killingly	*
Amos Lake	Preston	*
Andersons Pond	North Stonington	
Avery Pond	Preston	
Beaver Brook Pond	Windham	*
Billings Lake	North Stonington	
Black Pond	Woodstock	*
Bog Meadow Reservoir	Norwich	
Fort Shantok Pond	Montville	*
Glasgo Pond	Griswold	
Godfrey Pond	Stonington	*
Halls Pond	Eastford	
Hampton Reservoir	Hampton	
Hewitt Pond	North Stonington	*

TABLE 6 (Continued)

WATER BODY	LOCATION	STOCKED TROUT
Hopeville Pond	Griswold	
Keach Pond	Thompson	*
Killingly Pond	Killingly	
Lake of Isles	No. Stonington	
Lantern Hill Pond	Ledyard	*
Little Pond	Thompson	*
Long Pond	Ledyard	*
Mohegan Park Pond	Norwich	*
Moosup Pond	Plainfield	*
Muddy Pond	Woodstock	
Pachaug Pond	Griswold	
Perry Pond	Thompson	
Pine Acres Lake	Hampton	
Quaddick Reservoir	Thompson	
Roseland Lake	Woodstock	*
Tetreault Pond	Killingly	
Wauregan Reservoir	Killingly	*
Williams Pond	Lebanon	*
Wyassup Lake	North Stonington	
Beaver Brook	Sprague	*
Five Mile River	Killingly	*
Hunts Brook	Waterford	*
Indiantown Brook	Preston	*
Little River	Canterbury	*
Mashamoquet Brook	Pomfret	*
Moosup River	Plainfield	*
Quinebaug River	Canterbury	*
Shetucket River	Sprague	*
Shunock Brook	North Stonington	*
Snake Meadow Brook	Plainfield	*
Still River	Eastford	*
Susquetonscut Brook	Franklin	*
	Massachusetts[41,42]	
Bungay River	Attleboro	*
Segregansett River	Dighton	*
Rattlesnake River	Freetown	*
Wading River	Mansfield	*
Canoe River	Mansfield	*
Palmer River	Rehoboth	*
Rocky Run River	Rehoboth	*
Coles River	Swansea	*
Lewin River	Swansea	*
Fox Stream	Blackstone	*
Quick Stream	Blackstone	*
Mill River	Blackstone	*
Dix Brook	Franklin	*
Miscoe Brook	Franklin	*
Stall Brook	Bellingham	*
Cotley River	Taunton	*
Rabbit Hill Brook	Wrentham	*
Ten Mill River	Plainville	*
Peters River	Billingham	*

TABLE 7

Golf

COURSE	LOCATION	PUBLIC/ PRIVATE	#HOLES- PAR	MINIMUM FEE
BIG RIVER SITE				
	Rhode Island(43)			
Coventry Pines Country Club	Coventry	Public	9-36	$3.00
LOCAL AREA				
	Rhode Island(43)			
Washington Golf Course	Coventry	Public	9-71(18)	$2.50
Midville Golf Course	W. Warwick	Public	9-71(18)	$3.00
W. Warwick Country Club	W. Warwick	Private	9-35	Membership
E. Greenwich Golf/Country C.	E. Greenwich	Public	9-35	$2.75
Exeter Country Club	Exeter	Public	18-72	$5.50
IMMEDIATE STUDY REGION - 20 Miles				
	Rhode Island(43)			
Foster Country Club	Foster	Public	18-72	$3.50
Cranston Country Club	Cranston	Public	18-72	$3.75
Alpine Country Club	Cranston	Private	18-71	Membership
Triggs Memorial Golf Course	Providence	Public	18-72	$3.00
Valley County Club	Warwick	Private	18-72	Membersnip
Seaview Country Club	Warwick	Public	9-36	$3.50
Warwick Country Club	Warwick	Private	18-70	Membership
Potowomut Golf Club	Warwick	Private	18-71	Membership
Goddard State Park	Warwick	Public	9-36	$1.00
Quidnesset Country Club	N. Kingstown	Private	18-71	Membership
N. Kingstown Municipal G.C.	N. Kingstown	Public	18-70	$4.00
Woodland Golf & Country Club	N. Kingstown	Public	9-36	$2.75
Rolling Greens	N. Kingstown	Public	9-35	$3.50
Laurel Lane Golf Course	S. Kingstown	Public	18-71	$3.00
Meadow Brook Golf Club	Richmond	Public	18-71	$3.00
Spring Haven Golf Club	Hope Valley	Public	18-54	$2.50
STUDY REGION - 40 Miles				
	Rhode Island(43)			
Agawam Hunt Club	E. Providence	Private	18-71	Membership
Blue Eagle County Club	Burrillville	Public	9-28	$2.00
Bristol Golf Course	Bristol	Public	18-71	$3.00
County View Golf Course	Burrillville	Public	18-70	$2.50
Cumberland Country Club	Cumberland	Public	9-32	$1.75
Day & Night Golf Course	Lincoln	Public	9-3	$1.75
Glocester Country Club	Glocester	Private	9-35	Membership
Green Valley	Portsmouth	Public	18-72	$4.00
Jamestown Country Club	Jamestown	Public	9-36	$3.00
Kirkbrae Country Club	Lincoln	Private	18-71	Membership
Lincoln Country Club	Lincoln	Private	9-35	Membership
Louisquisset Golf Course	N. Providence	Public	18-69	$4.00
Melody Hills	G'ocester	Public	18-71	$3.00
Metacomet Golf Course	E. Providence	Private	18-70	Membership
Misquamicut Country Club	Westerly	Private	18-69	Membership
Montaup Country Club	Portsmouth	Public	18-71	$4.00
Newport Country Club	Newport	Private	18-69	Membership
Pawtucket Country Club	Pawtucket	Private	18-69	Membership
Pocasset Country Club	Portsmouth	Public	9-34	$3.00
Point Judith Country Club	Narragansett	Private	18-71	Membership
Pond View Country Club	Westerly	Public	9-36	$3.00
Rhode Island Country Club	Barrington	Private	18-71	Membership
Wanumetonomy Country Club	Middletown	Private	18-70	Membership
Sakonnet Golf Club	Little Compton	Private	18-69	Membership
Silver Spring Golf Course	E. Providence	Public	6-23	$1.50
Wannamoisett Country Club	E. Providence	Private	18-69	Membership
Winnapaug Hills Country Club	Westerly	Public	18-72	$4.00
Woonsocket Country Club	Woonsocket	Private	18-73	Membership

TABLE 7 (Continued)

COURSE	LOCATION	PUBLIC/ PRIVATE	#HOLES-PAR	MINIMUM FEE
	Connecticut[44]			
Juniper Hill Country Club	Brooklyn	Public	9-35	(a)
Shennecossett Golf Course	Groton	Public	18-72	(a)
Elmridge Golf Course	Pawatuck	Public	18-71	(a)
Pequot Golf Course	Stonington	Public	18-70	(a)
Norwick Golf Course	Norwick	Public	18-72	(a)
	Massachusetts[45]			
Bristol Country Club	Taunton	Public	9-34	(a)
Chemawa Country Club	N. Attleborough	Public	9-36	(a)
Crestwood Country Club	Rehoboth	Private	18-70	(a)
Deer Run Country Club	Rehoboth	Public	9-35	(a)
Dighton Golf Course	Dighton	Public	9-27	(a)
Franklin Country Club	Franklin	Private	9-35	(a)
Herring Run Golf Course	Taunton	Public	9-34	(a)
Hidden Hollow Country Club	Rehoboth	Public	9-35	(a)
Highland Country Club	Attleboro	Private	9-35	(a)
Inglewood Golf Course	Rehoboth	Public	9-36	(a)
Middlebrook Country Club	Rehoboth	Public	9-35	(a)
Norton Country Club	Norton	Semi-Pri.	9-35	(a)
Pine Valley Golf Course	Rehoboth	Public	9-36	(a)
Rehoboth Country Club	Rehoboth	Public	18-70	(a)
Segregansett Country Club	Taunton	Private	9-36	(a)
Stone-E-Lea Country Club	Attleooro	Semi-Pri.	18-70	(a)
Sun Valley Country Club	Rehoboth	Private	18-71	(a)
Suspiro Country Club	Somerset	Public	9-35	(a)
Swansea Country Club	Swansea	Public	18-72	(a)
Touisset Country Club	Swansea	Public	18-71	(a)
Wading River Golf Course	Norton	Public	18-54	(a)
Wampanoag Golf Course	N. Swansea	Semi-Pri.	9-35	(a)
Willowdale Golf Course	Mansfield	Public	9-30	(a)

(a) - User fees documented for Rhode Island only.

TABLE 8

Hunting

MANAGEMENT AREA	LOCATION	ACREAGE
BIG RIVER SITE		
Big River Management Area	Coventry, West Greenwich, East Greenwich	8,000
LOCAL AREA		
	Rhode Island[46]	
Arcadia Management Area	Exeter, West Greenwich	8,000
Wickaboxet Management Area	West Greenwich	405
IMMEDIATE STUDY REGION - 20 Miles		
	Rhode Island[46]	
Carolina State Management Area	Richmond	1,500
Great Swamp Management Area	South Kingstown	3,000
	Connecticut[40,47]	
Pachaug State Forest	Voluntown, North Stonington, Griswold, Sterling, Plainfield	22,937
Ross Marsh Management Area	Killingly, Sterling	277
STUDY REGION - 40 Miles		
	Rhode Island[46]	
Black Hut Management Area	Burrillville	1,300
Buck Hill Management Area	Burrillville	1,291
Burlingame Management Area	Charlestown	825
Durfee Hill Management Area	Glocester	925
George Washington Management Area	Burrillville	3,341
Indian Cedar Swamp State Management Area	Charlestown	1,000
Newton Swamp	Westerly	111
Sapowet Marsh	Tiverton	296
Woody Hill Management Area	Westerly	723
	Connecticut[40,47]	
Assekonk Swamp	North Stonington	694
Barn Island	Stonington	707
Bartlett Brook Management Area	Lebanon	480
Franklin Swamp	Franklin	452
Lebanon-Franklin	Lebanon	8,841
Mansfield Hunting Area	Mansfield	2,500
Mohegan State Forest	Scotland	390
Natchaug State Forest	Eastford	12,428
Norwich Fish & Game Association (A)	Norwich	1,500
Pease Brook Management Area	Lebanon	207
Pudding Hill Management Area	Scotland	135
Quaddick State Forest	Thompson	496
Quinebaug Management Area	Canterbury	1,227
Rose Hill Management Area	Ledyard, Preston	412
Sprauge Rod and Gun Club (A)	Sprauge, Franklin	3,400
Tetreault Pond	Killingly	60
West Thompson	Thompson	1,950
Woodstock Landowners (A)	Woodstock	4,611
	Massachusetts[48]	
Fall River	Fall River	2,000
F. Gilbert Hills State Forest	Foxboro	831

(A) - Permit required, regulated area.

TABLE 9

Picnicking

DESCRIPTION	LOCATION	JURISDICTION	NO. OF TABLES	OTHER USES
LOCAL AREA				
	Rhode Island(11)			
Camp Hamilton	Coventry	Private	25	Beach
Camp Westwood	Coventry	YMCA	25	Campground, Day Camp, and Overnight Camp
Oak Embers Camp	W. Greenwich	Private	25	Campground
Pine Top Ski Area	W. Greenwich	Private	10	Ski Area
Arcadia Management Area	Exeter	State	130	Beach, boating, camp, trails
Bassoqutogaug Grove	Exeter	State	10	Game field
Beach Pond State Park	Exeter	State	70	Beach, game field, camp, trails
Exeter Grove	Exeter	State	16	
Quanatumpic Grove	Exeter	State	10	
Camp Sunshine	Exeter	Private	10	
Yagoo Valley Ski	Exeter	Private	10	Ski, camp
Rocky Hill Grove	E. Greenwich	State	6	
Town Boat Launch	E. Greenwich	Town	2	Boat launch
Crompton Playground	W. Warwick	Town	1	Game field
Natick Playground	W. Warwick	Town	1	Game field and tennis
Carr's Playground	W. Warwick	Private	1	Fields
Christ Church	W. Warwick	Private	2	
IMMEDIATE STUDY REGION - 20 Miles				
	Rhode Island(11)			
Champlin Reservoir	Cranston	BSA	20	Beach and camp
Jerimoth Hill Grove	Foster	State	8	
Dyer Woods Camp	Foster	Private	4	Camp
Camp Yawgoo	Hopkinton	BSA	75	Fields, beach, boat slips, boat ramps, camp sites, trails
Greenwood Hill Camp	Hopkinton	Private	40	Camp
Whispering Pines Camp	Hopkinton	Private	100	Camp
Johnston Park	Johnston	Town	10	Pool, game fields, tennis
Matantuck Grove	N. Kingstown	State	6	
Pine Grove	N. Kingstown	State	4	
Richard Smith Grove	N. Kingstown	State	6	
Shady Lea Groves	N. Kingstown	State	10	
Stoney Brook Grove	N. Kingstown	State	6	
Kel Grant Camp	N. Kingstown	Private	20	Game, beach, trail
Nokewa Camp	N. Kingstown	GSA	15	Beach, camp, trail
Hopkins Park	Providence	City	5	
Beaver River	Richmond	State	2	
Miantonomi Grove	Richmond	State	12	
Mixano Grove	Richmond	State	4	
Camp Wah-Kanda	Richmond	Private	12	
Wawaloam Reservoir	Richmond	Private	30	Campground
Esek Hopkins Park	Scituate	State	12	Game field
Ponagansett Grove	Scituate	State	10	
Barbers Pond	S. Kingstown	State	5	Boat Launch
Hannah Robinson Grove	S. Kingstown	State	12	
Matunuck Management Area	S. Kingstown	State	20	Beach
Waites Corner Grove	S. Kingstown	State	12	
Abbie Perry Center	S. Kingstown	Town	2	Game field
Dam St. Playground	S. Kingstown	Town	2	Game field
Old Mountain Field	S. Kingstown	Town	7	Gamefield, tennis, boat slip
Peaceaale Elementary	S. Kingstown	Town	2	Game fields
South Road Elementary	S. Kingstown	Town	2	Game fields
Stepping Stones School	S. Kingstown	Town	2	Game fields
Village Green & Guild Area	S. Kingstown	Town	2	Game fields, tennis
Wakefield Elementary	S. Kingstown	Town	1	Game fields
West Kingston Elementary	S. Kingstown	Town	2	Game fields
A. B. Carpenters	S. Kingstown	Private	30	Beach, gamefield
Aguepaug Camp	S. Kingstown	BSA	5	Game field, beach, camp, trail

TABLE 9 (Continued)

DESCRIPTION	LOCATION	JURISDICTION	NO. OF TABLES	OTHER USES
Camp Fuller	S. Kingstown	YMCA	16	Game field, beach, boat, camp
Camp Hoffman	S. Kingstown	GSA	36	Field, beach, boat, camp, trail
Card's Camp	S. Kingstown	Private	200	Beach, boat, camp
Larkin's Pond Club	S. Kingstown	Private	40	Game, beach
M. A. Carpenter's	S. Kingstown	Private	4	Game, beach, camp
Steadman's Campground	S. Kingstown	Private	12	Game, beach, boat slip, camp
Tucker's Campground	S. Kingstown	Private	200	Game field
Goddard State Park	Warwick	State	372	Game fields, beach, boat, golf, trails
R.I. Jr. College	Warwick	State	10	Game fields
Salter Grove	Warwick	State	7	
Brown School	Warwick	City	2	Game fields
Sherman School	Warwick	City	8	Game fields
Warwick Park	Warwick	City	25	Game field, tennis, beach
R.I. Masonic Youth	Warwick	Private	82	Game field, tennis, beach
	Connecticut(29)			
Pachaug State Forest	Voluntown	State	6 Areas	Trails, camp
Rest Area-Rte. 14	Sterling	State	X	
Rest Area-Rt. 49	Voluntown	State	X	
STUDY REGION - 40 Miles				
	Rhode Island(11)			
Colt State Park	Bristol	State	200	Fish, boat, trail
Burlingame State Park	Charlestown	State	755	Multi-use
Charlestown Breachway	Charlestown	State	75	Fish, boat
Diamond Hill State Park	Cumberland	State	65	Fish, game fields, trail
Fisherman's Mem. State Park	Narragansett	State	30	Fish, game fields, trail
George Washington Area	Glocester	State	63	Camp, beach, fish, boat, trail
Haines Memorial Park	Barrington	State	45	Boat, game fields
Lincoln Woods State Park	Lincoln	State	176	Fish, boat, game fields, trails
Misquamicut State Beach	Westerly	State	50	Beach, fish
Pulaski Memorial State Park	Glocester	State	311	Beach, fish, game fields, trails
R. Wheeler Mem. State Beach	Narragansett	State	80	Beach, fish
Scarborough Beach	Narragansett	State	100	Beach, fish
World War II State Park	Woonsocket	State	40	Beach
Blackstone Grove	Cumberland	State	5	
Brenton's Grove	Narragansett	State	35	
Bulgarmarsh Grove	Tiverton	State	8	
Founders Grove	Portsmouth	State	10	
Grand Pre Grove	Charlestown	State	2	
Lawton Valley Grove	Portsmouth	State	10	
Lehigh Hill Park	Portsmouth	State	6	
Post Road Grove	Westerly	State	14	Beach
Squantum Woods State Park	E. Providence	State	10	
Washington Grove	Smithfield	State	35	
Westerly Airport Grove	Westerly	State	6	
I-295 Information Area	Lincoln	State	30	
Brenton Point	Newport	State	10	Fish
Fort Adams	Newport	State	25	Fish
	Connecticut(29)			
Beaver Brook State Park	Windham	State	X	Fish, boat
Ft. Shantok State Park	Montville	State	X	
Harkness Mem. State Park	Waterford	State	X	Fish
Hopeville Pond State Park	Griswold	State	X	Multi-use
Mansfield Hollow State Park	Mansfield	State	X	Fish, boat, trails
Mashamoquet Brook State Park.	Pomfret	State	X	Multi-use
Old Furnace State Park	Killingly	State	X	Fish, trails
Quaddick State Park	Thompson	State	X	Beach, fish, boat
Stoddard Hill State Park	Ledyard	State	X	Fish, boat
Natchaug State Forest	Ashford	State	X	Fish, hunt, trails, winter sports

TABLE 9 (Continued)

DESCRIPTION	LOCATION	JURISDICTION	NO. OF TABLES	OTHER USES
Rest Areas-Rte. 131	Thompson	State	X	
Rest Areas-U.S. Rte. 44	Putman	State	X	
Rest Area-Rte. 12	Putnam	State	X	
Rest Area-U.S. Rte. 44	Eastford	State	X	
Rest Area-Rte. 97	Pomfret	State	X	
Rest Area-U.S. Rte. 6	Brooklyn	State	X	
Rest Area-U.S. Rte. 6	Chaplin	State	X	
Rest Area-Rte 12	Plainfield	State	X	
Rest Area-U.S. Rte. 6	Windham	State	X	
Rest Area-Rte. 87	Lebanon	State	X	
Rest Area-Rte. 207	Lebanon	State		
Rest Area-Rte. 12	Lisbon	State	X	
Rest Area-Rte. 82	Montville	State	X	
Rest Area-U.S. Rte. 1	Waterford	State	X	
	Massachusetts[30]			
Watson Pond State Park	Taunton	State	X	Beach, fish
Dighton Rock State Park	Berkley	State	X	Fish, scenery
Freetown State Forest	Assonet	State	X	Trail, hunting, snowmobiling, scenery
Rest Area-Rte. 1A, 121	Wrentham	State	X	
I-95 Information Center	Mansfield	State	X	
Rest Area-Rte. 152	N. Attleborough	State	X	
Rest Area-I-95	Attleboro	State	X	
Rest Area-I-195	Seekonk	State	X	
Rest Area-U.S. Rte. 6	Swansea	State	X	
Rest Area-I-95	Swansea	State	X	
Rest Area-Rte. 140	Taunton	State	X	

X - The number of picnic tables was inventoried for Rhode Island only.

TABLE 10

Fresh Water Swimming

BEACH	LOCATION	LAKE	JURISDICTION	FRONTAGE
LOCAL AREA				
	Rhode Island(11)			
Briar Point	Coventry	Tiogue Lake	Town	500'
Camp Ayoho	Coventry	Flat River Reservoir	W. Warwick	1000'
Calwell's Camp	Coventry	Flat River Reservoir	Private	200'
Camp Hamilton	Coventry	Unnamed pond	Private	2,325'
Camp Westwood	Coventry	Quidneck Reservoir	YMCA	200'
Hickory Ridge Camp	Coventry	Unnamed pond	Private	1550'
Mishnock Beach	West Greenwich	Mishnock Pond	Private	850'
Beach Pond State Park	Exeter	Beach Pond	State	390'
Austin Farm	Exeter	Austin Farm Pond	Private	85'
Camp Cononicus	Exeter	Unnamed pond	Private	90'
IMMEDIATE STUDY REGION - 20 Miles				
	Rhode Island(11)			
Champlin Reservation	Cranston	Unnamed pond	Private	200'
Moosup Valley Park	Foster	Moosup River	Town	75'
Dyer Woods Camp	Foster	Unnamed pond	Private	400'
Ginny-B Camp	Foster	Moosup River	Private	150'
Whipporwill Hill	Foster	Unnamed pond	Private	75'
Camp Yawgoog	Hopkington	Yawgoog Pond	BSA	800'
Camp Massosoit	Johnston	Oak Swamp Reservoir	Private	120'
Kel Grant Camp	North Kingstown	Pettaquamscutt River	Private	100'
Nokewa Camp	North Kingstown	Pettaquamscutt River	Private	45'
Pettaquamscutt Reserv.	North Kingstown	Pettaquamscutt River	Private	1760'
YMCA Camp	North Kingstown	Pettaquamscutt River	YMCA	100'
Arcadia Mgmt. Area	Richmond	Arcadia Beach	State	540'
Town Beach	Richmond	Meadow Brook Pond	Town	1160'
Aguapaug Camp	South Kingstown	Worden Pond	BSA	50'
Camp Hoffman	South Kingstown	Larkin Pond	GSA	40'
Camp Saugatucket	South Kingstown	Indian Lake	Private	300'
Indian Lake Beach	South Kingstown	Indian Lake	Private	155'
Larkin's Pond Club	South Kingstown	Larkin's Pond	Private	300'
Riverside Drive Beach	South Kingstown	Pettaquamscutt River	Private	465'
Steadman's Campground	South Kingstown	Tucker Pond	Private	300'
Gorton's Pond Beach	Warwick	Gorton's Pond	City	1340'
Little Pond Beach	Warwick	Little Pond	City	75'
Posnegansett Lake	Warwick	Posnegansett Lake	City	680'
Sandy Pond Beach	Warwick	Sandy Pond	City	1900'
Veteran's H.S.	Warwick	Little Pond	City	480'
Warwick Library	Warwick	Unnamed pond	City	20'
Warwick Pond Beach	Warwick	Warwick Pond	City	125'
	Connecticut(49)			
Pachaug State Forest	Voluntown	Green Falls Pond	State	N/A
STUDY REGION - 40 Miles				
	Rhode Island(11)			
Pulaski State Park	Burrillville	Clarkville Pond	State	775'
Buck Hill	Burrillville	Wakefield Pond	BSA	300'
Echo Lake Camp	Burrillville	Pascoag Reservoir	Private	1000'
Flynn's Beach	Burrillville	Spring Lake	Private	220'
Gilleran's Beach	Burrillville	Gilleran Pond	Private	80'
Glenburr Beach	Burrillville	Spring Lake	Private	100'
Pascoag Beach Club	Burrillville	Pascoag Reservoir	Private	80'
Spring Lake Beach	Burrillville	Spring Lake	Private	600'
Woonsocket Day Camp	Burrillville	Spring Lake	Private	80'
Burlingame Mgmt. Area	Charlestown	Watchaug Pond	State	775'
Camp Davis	Charlestown	School House Pond	Private	2500'
Camp Tanner Collins	Charlestown	Unnamed pond	Private	50'
Camp Wahelo	Charlestown	Watchaug Pond	Private	150'
Camp Watchaug	Charlestown	Watchaug Pond	Private	150'
Lippitt Estate	Cumberland	Unnamed pond	Private	775'
Town Beach	Glocester	Nipmuc River	Town	775'

TABLE 10 (Continued)

BEACH	LOCATION	LAKE	JURISDICTION	FRONTAGE
Bowdish Lake Camp	Glocester	Bowdish Reservoir	Private	200'
Camp Aldersgate	Glocester	Lake Aldersgate	Private	150'
Camp Cookie	Glocester	Unnamed pond	GSA	90'
Camp Russell	Glocester	Waterman Reservoir	Private	300'
Coomer Beach	Glocester	Unnamped pond	Private	1550'
Episcopal Center	Glocester	Pascoag Reservoir	Private	75'
Holiday Acres Camp	Glocester	Unnamed pond	Private	550'
Iron's Homestead	Glocester	Unnamed pond	Private	60'
Mater Spei Day Camp	Glocester	Pascoag Reservoir	Private	400'
Lincoln Woods	Lincoln	Olney Pond	State	775'
Camp Meehan	Lincoln	Wenscott Reservoir	Private	100'
Manville Park	Lincoln	Unnamed pond	Private	300'
McColl Field	Lincoln	Unnamed pond	Private	100'
Twin Rivers Area	N. Providence	Unnamed pond	Town	500'
Twin Rivers Beach	N. Providence	Wenscott Reservoir	Private	200'
Georgiaville Beach	Smithfield	Georgiaville Pond	Town	1085'
Greenlake Beach	Smithfield	Slack Reservoir	Town	1055'
Mountaindale Beach	Smithfield	Stillwater Reservoir	Town	2710'
Camp Shepard	Smithfield	Unnamed pond	Private	150'
Steere's Beach	Smithfield	Waterman Reservoir	Private	150'
STUDY REGION - 40 Miles				
	Connecticut[29]			
Hopeville Pond St. Pk.	Griswold	Hopeville Pond	State	N/A
Mashamoquet Brk. S.P.	Pomfret	Unnamed pond	State	N/A
Quaddick State Park	Thompson	Quaddick Reservoir	State	N/A
	Massachusetts[30]			
Watson Pond State Park	Taunton	Watson Pond	State	N/A
Massasoit State Park	Taunton	Unnamed pond	State	N/A

N/A - Frontage not available

TABLE 11

Trails

TRAIL	LOCATION	JURISDICTION	MILEAGE BY ACTIVITY				
			Hiking	Horse	Snow-mobile	RV	Motor Bike
BIG RIVER SITE							
	Rhode Island(50)						
Big River	W. Greenwich				X		
LOCAL AREA							
	Rhode Island(a)						
Parker Woodland	Coventry	Audubon	2.0				
Trestle Trail	Coventry	Private	8.0	7.0	7.0		
S. Country Rod and Gun	W. Greenwich	Private	2.0				
Arcadia Mgmt. Area & Park	Exeter	State	32.0	30.0	4.0	50.0	50.0
Beach Pond	Exeter	State	13.0	2.0	11.0		
Camp Ninigret	Exeter	Private	10.0				
Warwick Sportsman's	Exeter	Private	2.0	2.0			
Wickaboxet Mgmt. Area	W. Greenwich	State			X		
IMMEDIATE STUDY REGION - 20 Miles							
	Rhode Island(a)						
Champlin Reservoir	Cranston	BSA	2.0				
Stamp Snowmobile	Cranston	Private	2.0		2.0		
Kirkleridge Stable	E. Greenwich	Private		5.0			
Camp Yagoo	Hopkington	BSA	15.0				
Walmsley Park	North Kingstown	Town	1.6	1.6			
Kel Grant Camp	North Kingstown	Private	2.0				
Nokewa Camp	North Kingstown	GSA	0.5				
Great Swamp Mgmt. Area	South Kingstown	State	10.0				
Aquapaug Camp	South Kingstown	BSA	5.0				
Camp Hoffman	South Kingstown	GSA	2.0				
Pettaquamscott Rock	South Kingstown	Private	0.3				
Goddard State Park	Warwick	State	5.0	17.0			
Masthead Walk	Warwick	City	0.5				
Snake Den State Park	Johnston	State			X	X	
Carolina Mgmt. Area	Richmond	State			X	X	
Rockville Mgmt. Area	Richmond	State			X	X	
	Connecticut(49)						
Pachaug State Forest	Voluntown	State	20.0	47.0	X		
STUDY REGION - [illegible] Miles							
	Rhode Island(a)						
Veterans Park	Barrington	Town	2.7				
Walkers Farm	Barrington	Town	1.0				
Colt State Park	Bristol	State		2.0	1.0		
Black Hut Mgmt. Area	Burrillville	State	5.0		X	X	
Buck Hill Mgmt. Area	Burrillville	State	5.0	5.0	X		
Pulaski State Park	Burrillville	State	2.0		9.0	X	
Washington Mgmt. Area	Burrillville	State	10.0		X	X	
Railroad ROW	Burrillville	Town	3.0	3.0			
Buck Hill	Burrillville	BSA	15.0				
Bourne Park	East Providence	City	0.7				
Waddington Park	East Providence	City	0.7				
Burlingame Mgmt. Area	Charlestown	State		9.0	X		
Ninigret Area	Charlestown	State	1.0			X	
Kimball Wildlife Refuge	Charlestown	Audubon	2.0				
Indian Cedar Swamp Mgt. Area	Charlestown	State			X		
Diamond Hill Park	Cumberland	State	0.5			X	
Bowdish Lake Camp	Glocester	Private	2.3				
Camp Cookie	Glocester	GSA	0.5				
Durfee Hill Mgmt. Area	Glocester	State			X	X	
Lincoln Woods	Lincoln	State	7.5	7.5	3.0	X	

TABLE 11 (Continued)

TRAIL	LOCATION	JURISDICTION	MILEAGE BY ACTIVITY Hiking	Horse	Snow-mobile	RV	Motor Bike
Manville Rod and Gun	Lincoln	Private	5.0				
Camp Aquidneck	Little Compton	Private	1.0				
Tally Ho Stables	Little Compton	Private		20.0			
Norman Sanctuary	Middletown	Audubon	15.0				
Roger Wheeler State Park	Narragansett	State			X		
Good Grief Stables	Narragansett	Private		2.0			
Scarborough State Park	Narragansett	State				X	
Cliff Walk	Newport	City	3.5				
Acres Wild Farm	No. Smithfield	Private		25.0			
Slater Park	Pawtucket	City	0.3				
Roseland Riding	Tiverton	Private		20.0			
Ruecker Wildlife Refuge	Tiverton	Private	1.7				
Burr Hill Park	Warren	City		0.2			
Woody Hill Mgmt. Area	Westerly	State			X		
	Connecticut(29,53)						
Hopeville Pond State Park	Griswold	State	X				
Mansfield State Park	Mansfield	State	X				
Mashamoquet Brook State Pk.	Pomfret	State	X		X		
Old Furnace State Park	Killingly	State	X				
James L. Goodwin St. Forest	Hampton	State	X				
Quaddick State Forest	Thompson	State	X				
Mohegan State Forest	Scotland	State	X		X		
Natchaug State Forest	Ashford	State	X		17.0		
	Massachusetts(30)						
F. Gilbert Hills S. Forest	Foxboro	State	X		X		
Freetown State Forest	Assonet	State	X		X		
Massasoit State Park	Taunton	State	X		X		

(a) Sources: (11,33,50,51,52).

X - Activity permitted, mileage not available.

Recreational facilities are also supplied by the federal government, local municipalities, and private groups or businesses. Most of the federally owned areas in Rhode Island are utilized as wildlife refuges and conservation lands, open to the public for aesthetic enjoyment. The local municipalities provide the majority of facilities required for organized sports activities within the community, which include multi-use parks, playgrounds, and school lands. The private sector generally provides facilities which fulfill the specific recreational needs of the population. Although a fee is usually charged for use of the facilities, the private sector can provide opportunities which are not the responsibility of government agencies. However, when recreational facilities are not adequately provided by other agencies or organizations, it is up to the state to satisfy these demands.

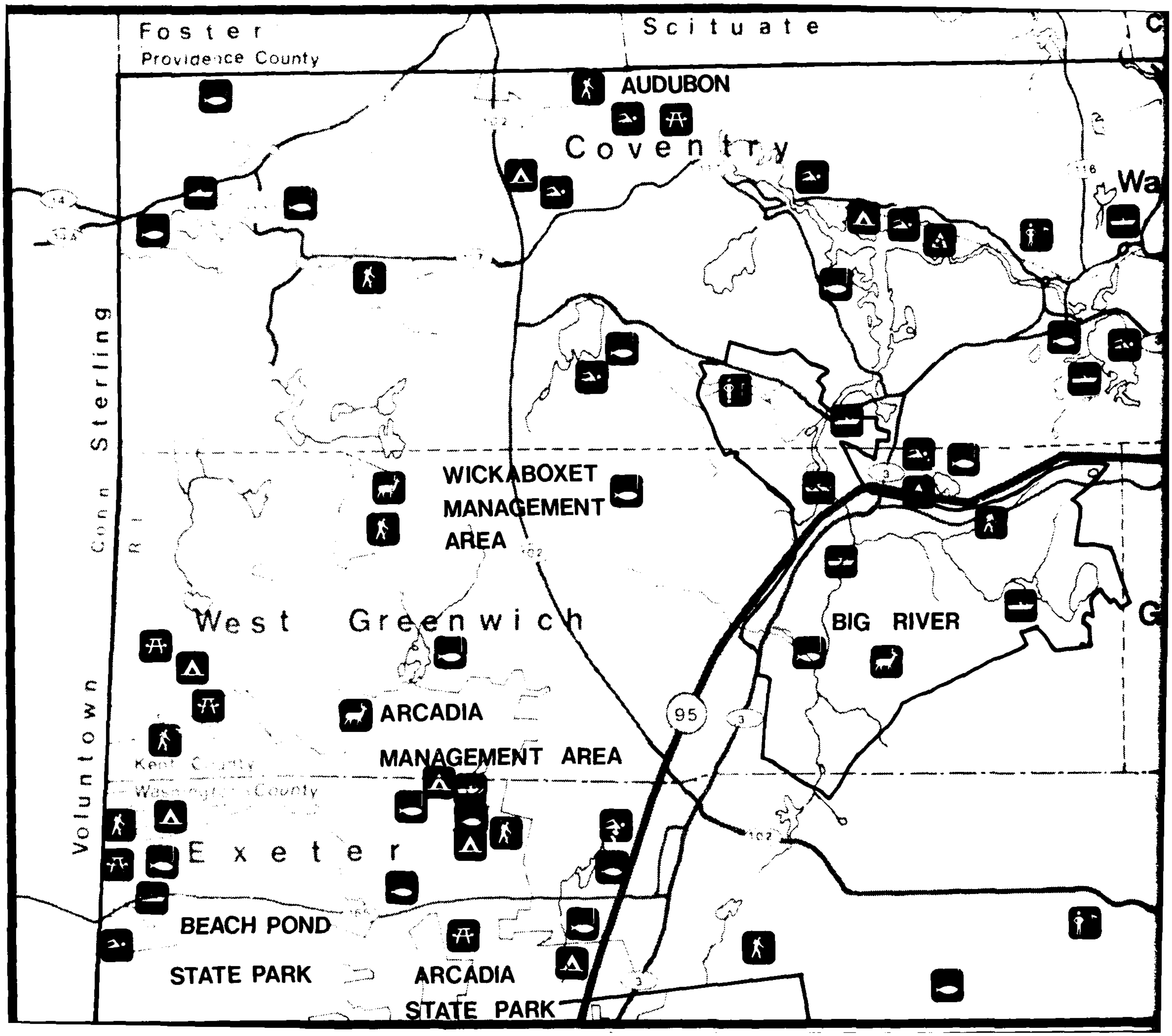
2. Recreational Activities in the Local Area

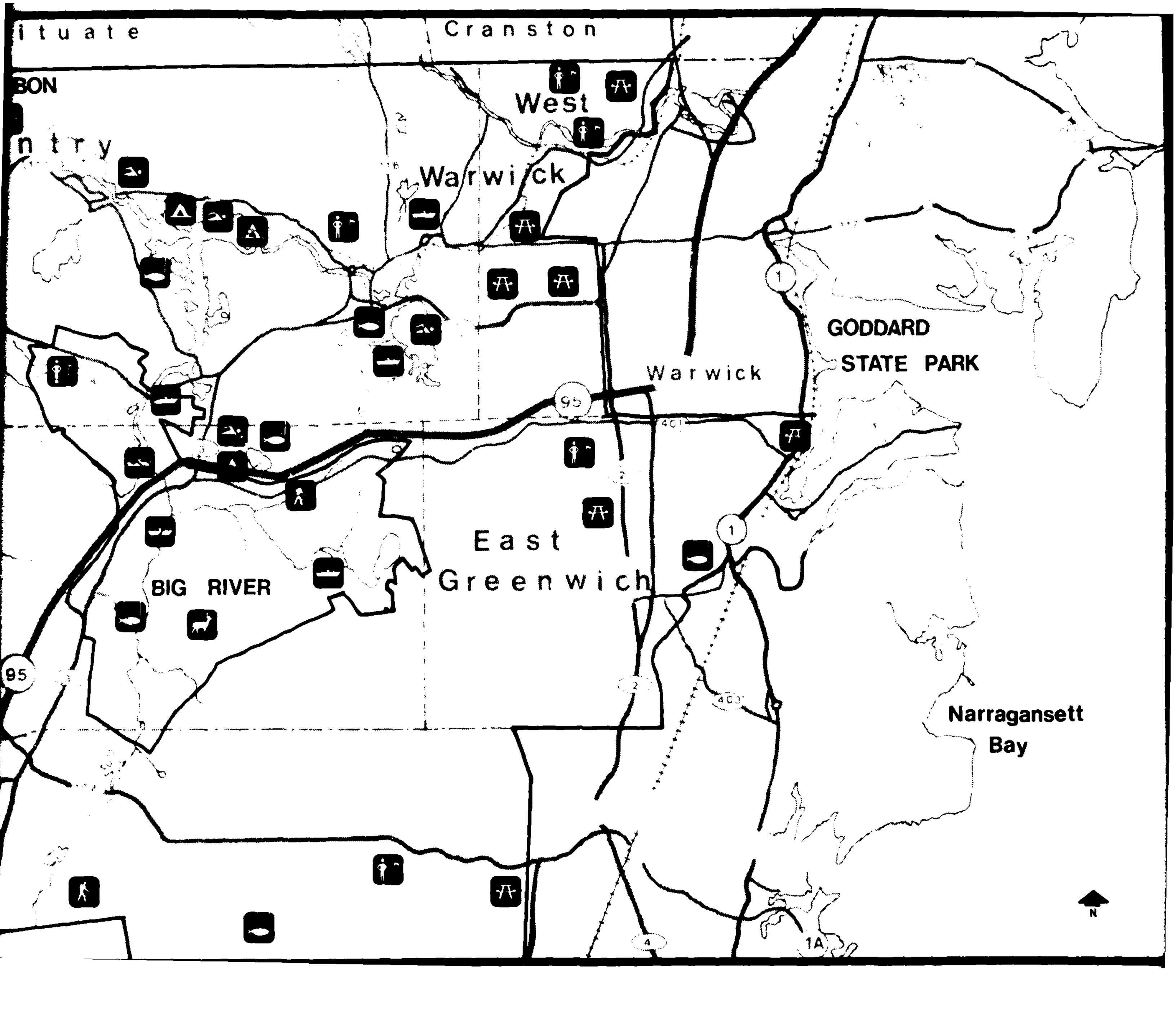
There are a variety of recreational facilities available in the local area, which consists of West Greenwich, Coventry, Exeter, East Greenwich, and West Warwick. These facilities are shown on Tables 3 through 11, and on Figure 7.

There are two state parks in the local area: Beach Pond State Park in Exeter and West Greenwich, and Arcadia State Park in Exeter and Richmond. Activities there include camping, picnicking, swimming, fishing, hiking, and various winter sports. Besides Big River there are also two state management areas, Arcadia (8,000 acres) in Exeter and West Greenwich, and Wickaboxet (405 acres) in West Greenwich. Both of these management areas are designated hunting areas. Game species include white-tailed deer, grey squirrel, grouse, and snowshoe hare. Other species at Arcadia include pheasant, quail, mourning dove, woodcock, duck, and cottontail rabbit.(46)

The local area also has a number of designated multi-use trails. One of the most notable is the Trestle Trail, a year-round multi-use trail which stretches westward from Stump Pond in central Coventry to the Connecticut border. The trail was developed from an eight-mile abandoned railroad right-of-way, leased by the State from the Narragansett Electric Company. Another extensive trail system is found throughout the Arcadia Management Area, Beach Pond State Park, and adjacent areas. The trail network is nearly 100 miles in length, and has been designed for use throughout the year. Trails include the Breakheart Trail (a hiking trail which has been in existence for fifty years), miles of gravel roads for horse trails, and a 50-mile loop for recreational vehicles.

There are thirteen camping grounds in the local area, with a total of 716 campsites. Of these, four are operated by the State. One, Beach Pond Camps, is opened to underpriviledged children in July and August;


Foster
Providence County
Scituate
AUDUBON
Coventry
Wa
Sterling
Conn
WICKABOXET
MANAGEMENT
AREA
West Greenwich
BIG RIVER
G
Voluntown
ARCADIA
MANAGEMENT AREA
95
Kent County
Washington County
Exeter
BEACH POND
STATE PARK
ARCADIA
STATE PARK


ituate
Cranston
BON
ntry
West
Warwick
Warwick
GODDARD
STATE PARK
95
401
1
2
East
Greenwich
BIG RIVER
95
2
403
Narragansett
Bay
4
1A
N

the remainder of the season they are available for public use. Another, Horsemen's Camping Area, provides a horse show ring and riding trails, and is open only to people with horses.

As shown in the preceeding tables, the local area has a number of areas for swimming, fishing, boat launching, and picnicking. There are also six golf courses, including the one at Big River, five of which are public courses.

3. Recreational Activities on the Big River Site

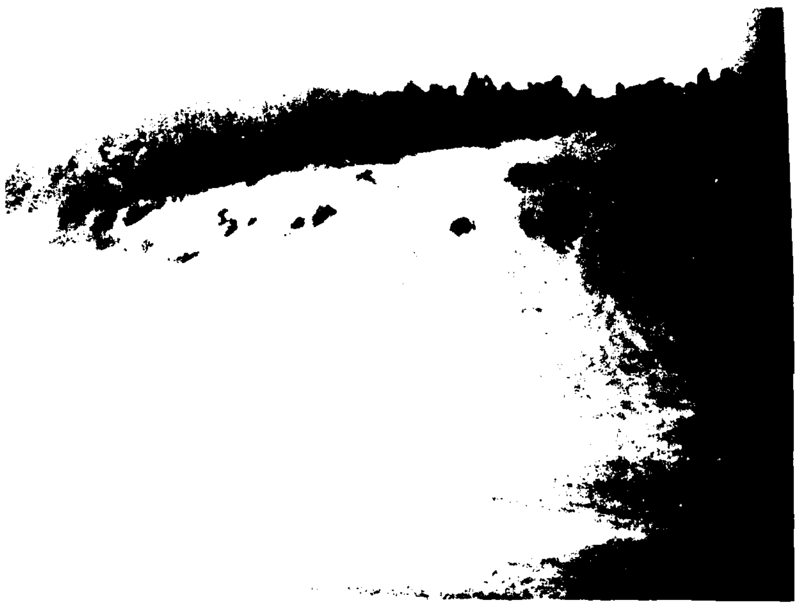
The proposed Big River Site is extensively used for a variety of recreational purposes by residents of the surrounding area. The site is heavily forested with numerous wetlands, several quarries, and the former West Greenwich town dump. Since coming under state ownership over ten years ago, it has been heavily used for recreation. Although the majority of people who visit the site come from the local area, many travel from Providence and other communities in the study region.

There are several rivers and streams flowing through the site, as shown in Figure 2. The major river, both in terms of size and recreational use, is the Big River. Activities on the Big River include boating, canoeing, and fishing. Other rivers, such as Nooseneck and Congdon, do not allow access by boat or canoe in many places, but are nevertheless good hunting and fishing areas.

Proposed Dam Site

The site also has many ponds. Besides Carr Pond and Tarbox Pond, the two largest and most widely used, there are also a number of smaller ponds including Capwell Mill, Rathbon, Reynolds, and Sweet Ponds. Phelps Pond, also known as Gillespie Pond, is a quarry pond in the northeast corner of the site. These ponds, along with the rivers, streams, swamps, and marshes, provide excellent wildlife habitat, some of the best in the state.

One of the most heavily used areas in the site is the region to the south of Interstate 95 and north of Division Street. Found in this area are open fields and sand banks made from former excavations. These areas are used for motorcycle and recreational vehicle riding, model airplane flying, dog training, target shooting, snowmobiling, and sledding.



Sand Banks

Another popular region is the area around Carr Pond. Although primarily a swimming area, it is also used by motorcyclists and horseback riders. A series of trails connect the Carr Pond area to Hopkins Hill Road and New London Turnpike. In addition, there are many other trails and paths, most of which were cleared by the Department of Environmental Management, throughout the entire site. These trails are used for motorcycling, horseback riding, hiking, and snowmobiling.

Trail Near the Proposed Dam Site

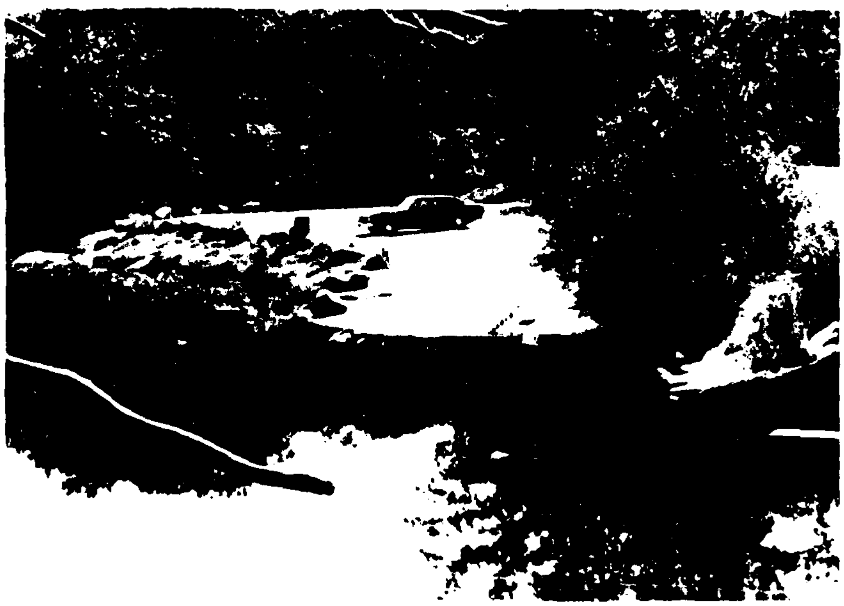
The following sections provide descriptions of the recreational activities which occur on the Big River Site.

a. <u>Boating</u>

There are four boat launch ramps on the Big River Site: Big River Landing, off Weaver Road; Big River Landing, off Burnt Sawmill Road; Zeke's Bridge, access to Big River and portions of Flat River Reservoir; and Tarbox Pond, off Hopkins Hill Road. Except for the boat launch at Zeke's Bridge, the ramps are suitable only for car-top boats or canoes.

Canoes and small motor boats are used on the Big River, although canoe travel only is possible on some portions of the river. Sailboating and canoeing take place on Carr Pond. Boating on waterways such as Capwell

Mill Pond or the Nooseneck River is done mainly in conjunction with fishing. There is also heavy boating activity on Flat River Reservoir, a portion of which falls within site boundaries.



Boat Ramp at Zeke's Bridge

b. Camping

Camping is prohibited on the Big River Site; signs are posted to this effect, although some backpacking does occur. At one time there was a boy scout camp, Camp Bosco, near the western border of the site. The camp is no longer in use.

c. Fishing

Fishing is a popular sport on the Big River Site, particularly on the Big River and Tarbox Pond. There is also some fishing on the other ponds in the area, including Carr, Capwell Mill, Phelps, Rathbon, and Sweet Ponds, as well as on Congdon Mill and Nooseneck Rivers.

The Big River is stocked for trout by the Division of Fish and Wildlife, and is given a "B" rating. (Trout areas are classified into three categories - A, B, and C - according to fishing intensity and suitability of environment.) Approximately 2,000 trout are stocked each year at six different points along the river. It was proposed at one time that a trout hatchery could be constructed at the proposed Big River Reservoir; no further action was taken, however. Largemouth bass, pickerel, and yellow perch are also found in the Big River. On the opening day of the fishing season, 100-150 people may be found along the shores.(39,54)

Tarbox Pond, although not stocked for trout, is often fished by area residents. People can be seen fishing throughout the week during warm weather. Chain pickerel, largemouth bass, and yellow perch are the primary species caught. In the winter, the pond is used for ice fishing. On an average day, two to three people can be seen ice fishing on Tarbox Pond, although there have been, at times, up to fifty people ice fishing.

Fishing is limited on Carr Pond, although there is potential if properly managed. The known fish population of the pond includes yellow perch, bluegill sunfish, largemouth bass, smallmouth bass, and brown bullhead. The rocky shores, clear water, and sandy-bottomed shallows are suitable for smallmouth bass. Unauthorized introduction of the competitive largemouth bass, however, has resulted in increasing numbers of this species, with a subsequent reduction in the smallmouth bass population. In 1977, the Division of Fish and Wildlife suggested Carr Pond be re-evaluated for trout management, and that its unusual thermal characteristics should be studied further. A state boat launching ramp is projected for the future.(38)

Native trout can be found in the Nooseneck and Congdon Rivers, as well as trout stocked by the Division of Fish and Wildlife. Both are considered good fishing areas by local residents, and may get 25 to 30 people on opening day. Capwell Mill and Rathbon Ponds also provide fair fishing, with perhaps 20 people fishing there throughout the week. Reynolds Pond offers good bass fishing. Occassional fishing is also done on Phelps and Sweet Ponds. The most common species caught in all the onsite ponds are largemouth bass, brown bullhead, yellow perch, and American eel. In addition, all the ponds have some ice fishing throughout the winter.

d. Golf

There is one golf club presently operating in the Big River site area. The golf club, Coventry Pines Country Club, is located on Harkney Hill Road in Coventry, in the northwestern portion of the site. The course has nine holes, with a length of 3,160 yards. Par for the course is 36. Carts are available at the club, which also has a pro-shop and a snack bar. Fees on weekends are $3.00 for nine holes and $5.00 for eighteen.

The market area of the club generally includes the region west of Providence and north of Coventry. Approximately 75 to 80 percent of the visitors are from within 8 to 10 miles of the club. It is a public course and does not have private membership. Leagues, however, are very important, especially during the week. Membership in the leagues varies from 25 to 40 persons, with one league having 60 members. These leagues are formed by local companies, bars, hospitals, etc.

Sunday morning is generally the busiest time of the week, with up to 200 people on a good day. On an average day, approximately 150 to 175 people play golf at Coventry Pines. The course closes about the middle of December and opens again in the middle of March.(55)

Coventry Pines Country Club

e. <u>Hunting</u>

The Big River Site is one of the most popular hunting areas in the state. All the species of game that are hunted in the state are found within the site, including pheasant, grouse, quail, woodcock, common snipe, mourning dove, ducks, cottontail rabbit, snowshoe hare, raccoon, and white-tailed deer. Although the ponds and streams on the site generally provide only minimal habitat for waterfowl, the Division of Fish and Wildlife has managed a wood duck nest box program which has assisted in the development of the population. The mourning dove, the other migratory species on the site, can be found in varying numbers depending on crop and field conditions. The Division of Fish and Wild-life has a management program for this species on fifteen acres of the Big River Site. Pheasant is also stocked around the Carr Pond area.(33)

Reynolds Pond, in the northwest portion of the site, is in an excellent hunting area. Black duck, partridge, and ruffled grouse provide exceptional hunting. The area is considered to be one of the best areas for partridge in Kent County.

There are an estimated 1,000 hunter trips during the month of November for the small game season at the Big River Site.(56) The table below illustrates the increase in deer harvested since 1971 at Big River. During the 1973-1975 seasons, deer harvested at Big River accounted for over one-third of the state total.

STATISTICS FOR SHOTGUN DEER SEASON - BIG RIVER (56)

Year	Hunter Trips	Deer Harvested (Big River)	Total Deer Harvested On State Areas	Percent of Deer Harvested At Big River
1971	319	4	28	11
1972	455	5	31	16
1973	978	6	18	33
1974	997	5	14	36
1975	1,304	12	24	50
1976	1,068	11	49	22
Total: (1971-1976)	5,121	43	164	26

Should recreation be allowed in the proposed Big River Reservoir area, the Division of Fish and Wildlife has proposed various areas of the site for hunting and for wildlife management. Hunting would essentially be confined to the southern and eastern upland areas of the site, and emphasis would probably lean towards waterfowl shooting. Possible management techniques could include the development of Canada goose grazing fields and a comprehensive wood duck nest structure installation program. All programs would, of course, be in conformance with the policies of the managing water supply agency.(56)

f. Model Airplane Flying

The northern part of the site, near the sand banks and Division Street, is a popular area for model airplane flying. Rhode Island Aeromodelers, Inc., a club interested in this activity, presently has a one-year lease with the Water Resources Board which permits the use of a specified area. Flying is restricted to radio-controlled aircraft. The Rhode Island Army National Guard is presently constructing a grass airstrip on the site for use by the club.

g. Outdoor Game Fields

There are three game fields on the Big River Site; all are in Coventry, on the northwest portion of the site. The fields were constructed by the Town of Coventry on land owned by the State. The Town presently maintains these fields, which are used primarily in late spring and early summer. These fields, along with the others in Coventry, are used by various groups and little leagues, including the Police Athletic League, the Babe Ruth League and the Slow Pitch League.

Outdoor Game Fields in Coventry

h. Picnicking

Some picnicking does occur at the Big River Site, although there are no picnic tables or other picnic facilities on the site. A substantial amount of picnicking occurs, however, in conjunction with other activities such as swimming or fishing.

i. Swimming

Swimming is a popular activity at the Big River Site, particularly at Carr Pond. The clear water and sandy bottom, in addition to easy access provided by the roads and trails in the area, increase the popularity of the pond. Although there is a sandy beach along one shore, the entire shoreline is used for swimming. It is estimated that up to 300 people may swim at the site on a good summer weekend. There are no lifeguards or swimming facilities. Local residents also swim at Tarbox Pond and Phelps Pond.

Swimming At Carr Pond

j. Trails

The Rhode Island Trails Advisory Committee is currently circulating a questionnaire to a wide range of recreation groups to determine the extent of trail use in the Big River Site. Results of this survey will not be available until mid-1979. The Trails Advisory Committee is interested in determining if there is sufficient interest to connect trails at Big River with north-south trails in the vicinity of Arcadia Management Area.

(1) Hiking

Although there is some hiking along the many trails of the Big River Site, the area is not extensively used by hikers. The trails are not marked, and many of the existing roads and trails are heavily used by motorcyclists. In addition, many hikers object to the extensive trash in the area.

In 1974, a right-of-way was granted to the Narragansett Electric Company for the construction of transmission lines. These lines have not yet been constructed. By agreement, a portion of the easements may be developed as a place to take "pleasure walks." The area would be open to the general public, subject to the prior approval of the Water Resources Board and the Department of Environmental Management. The easements, consisting of two strips 350 and 250 feet in width, roughly encircle the southern and western portions of the Big River Site, running generally within site boundaries from Carr Pond to Harkney Hill Road.(57)

(2) Horseback Riding

Horseback riding is a popular activity at the Big River Site, although there are no specially marked trails or public riding stables. Trails and unpaved roads such as the New London Turnpike provide excellent riding paths. Occassionally fallen trees are placed across the trails for the horses to jump. It is not uncommon to find ten to twelve horsemen, mainly from the local area, riding throughout the site. These numbers would increase and people would come from greater distances if there were an onsite parking area for cars and vans.

Various horsemen's clubs occassionally sponsor special events at the site. These events include horse showing and competitive rides around Carr Pond. Over the Labor Day weekend horsemen from states such as Rhode Island, Massachusetts, and Pennsylvania rode from Horsemen's Camp and Beach Pond State Park to Carr Pond as part of the Bicentennial Wagon Train, a special horsemen's event.

Fox hound hunting is a popular onsite activity, occurring primarily on weekends from the beginning of October until the end of February. Generally twelve to twenty people participate approximately once every week.

(3) Motorcycling

The Big River Site is an extremely popular area for motorcycle and recreational vehicle enthusiasts. The most popular areas are the sand banks along Division Street and the trails leading from them. The Carr Pond area is another favored place for riding. On a peak Sunday, over a hundred motorcycles and other recreational vehicles can be seen on the site. Most people ride off-road motorcycles or dirt bikes, although four-wheel drive vehicles such as dune buggies are also used. One club, the Rhody Rovers, plans to sponsor organized events at the site in the future.

(4) Snowmobiling

Snowmobiling, the most popular winter activity at the Big River Site, is permitted by the Department of Environmental Management on trails in the vicinity of Division Street. There is, however, substantial unauthorized use throughout the entire area.

k. Winter Recreation

In addition to snowmobiling and ice fishing, many local residents enjoy ice skating on Tarbox Pond and Carr Pond. On a good day, an average of ten to fifteen people might participate in this activity. Cross-country skiing and snowshoeing are other winter activities which are found in the Carr Pond area, as well as throughout the entire site. Cross-country skiing, in particular, is steadily growing in popularity. Tobogganing is another activity which occurs onsite, mainly in the sand banks area.

l. Other Activities

Some sightseeing occurs throughout the Big River Site during summer or fall when the foliage begins to change. Approximately twenty sightseers may visit the site on a peak day.

The northern part of the site near the sand banks is also utilized for hang gliding, target shooting, and dog training, and as a high school field trip study area. The area is used extensively by target shooters all week long, weather permitting, throughout the year. Target shooting also occurs in an area south of Division Street, east of the sand dunes. Approximately 20 persons may be target shooting at these areas on an average weekend day.

Mushrooms are found in abundance throughout the site, and many people can be seen mushrooming throughout the week.

4. Recreational Activities on Alternative Water Supply Impoundments

As indicated in Section I, several alternatives have been proposed in conjunction with the construction of the Big River Reservoir. Alternatives proposed include diversion of the Flat River, development of the Wood River Reservoir, diversion of the Wood River, construction of the

Bucks Horn Brook Reservoir, maximum development of ground-water resources, and construction of the Moosup River Reservoir. Construction of reservoirs or impoundments at Wood River, located within Arcadia Management Area, at Bucks Horn Brook, or at Moosup River would impact existing recreation activities. Impoundments are illustrated in Figure 1 ir Section I. These activities are described below.

a. Wood River Impoundment

This alternative entails the construction of a 1.4-square mile impoundment on the Wood and Flat Rivers in Exeter and West Greenwich. This site is located on 4,378 acres owned by the Rhode Island Water Resources Board (WRB). Since the land owned by the WRB is incorporated within the 8,000 acres included within the Arcadia Management Area, Beach Pond State Park, Arcadia State Park and Dawley Memorial State Park, the entire tract is used for recreation and conservation purposes. This multi-purpose area is one of the Rhode Island Department of Environmental Management's most extensively developed and used facilities in the state.

The land within the WRB property is used for a variety of recreation and management uses. A total of 48 cabins are located in four units on this property. Two units are east of the Flat River and two units are west of the Flat River in the vicinity of Lewis City. This facility, built as a CCC Youth project during the 1930's, now houses Rhode Island Camps,

Beach Pond Camps

Inc., a private camp for underpriviliged children. This overnight camp is held in July and August. From April 15 to June 20 and from September 1 to October 31, these cabins are available to the general public for $1 per person per night. Cabins sleep two to six or eight people. Each of the four units has a large lodge with fireplace/cooking facilities and a bathhouse. Other facilities include a council ring, walking trails, fishing streams, game field and swimming pools.(33) These cabins are above the elevation of the proposed impoundment. They are, however, located very close to the proposed shoreline.

Frosty Hollow camping area is located on the Shelter Trail, west of Frosty Hollow Road in the WRB property area. Two Adirondack shelters are open year round for adults and supervised groups. Facilities include toilets and a dumping station. Permits are issued at the Division of Parks and Recreation in Providence for $3.00 per night for both shelters.(33)

Several marked trails connecting with the extensive trail system in the Arcadia Management Area and Pachaug State Forest in Connecticut cross the land owned by the WRB. Foot trails within or adjacent to the site include the 1.6-mile John B. Hudson Trail, the 4.9-mile Breakheart Trail, 1.1 miles of the Mount Tom Trail, the 2-mile Escoheag Trail, and a portion of the Ben Utter Trail. These trails form a circuit connecting on the southeast with the Arcadia Trail and on the northwest with Tippecansett Trail, a north-south trail with access to the trail system in the Pachaug State Forest in Voluntown, Connecticut. Trails within the site are maintained by the Narragansett Chapter, Appalachian Mountain Club with some assistance from the Rhode Island Dept. of Environmental Management, Division of Parks and Recreation.(51,52)

The Arcadia Management Area also maintains horse trails through the WRB site on paved road and marked trails. Horse trails are generally separate from hiking trails although the Ben Utter Trail is multipurpose. Approximately 7 1/2 miles of horse trail traverse the property area. These trails are part of an extensive 30-mile network of horse trails on local roads and through state-owned land in West Greenwich, Exeter and Hopkinton. Connections are also made with horse trails in the adjacent Pachaug State Forest in Connecticut.(49,52)

Marked motor bike trails cross the Wood River property area on several paved roads. Approximately 4 miles of the 50-mile motor bike network which extends through the western part of the three-town area, traverse the site.(52)

Several water bodies are located within the WRB property area. As indicated in Figure 1 in Section I, two rivers converge to the south of the proposed impoundment to form the Wood River. In accordance with USGS, the west branch is referred to as the Wood River and the east branch is referred to as the Flat River in this report. Other sources label the west branch the Falls River and the east branch either the Flat or Wood Rivers. Other water bodies include Breakheart Pond, Breakheart Brook, and Frosty Hollow Pond which form a tributary system of the Flat River.

The Division of Fish and Wildlife has planted numerous management fields throughout the site, especially in the vicinity of the Wood and Flat Rivers. Some of these will be below the water elevation. A hunter check station is located just south of the property area on the Wood River. Species of game found in Arcadia Management Area include pheasants, quail, mourning dove, grouse, woodcock, ducks, cottontail rabbit, snowshoe hare, grey squirrel, and white-tailed deer.(46) Three parking areas are located on the site in the southern part near Route 165. Sanitary facilities are located near Breakheart Pond and at the Frosty Hollow parking areas.

The Division of Fish and Wildlife stocks the Wood and Flat Rivers within the WRB property. Both branches are Class A trout fishing areas.(39) Frosty Hollow Pond is categorized as a Class C trout fishing area. It is also stocked by the Division of Fish and Wildlife annually. According to special regulations, the pond is only open to those 15 years of age and under.(39) No boats are permitted on this pond.

Breakheart Pond, located east of the Flat River, is within the ownership area. Although it will not be flooded by the proposed impoundment, it is within the watershed. This man-made 45 acre pond has an average depth of 4 feet. Access is provided for parking, boat launching, and shore fishing. Largemouth bass dominate the fish population. Although the pond is small, sampling in this pond yielded greater numbers of this species per unit area than any other pond surveyed in the state.(38) Both Breakheart Pond and Breakheart Brook are Class A trout streams. They are stocked annually by the Division of Fish and Wildlife with brook, brown, and rainbow trout. The state maintains a boat ramp at the pond. Outboard motors over 10 horsepower are prohibited.(31)

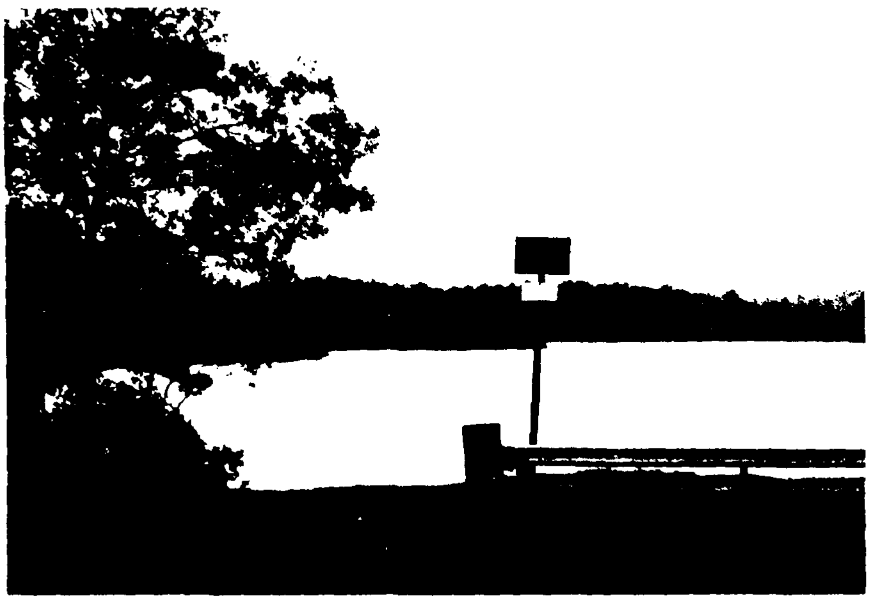
b. <u>Bucks Horn Brook Reservoir</u>

The Bucks Horn Brook alternative is located in Greene, a village in Coventry. Although the lower reaches of the brook are stocked with trout by the Division of Fish and Wildlife, the area affected by the 0.8-square mile impoundment is not stocked. The Trestle Trail, an abandoned railroad right of way, passes along the northern shore of the impoundment. This 8-mile trail, owned by the Narragansett Electric Company, is leased to the Rhode Island Department of Environmental Management. The multi-purpose trail is suitable for use by hikers, cross country skiers, motor bikers, and horsemen. It extends from the Connecticut line east through Greene and Summit to Coventry Center.

c. Moosup River Impoundment

The Moosup River alternative involves the construction of a dam in Sterling, Connecticut, about 2,000 feet west of the Rhode Island border. Most of the 0.8-square mile impoundment would be in Coventry, Rhode Island and would encompass state-owned Carbuncle Pond and privately owned land along the Moosup River.

Carbuncle Pond is owned by the State of Rhode Island and managed by the Division of Fish and Wildlife. This 35-acre pond has a maximum depth of 24-feet although the average depth is 15 feet. A boat launch has been constructed by the state at the south end of the pond with access via Route 14. Boats with outboard motors are prohibited, but electric trolling motors are permitted.(46) Although the pond is stocked with trout by the state, other known fish species include yellow perch, white perch, bluegill sunfish, pumpkinseed sunfish, redbreasted sunfish, largemouth bass, and chain pickerel. Dissolved oxygen levels drop significantly in the deep areas; only some trout stocked for put-and-take trout management survive through the summer.(38) Carbuncle Pond is classified as a Class B trout pond. Signs are posted indicating that no lifeguards are on duty at Carbuncle Pond. However, a narrow grassy area adjacent to the boat ramp and the parking lot is obviously used as a beach during summer months. Carbuncle Pond is only one of several ponds



Carbuncle Pond

and reservoirs in Coventry which is suitable for swimming. Population density is much higher in the east part of town than in the west where Carbuncle Pond is located. This pond is just east of the state line and the village of Oneco, in Sterling, Connecticut.

Moosup River, which flows west into Connecticut, is stocked with trout in the Town of Coventry. The Division of Fish and Wildlife has rated the river a Class A trout area.(39) The Trestle Trail traverses the impoundment. The trestle bridge over the Moosup River now affords a hiking enthusiast a view of farm land, the river, and lowland marsh. Although the Moosup River would be impounded in the vicinity of the trail, neither the bridge, nor the trail, illustrated below, would be affected.

Trestle Trail Bridge over the Moosup River

5. Supply Capacities of Recreational Facilities

Tables 12, 13, and 14 indicate the capacity of the recreational facilities inventoried in the State of Rhode Island, the local area, and the Big River Site. Supply refers to the number of facilities or recreation areas available for public use. The term "facilities" includes feet of shoreline, miles of trail, etc. Figures for state supply are taken from the Rhode Island SCORP report, and are used to represent the Big River study region; information on a town by town basis for Connecticut and Massachusetts was not available. Supply in the local area and on the Big River Site was determined from the facilities listed in the SCORP report and other available reference sources. Existence of additional recreational facilities and areas in the Big River Site was determined from conversations with area residents and local officials, as well as by observations of staff members. Supply in the local area includes facilites in the Big River Site.

Capacity refers to the maximum number of persons which ideally can utilize these recreation facilities each day. Capacity is determined by multiplying the supply (number of facilities) by a conversion factor (i.e., the ideal number of persons which would utilize each facility). This number, which represents the maximum use at one time, is then multiplied by an estimated turnover rate yielding the total number of users in one day. Conversion factors and turnover rates are taken from the Rhode Island SCORP report unless otherwise noted.

C. Existing and Projected Recreational Demands

This section discusses the demand for the existing recreational facilities described in the previous section, and forecasts what the demand will be in the future. Present demand can be defined as current use of existing recreational facilities. Much of the information is based on the Rhode Island SCORP report and the diary surveys which were conducted in 1974-1975 by the Statewide Planning Program, Department of Natural Resources, and University of Rhode Island. Two thousand households in Rhode Island were sent diary-type questionnaires which contained a variety of questions concerning their participation in eighteen major recreational activities. Five periods were surveyed: January/February, April/March, July, August, and October/November. Information such as distance and means of travel, household income, age, and education was also requested. The analyses of the responses to these questionnaires provided the basis for the estimate of 1975 demand in the SCORP report.

In order to compare supply with demand, the estimated number of people participating in a certain recreational activity on a peak day was used. This average peak day or "design day" was computed in the SCORP report by taking the average of the five highest days of activity, as deter-

TABLE 12

Supply Capacities of Recreational Activities-
State of Rhode Island

Facility	Number of Facilities	Conversion Factor	Turnover Rate/Day	Present Capacity (Persons/Day)
Boating	183 ramps	3 persons/boat, 19 boats/ramp	1.5	15,647[(a)]
Camping	4,276 sites	4 persons/site	1	17,104
Fishing	986,550 feet of shoreline	1 person/75' of shoreline	2	26,308
Golf	708 holes	8 persons/hole	2	11,328
Hiking	198.3 miles	15 persons/mile	6	17,847
Horseback Riding	238.8 miles	10 persons/mile	5	11,940
Hunting	N/A	N/A	N/A	N/A
Picnicking	4,273 tables	5 persons/table	1.5	32,047
Swimming	40,765 feet of shoreline	0.75 persons/ linear foot	1.5	45,861[(b)]

N/A - not available

(a) Included in SCORP analysis, but not in this inventory, are 30,824 boat slips, most of which are along Narragansett Bay and the Atlantic coast. This increases the supply capacity to 46,471.

(b) Included in SCORP analysis are 132,200 square feet of swimming pool area, not included in this inventory. This increases the supply capacity to 53,792.

TABLE 13

Supply Capacity of Recreational Facilities-Local Area

Activity	Number of Facilities	Conversion Factor	Turnover Rate/Day	Present Capacity (Persons/Day)
Boating	9 boat ramps	3 persons/boat, 19 boats/ramp	1.5	770
Camping	716 camp sites	4 persons/site	1	2,864
Fishing	231,600 feet	1 person/75 feet of shoreline	2	6,176
Golf	63 holes	8 persons/hole	2	1,008
Hiking	69 miles[(a)]	15 persons/mile	6	6,210
Horseback Riding	41 miles[(a)]	10 persons/mile	5	2,050
Hunting[(b)]	16,405 acres	1 person/5 acres[(c)]	1	3,290
Picnicking	354 tables	5 persons/table	1.5	2,655
Swimming	7,190 feet[(a)]	0.75 per/linear foot	1.5	8,089

(a) Does not include facilities on the Big River Site.

(b) Includes only State management areas.

(c) Not available from Rhode Island; conversion factor taken from the Vermont SCORP report.[(57)]

TABLE 14

Supply Capacity of Recreational Facilities-
Big River Site

Activity	Number of Facilities	Conversion Factor	Turnover Rate/Day	Present Capacity (Persons/Day)
Boating	4 boat ramps	3 persons/boat 19 boats/ramp	1.5	342
Camping	0 campsites	4 persons/site	1	0
Fishing	13,500 feet of shoreline[(a)]	1 person/75' of shoreline	2	360
Golf	1 course, 9 holes	8 persons/hole	2	144
Hiking	30 miles[(b)]	15 persons/mile	6	2,700
Horseback Riding	30 miles[(b)]	10 persons/mile	5	1,500
Hunting	8,000 acres	1 person/5 acres[(c)]	1	1,600
Picnicking	0 picnic tables	5 persons/table	1.5	0
Swimming	8,400 feet of shoreline[(d)]	0.75 persons/ linear foot	1.5	9,450

(a) Based on estimated shoreline available to fisherman at onsite waterbodies that are presently fished. (Carr Pond is not included.) Assessibility to these waterbodies was a primary consideration.
(b) Based on estimated miles of unpaved roads and trails, as shown on U.S.G.S. and other site maps. The region within the sand banks area was not included.
(c) Not available from Rhode Island; conversion factor taken from Vermont SCORP report.[(57)]
(d) Based on estimated shoreline available for swimmers at Carr, Tarbox, and Phelps Ponds. The formula used by SCORP for determining swimming capacity assumes there is beach frontage, which can accommodate more people than a wooded shoreline such as is found along onsite ponds. The fact that the capacity figure is very high must be considered during the impact analysis.

mined from the diary survey. Thus, an example of a design day use would be the estimated number of people who would go swimming on a hot, sunny Saturday during the height of the summer season.

Table 15 indicates the demand forecasts for the State of Rhode Island, as determined by the SCORP report. Numbers for present demand were obtained from the SCORP report, and were based on the diary survey, which represents the year 1975. Use of these figures, however, gives a fairly accurate determination of recreation demand for 1978.

Present demand forecasts for the local area were also taken from 1975 data. This information is presented in Table 16. As demand for the local area was not given in the SCORP report, the raw data contained in the diary surveys for Coventry, East Greenwich, Exeter, West Greenwich, and West Warwick were used to compute local area demand. The diary survey identified the total number of single day trips to the local area for the various recreational activities surveyed. These figures were then corrected for trips coded in the survey without destinations. Total recreational use of the local area for the activities survey was then estimated for the five survey periods during the year. The design day (or average of the five highest days of use) was estimated for the peak survey period for every activity by applying the ratio of the statewide design day to total activity days for the same survey period.

Present demand for the Big River Site, shown in Table 17, was estimated from information given by area residents and local officials, as well as from observations by staff members, much as in the determination of supply. In addition, the results of the diary survey for West Greenwich were studied, since the Big River Site is the major recreation area in the town.

Projections for 1995 design days were made by applying the percentage increase identified by the model used for the SCORP report for each activity. This model was based on income and population. Design day use for 2020 was estimated based on a model which assumes that growth in recreation will be similar to that identified by the SCORP report for the period 1975 to 1995, corrected for changes in the rate of population growth as projected by the Rhode Island Statewide Planning Program.

TABLE 15

Existing and Projected Recreation Demands-
State of Rhode Island

Activity	Design Day Demand (Number of Persons) Present	1995	2020
Boating	19,426	34,491	77,614
Camping	14,854	20,936	28,607
Fishing	5,939	8,358	11,375
Golf	5,951	10,883	22,462
Hiking	4,534	6,333	9,824
Horseback Riding	2,543	4,679	8,370
Hunting	2,326	4,160	7,687
Picnicking	51,951	58,300	59,881
Swimming	50,501	74,466	107,777

TABLE 16

Existing and Projected Recreation Demands-
Local Area

Activity	Design Day Demand (Number of Persons) Present	1995	2020
Boating	657[a]	1,451	3,341
Camping	128	180	247
Fishing	330	464	632
Golf	793	1,450	2,579
Hiking	50	70	94
Horseback Riding	55	101	181
Hunting	115	206	380
Picnicking	2,420	2,627	2,698
Swimming	2,633	3,883	5,619

(a) Does not include the demand for East Greenwich, as the town has no fresh water boat launches, and most of the boating activity is salt water boating.

TABLE 17

Existing and Projected Recreation Demands-
Big River Site

Activity	Design Day Demand (Number of Persons) Present	1995	2020
Boating	45[a]	90	207
Camping	0	0	0
Fishing	100	128	174
Golf	175	286	509
Hiking	10	13	17
Horseback Riding	20	33	59
Hunting	100	165	304
Picnicking	100	101	104
Swimming	200	277	401

(a) Number of boats estimated for the design day is 15. SCORP estimate of three persons per boat is used to determine demand.

IV. RECREATION SUPPLY AND DEMAND

A. Outdoor Recreation Needs

This section compares the estimated supply capacity with the present and future demand, as determined in the previous sections, for the State of Rhode Island, the local area, and the Big River Site. From this comparison, various recreation problems and needs can be determined. Specific conclusions drawn from raw data of the diary survey and the Rhode Island SCORP report are also presented. Additional documentation of the diary survey is obtained from a 1978 analysis by the Department of Environmental Management.(59) Other problems and considerations that are not directly computable but that could be determined from public and government opinion, the raw data of the diary survey, and professional judgement are also addressed.

As stated previously, present demand for the State of Rhode Island and the local area are based on the 1974-1975 diary survey. The forecast years, 1995 and 2020, are standard planning periods for long-term analyses.

1. Boating

For purposes of this study, boating includes all types of fresh water and salt water activity, ranging from canoeing to yachting. The diary survey data show boating to be the sixth most popular activity in terms of activity days among the eighteen activities surveyed. Fifty-eight percent of the boating activity takes place within ten miles of home, 30 percent of which takes place within five miles. Weather conditions appear to be a primary determinant of most boating activity. There is, however, a fair amount of boating recorded in the cooler periods of spring and fall, indicating the influence of fishing, a secondary trip purpose, or a desire to take advantage of less crowded conditions. Income is the strongest variable affecting participation in boating. Higher income groups comprise a large part of total participation. There is also a correlation with home ownership, car ownership, and education.

A comparison of boating supply capacity versus demand is presented below.

Boating	Supply Capacity	Demand		
		Present	1995	2020
State	46,471	19,426	34,491	77,614
Local	770	657	1,451	3,341
Big River	342	45	90	207

On the state level, the present supply capacity substantially exceeds the demand. Boating, however, is the fastest growing activity in Rhode Island, largely due to the rise in income. By the year 2000, the demand is expected to exceed the supply, and additional facilities would be required.

In the local area, the present supply capacity somewhat exceeds demand. By 1995, however, a fairly severe shortage may develop. Although some of the demand would be satisfied by the boating done in areas without boat launches, a substantial shortage is still indicated.

On the other hand, at the Big River Site the opposite is true; supply far exceeds demand. Although there are four boat ramps on the site, they are not fully utilized. This is probably due to several reasons. Three of these ramps are found on the Big River, which is very narrow and not accessible in many places. The river may not provide, in many areas, an aesthetically appealing boating trip. The fourth ramp is found at Tarbox Pond, which is not very well-known outside the immediate site area. In addition, parking areas near these ramps are limited.

2. Camping

Camping in Rhode Island is primarily a family activity, enjoyed by all income groups. Camping generally occurs in conjunction with other activities such as picnicking, hiking, and swimming, and ranks seventh in the activities surveyed. Rhode Island's salt water coast is the greatest attraction for campers, and campgrounds located along the southern shore are generally filled to capacity for most of the season. Camping usually requires travel of some distance, with over 65 percent taking place out of state. Conversely, 61 percent of the camping done in Rhode Island is by out-of-state residents. Camping and salt water swimming are the only activities in which major nonresident use occurs.

Supply capacity of camping facilities versus camping demand is presented below.

Camping	Supply Capacity	Demand Present	Demand 1995	Demand 2020
State	17,104	14,854	20,936	28,607
Local	2,864	128	180	247
Big River	0	0	0	0

There is presently a surplus of camping facilities in the state. By 1980, however, the demand is expected to exceed the supply, and additional campgrounds would be required. For the local area, it appears that the capacity of available camping facilities far exceeds the demand. The

AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED NL

2 of 9

figure for local camping demand is low, however, as it is based on single day trips only, whereas state demand is based on multiple trips. Nevertheless, although a demand of 128 may not be truly representative of camping activity in the local area, a surplus of camping facilities is still indicated.

Camping demand for the Big River Site is computed to be zero, as there are no camping facilities on the site, and camping in Rhode Island is allowed only at authorized areas. There is some unauthorized onsite camping activity, however, and there would probably be a demand for the activity if there were camping areas or facilities.

3. Fishing

Only fresh water fishing is analyzed in this report, as the addition of salt water fishing statistics would not provide an accurate demand forecast for the Big River Site. Supply capacity is based on length of accessible shoreline available for fishing. Quality of fishing and quantity of fish caught are not considered for the state and local supply, as this would require a subjective and seasonal interpretation. Quality of fishing at Big River Site ponds and rivers, however, is taken into consideration.

Thirty-four percent of the fishing activity takes place within five miles of home. This is due to the many lakes and streams that are stocked by the Division of Fish and Wildlife, which make it unnecessary to travel a great distance for prime fishing.

Peak participation for fresh water fishing occurs in the spring. This is due to the fact that opening day, usually the most popular day for fishing, occurs in April. In addition, streams are stocked at this time, so there is usually an abundance of sport fish. Although spring is the peak period, there is still a good amount of activity through the fall season. Fresh water fishing ranks thirteenth in activity days computed in the diary survey.

The following indicates supply capacity versus demand forecast for fresh water fishing.

Fishing	Supply Capacity	Demand Present	Demand 1995	Demand 2020
State	26,308	5,939	8,358	11,375
Local	6,176	330	464	632
Big River	360	100	128	174

Although the supply capacity seems to be adequate for all three areas, it must be remembered that quality of fishing was not included in the analysis. This activity provides a clear example of the ability to stimulate demand, as peak activity in spring is directly due to the stocking program. Thus, although the length of shoreline available for fishing in Rhode Island is adequate, it appears that additional attention should be paid to improving the quality of existing fresh water fishing-areas. It should also be noted that almost one-third of the local area demand comes from the Big River Site, while supply capacity is only about five percent.

4. Golf

Golfing ranks ninth in popularity among the activities surveyed in the SCORP report. A strong correlation exists between income and participation. Households with incomes exceeding $21,000 constitute 21 percent of the total, while lower income households (under $9,000) comprise only 3 percent. This is due mainly to the high costs of club memberships and equipment. Golfers tend not to travel long distances to play, and usually frequent their local golf courses. Sixty-four percent of all participation is within a 20-mile radius of home; 36 percent is within 10 miles. Golfing is generally a year-round activity, with only severe weather in January and February restricting playing.

The following table indicates supply capacity and demand for golfing.

Golf	Supply Capacity	Demand Present	Demand 1995	Demand 2020
State	11,328	5,951	10,883	22,162
Local	1,008	793	1,450	2,579
Big River	144	175	286	509

A surplus exists for state supply capacity up to the year 2000. There is also a surplus at the local level, although not a substantial one, particularly when considered without the golf course on the Big River Site. By 1995, a shortage is expected in the local area, growing much more critical in 2020. Thus, it is likely additional golf courses will be needed.

5. Hiking

Hiking is a year-round activity in Rhode Island, with only moderate peaking during the summer and a slight increase during the fall foliage season. Forty percent of the hiking activity takes place within five miles of home. Since the definition of hiking is not limited to walking a foot path through a forest, however, the true hiking enthusiast would probably be one of the 21 percent who travel 20 to 29 miles to enjoy this sport.

The following table presents a comparison of hiking supply capacity with demand.

Hiking	Supply Capacity	Demand Present	Demand 1995	Demand 2020
State	17,847	4,534	6,333	9,824
Local	6,210	50	70	94
Big River	2,700	10	13	17

An ample supply of trails will meet demand for hiking through 2020, particularly in the local and Big River areas. However, almost twice as much participation occurs out-of-state as in Rhode Island. While some of this hiking is done in conjunction with camping, sightseeing, or other out-of-state activities, there are three factors having a strong influence on lower in-state demand figures: 1) the avid hiker prefers a primitive wilderness setting with a variety of natural attractions, and much of the state is urbanized; 2) many of the state's hiking trails are poorly mapped, poorly marked, and underpublicized; and 3) hiking trails throughout the state do not form a complete and continuous system. The latter reasons have often been cited for the limited amount of hiking done at the Big River Site. Thus, improving the quality of hiking trails throughout the state could provide much higher participation without overcrowding existing trails.

6. Horseback Riding

Horseback riding occurs throughout the year, with only severe weather conditions limiting the activity. A peak period occurs during the summer. Horseback riding generally takes place close to home, perhaps because transportation costs to riding areas are high. Sixty-three percent takes place within a ten-mile radius of home. Income is an important factor in participation, attributable to the expense of owning and stabling riding horses.

A comparison of supply capacity versus demand for horseback riding is presented below.

Horseback Riding	Supply Capacity	Demand Present	Demand 1995	Demand 2020
State	11,940	2,543	4,679	8,370
Local	2,050	55	101	181
Big River	1,500	20	33	59

The supply capacity appears to be adequate throughout the year 2020 on all three levels. Next to hunting, horseback riding ranked lowest of the eighteen activities surveyed, probably due to a number of reasons. Like hiking, the urban nature of the state discourages participation. Horses are difficult to keep in urbanized areas, and it is expensive to transport horses to riding areas. In addition, many trails are geared to the casual, more inexperienced rider. A better variety of trails would probably encourage more participation.

There are several reasons for the low demand for horseback riding on the Big River Site. The trails are not marked, and are often littered with trash. Many people are not aware of the trails available on the site. Still others would like to ride through the site but do not know where to park their cars and vans. Riding clubs have expressed an interest in the site as a place for riding and related activities, due to its central location, but are forced to go to other areas with available facilities. Even with these undesirable conditions, however, almost one-third of the present demand in the local area is for the Big River Site.

7. Hunting

Supply capacity for hunting in the State of Rhode Island is not estimated in the SCORP report, as variables such as game species available and season of activity make estimation of supply virtually impossible. For purposes of this report, however, supply for the local area and the Big River Site is determined through acreage of state management areas designated for hunting. Although hunting is often permitted on private or town lands, relevant information is not available. Capacity of state management areas is determined by utilizing the standard of five acres per hunter.(58)

Participation is greatly affected by the legal hunting seasons which occur during fall and winter. The number of hunters in October and November is more than double the number in all other months combined. (It should be noted, however, that the diary survey was not conducted in December, during the shotgun deer season, a peak hunting period.)

Most hunting occurs close to home, as many Rhode Island hunters live in rural areas and hunt in their local surroundings. Fifty-three percent of the hunting activity takes place within ten miles of home.

The following table shows the comparison between hunting supply capacity and demand.

Hunting	Supply Capacity	Demand Present	Demand 1995	Demand 2020
State	6,000	2,326	4,160	7,687
Local	3,290	115	206	380
Big River	1,600	100	165	304

The number of activity days for hunting is the lowest of all eighteen activities surveyed. However, resident satisfaction is shown by the fact that 69 percent of all activity days are spent within the state. As there are over 30,000 acres of state management areas (with a supply capacity of 6,000, using the Vermont SCORP conversion factor), there seems to be an adequate supply through 2020. Supply in the local area also appears adequate, even without Big River. These figures should be used with caution, however, due to the difficulty of estimating hunting supply capacity. In addition, acreage of management area is used to compute supply; not all of this area is available to hunters. Nevertheless, an adequate supply of hunting areas is indicated.

A comparison of local area hunting demand with that of the Big River Site shows that most of the hunting done in the local area takes place at the Big River Site. Although the figure for the local area is somewhat low due to the different methods of calculating demand, it does show a substantial demand for hunting in the Big River area.

8. Picnicking

Picnicking is defined as eating outdoors, specifically for recreational purposes. Picnicking ranks fourth among the activities surveyed. This popularity is due to the relatively inexpensive nature of the activity and the numerous facilities throughout the state. Nearly 70 percent of the picnicking is done on weekends or holidays, which accounts for the high design day figure of 51,951. Picnickers also tend to travel farther from home than do participants in the other activities.

The following table shows the comparison between supply capacity and demand for picnicking.

Picnicking	Supply Capacity	Demand		
		Present	1995	2020
State	32,047	51,951	58,300	59,881
Local	2,655	2,420	2,627	2,698
Big River	0	100	101	104

The above figures show there is a present shortage of picnic facilities in the state. Supply capacity may be low, since the inventory was conducted during fall and winter when many picnic tables were stored for the season. However, the forecast still shows a substantial shortage of picnic facilities through 2020, even though the demand is not expected to increase at a rapid rate.

In the local area, the supply and demand for picnic facilities is very close, with the supply only slightly exceeding demand until 2020. Although there are no picnic tables at the Big River Site, the present design day for picnicking is 100. Much of the picnicking is done in conjunction with other activities; the demand, therefore, would probably increase if picnic facilities were available.

9. Swimming

In the SCORP analysis, the fresh water swimming inventory includes fresh water rivers, lakes, ponds, and artificial pools. (An analysis of salt water swimming is done separately.) In this report, however, artificial pools are not inventoried, in order to be more representative of the Big River Site.

Fresh water swimming is the third most popular activity surveyed, after sightseeing and salt water swimming. This activity generally takes place close to home, with a mean distance traveled of 7.5 miles. Sixty-five percent takes place within five miles of home, although this may be somewhat attributable to backyard pool swimming.

The comparison between supply capacity and demand for swimming is shown below.

Swimming	Supply Capacity	Demand		
		Present	1995	2020
State	53,792	50,501	74,466	107,777
Local	8,089	2,633	3,883	5,619
Big River	9,450	200	277	401

The supply capacity for the state, although presently adequate, would probably be surpassed by 1980. By 1995 the shortage would be much more severe without additional facilities. Many of the deficiencies, both present and future, are in the Providence metropolitan areas and the Aquidneck/Prudence Island communities in Narragansett Bay.

A substantial surplus of swimming capacity exists in the local area, even without the inclusion of swimming area at the Big River Site. This surplus continues throughout the year 2020. The same is true for the Big River Site.

B. Other Needs

Other needs, such as those associated with forest preservation, archaeological and cultural resources, preservation and enhancement of natural features, and fish and wildlife preservation are addressed in the Environmental Impact Statement and appropriate appendices.

V. ASSESSMENT OF RECREATION OPTIONS

A. Description of the Big River Site

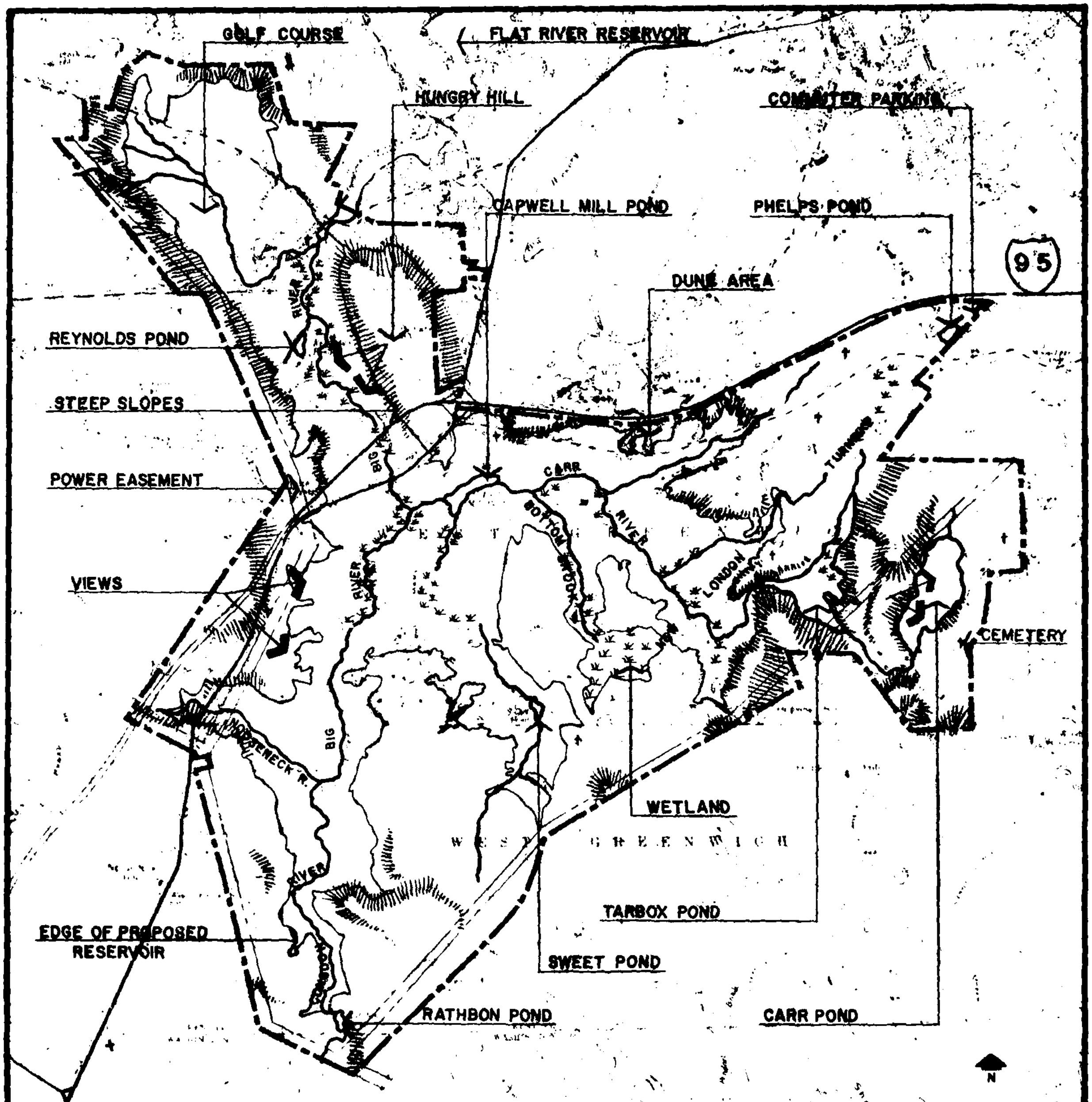
Many of the existing natural and cultural features of the Big River Site are illustrated in Figure 8. The shoreline of the proposed reservoir is also indicated. The existing roadway and trail network through the area provides access to most of these features. Interstate 95 (I-95) borders and crosses over 5-1/2 miles of the site. Interchanges are located on the New London Turnpike in the east and at Nooseneck Hill Road (Route 3) in the center of the site. Access between the northern and southern end of the site is constrained by I-95. In addition to the Nooseneck Hill Road bridge over the highway, a local road passes beneath I-95 west of Big River at Kitts Corner. Other major roads include Harkney Hill Road in the northwest section of the site and Division Street which parallels I-95 in the east. Several other local roads lead to homes in the area. Roads to these homes are plowed in the winter. Many, including sections of the New London Turnpike, are unpaved.

Narragansett Electric has an easement for powerlines along the southeast and west borders of the property. Other features of the site include a a commuter parking lot at the New London Turnpike interchange on I-95, numerous homes and businesses remaining throughout the site, and several historical cemeteries identified by local historical societies.

The location of these cultural features has been determined by the general terrain characteristics. The most notable feature is the extensive network of wetlands, streams, ponds and rivers which forms the Big River watershed. Many of these streams flow in a north or northwesterly direction. The Big, Carr, Nooseneck, and Congdon Rivers and Bottom Brook are identified in Figure 8. Carr and Tarbox Ponds drain into the Carr River which then flows into Capwell Mill Pond before reaching the Big River. Congdon and Nooseneck Rivers flow north to form the Big River. Wetlands are located between the Big River and Carr River, north of Sweet Pond. Most of this watershed is under the ownership of the Rhode Island Water Resources Board (WRB).

Although the terrain is gently rolling with extensive lowland area, there are several steep slopes, identified on Figure 8. Steep slopes are found around Hungry Hill along the west border of the site, in the vicinity of Carr Pond in the east, and south of I-95. The elevation ranges from 250 feet msl along the Big River to 450 feet msl near Carr Pond. The proposed impoundment at elevation 302.5 feet msl will encompass 5.9 square miles or 3,775 acres of lowland.

Unique features have been created by the excavation of sand and gravel. Granular soils, sands, and gravels underlie much of the Big River Site. The sand banks between I-95 and Division Street are known throughout the



BIG RIVER RECREATION STUDY

GENERAL SITE CONDITIONS
BIG RIVER SITE

SCALE: 1" = 4000'	SCHOENFELD ASSOC., INC - ENGINEERS, ARCHITECTS & PLANNERS U.S. ARMY CORPS OF ENGINEERS	FIGURE 8

state as the Rhode Island dunes or desert, an unusual inland feature marked by scrub growth and sandy soil. Phelps Pond, also located south of I-95 near the New London Turnpike interchange and the commuter parking lot, was created by rock excavation.

The Big River Site has been utilized for recreation since the state began purchasing the land in the 1960's. This informal use is described in Section III-B. As indicated, the rivers, streams and ponds are used for boating and fishing, the ponds for swimming, the wetlands and adjacent woodlands for hunting, and the sand dunes and fields by motorcyclists, snowmobilers, hang gliders, and model airplane operators, among others. Easy access via I-95 and state routes has fostered use of the site by local residents.

With the construction of the Big River Reservoir, new features with recreation potential will be created. The most significant will be the two impoundment areas, one north of I-95 and the other to the south. Recreation opportunities in brooks and rivers will be lost, but additional open-water and shoreline recreation opportunities will be created on the reservoir.

B. Plan Identification

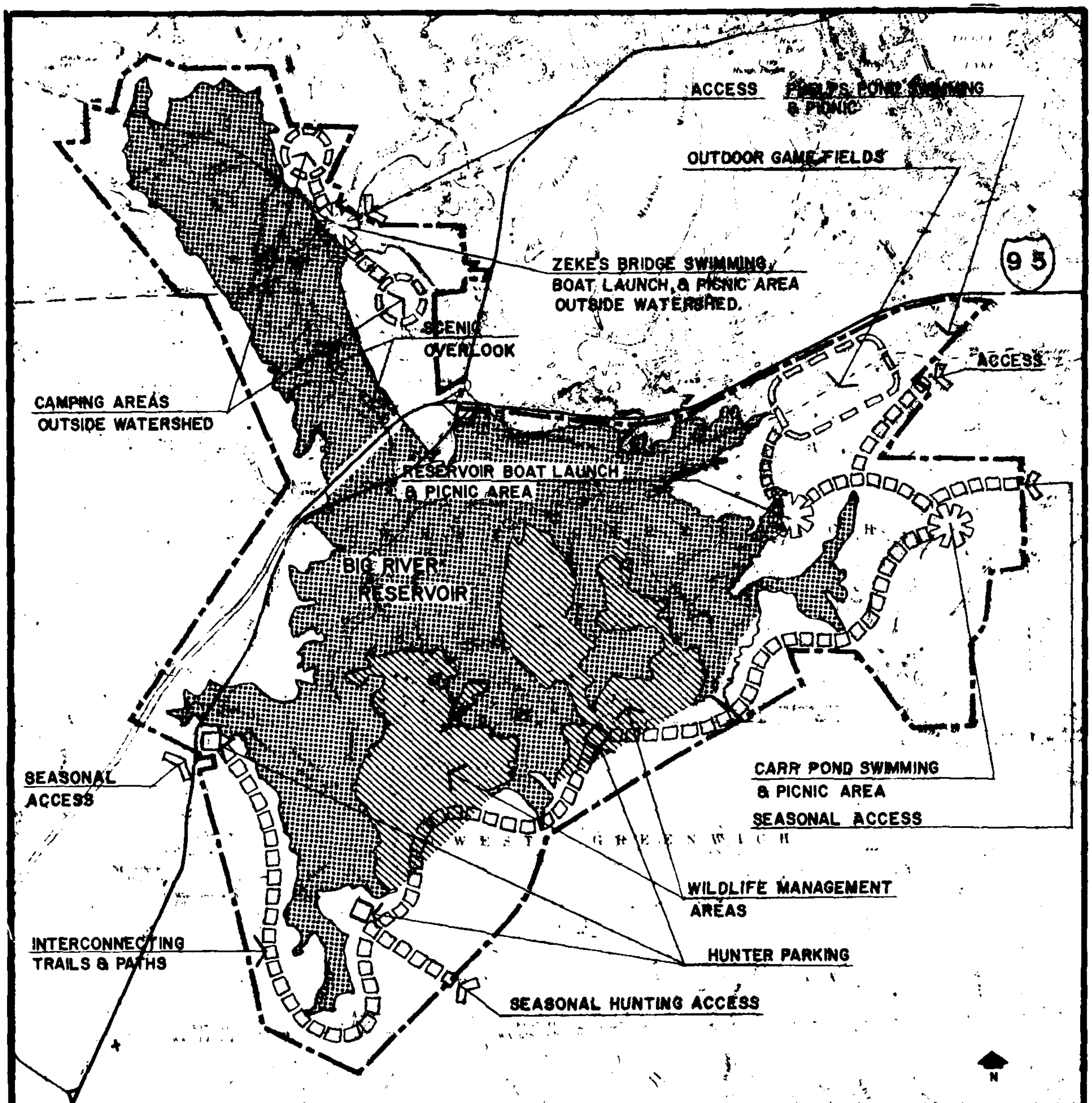
1. Design Parameters

Several parameters have been considered in the design of recreation alternatives or options for the Big River Reservoir. These parameters include the physical features of the site, the safety issue involved in multiple use of public water supply reservoirs, and the demand for recreational use.

a. Site Conditions

Four major sections of the site have physical characteristics which are or will be conducive to recreational development. These include the area around Zeke's Bridge downstream of the proposed dam on Harkney Hill Road, the east shores of the reservoir, the Carr Pond area, and the wildlife management areas south of the proposed reservoir. These and other locations are identified on Figure 9.

The Zeke's Bridge site, located downstream of the proposed reservoir but on WRB property, combines easy access with shore frontage on Flat River Reservoir. In addition to the existing boat launch, swimming and picnicking could also be developed here. Activities could be designed on adjacent hills to provide vistas of the proposed impoundment and the



BIG RIVER RECREATION STUDY

RECREATIONAL OPTIONS BIG RIVER RESERVOIR

SCALE: 1" = 4000'	SCHOENFELD ASSOC., INC - ENGINEERS, ARCHITECTS & PLANNERS U S ARMY CORPS OF ENGINEERS	FIGURE 9

surrounding area. The physical features of the hillside are also suitable for the development of a campground.

Flat River Reservoir is considered by many to be the best largemouth bass pond in Rhode Island. Both boating and fishing are extremely popular on this 659-acre man-made lake. According to the Rhode Island Division of Fish and Wildlife, the reservoir is stocked with northern pike to maintain a favorable ecological balance and to provide increased sport fishing. Other known fish species include yellow perch, bluegill sunfish, pumpkinseed sunfish, eastern banded sunfish, bridle shiner, chain pickerel, and brown bullhead.(38)

Physical features in the east section of the site conducive to recreation use include Carr Pond and the fields along Division Street. This area is easily accessible via the New London Turnpike interchange on I-95. Carr Pond, a popular swimming area, will remain east of and above the proposed impoundment. This pond has the potential for development as a fishing, boating, and swimming area. The fields on Division Street, identified in Figure 9, have potential for the development of such facilities as a model airplane landing strip, target shooting area, horse show rings, and playing fields.

The reservoir itself has potential for recreational development. Although swimming would probably not be permitted within the impoundment, boating and fishing could be allowed. The shoreline of the reservoir is suitable for bank fishing and multi-purpose trails with the east shore of the reservoir developed for access to these activities. A scenic picnic area could be constructed here to tie these activities together. The New London Turnpike interchange on I-95 provides access to this site.

The upland area south of the proposed reservoir is currently managed by the Division of Fish and Wildlife. This area has the potential for more extensive wildlife management facilities and the construction of parking areas for hunters as illustrated in Figure 9. According to the physical characteristics of the area, small game, deer, and waterfowl hunting would be possible here.

b. Multiple Use of Reservoirs

Development of recreation facilities on or adjacent to any public water supply raises the question of impact on water quality. As indicated in Section I-E, Rhode Island law does not expressly prohibit recreation (other than swimming) on reservoirs. Various agencies and associations involved with water supply, however, have adopted positions regarding multiple use of reservoirs.

Since it is unknown which agency would operate the Big River Reservoir, it cannot be ascertained whether future recreational access will be permitted. Any future recreational use of the Big River Reservoir would therefore be subject to the policy of the managing agency. The prime consideration of that agency, however, will be the management and delivery of a safe drinking water supply to the metropolitan Providence area. Recreation would only be permitted if it is determined that there would be no significant effect on health or safety.

c. Recreational Demand

Recreational demand at the Big River Site has been projected with and without construction of the proposed reservoir. Table 18 itemizes this demand by activity for the year 2020. It should be noted, however, that should the Big River Reservoir not be built, the land would probably revert to private ownership. Thus, it is not possible to predict what the actual conditions of the site would be like. Consequently, for purposes of this report, it has been assumed that if the reservoir is not constructed, recreational use of the 8,000 acre site will continue in the same informal and casual manner in which it is now undertaken. The demand figures would then be the same as those described in Section III-C. The supply capacity would remain the same assuming facilities would not change in the no-build situation. Demand, however, would increase as population and income increase.

With construction of a reservoir at Big River, recreational opportunities will change. Various recreational options are discussed later in this section. Options range from one prohibiting all access to the site, to a second outlining a limited recreation plan, and a third calling for maximum recreation development. Under either the second or the third use level option the provision of improved recreational facilities is expected to generate increased demand. As the range of recreational opportunities changes and the condition and supervision of facilities improves, more people are expected to participate.

The design day demand in the year 2020 for boating with construction of the reservoir is estimated to increase from 207 to 300. It is anticipated that more people will want to boat on the open waters of the reservoir than do currently on the narrow rivers and small ponds of the Big River Site.

The design day demand for camping in the year 2020 is estimated to increase from 0 to 100 with reservoir construction. This increase in demand is in recognition of the camping facilities and recreational activities which could be provided at the Big River Site and the statewide shortage of facilities projected for the year 2020.

TABLE 18

Design Day Demand
Year 2020

Activity	Without Reservoir Construction (Number of Persons)	With Reservoir Construction (Number of Persons)
Boating	207	300
Camping	0	100
Fishing	174	300
Hiking	17	50
Horseback Riding	59	75
Hunting	304	350
Picnicking	104	200
Swimming	401	800

It is anticipated that, in the year 2020, 174 people will want to fish at Big River if the reservoir is not constructed. With reservoir construction this number is estimated to increase to 300. The Big River Site, already a popular location for fishing, is expected to increase in popularity with the addition of 3,775 acres of open water. In addition, the Division of Fish and Wildlife has suggested that Carr Pond be reevaluated for trout management.(38) This, together with a stocking program for the reservoir itself, indicates a significant increase in the demand for fishing on the site.

On the design day in the year 2020, 17 people are expected to hike at the Big River Site if the reservoir is not constructed. With construction this number is projected to increase to 50 hikers. This increase is attributable to proposals for better designed, better marked, and better maintained trails.

Design day participation for horseback riding in the year 2020 is expected to be 59 without reservoir construction and 75 with construction. Again, this increase is based upon the design and maintenance of trails.

With reservoir construction, on the design day in the year 2020 it is estimated that 350 hunters will be found within the site. If the reservoir is not built, 304 hunters could be expected to participate in this sport. These numbers are about the same since although there will be better management efforts on the reservoir site and, subsequently, better hunting conditions, the acreage available for hunting would be substantially reduced. It should be noted, however, that game species with construction will differ from those now present on the site. Wildlife management would encourage waterfowl, and upland species would be diminished due to the reduction in dry land area.

The number of picnickers on the design day in the year 2020 is expected to increase from 104 without reservoir construction to 200 with reservoir construction. The increase in use is attributable to improved facilities and better management. Scenic sites will be selected for the placement of picnic shelters, tables and fireplaces. Restrooms and convenient parking lots will also increase the capacity for this activity with reservoir construction.

It is estimated that on the design day in the year 2020, 800 people would want to swim at the Big River Site with reservoir construction, a figure nearly double the 400 who would want to swim without reservoir construction. Beach construction can be justified as a means of controlling this popular activity. Rhode Island SCORP indicates that there will be a shortage of beach frontage both in the local area and statewide in that year. Development of swimming at the Big River Reservoir could help satisfy the demand for this activity.

2. Use Level Options

As indicated, three use level options have been proposed for the Big River Reservoir. Each option has been designed in accordance with the three parameters discussed on page 87 to provide a range of recreational opportunities at the reservoir site. The three options range from no access to development of a large-scale recreation facility.

a. Option I

This use level option would prohibit all access for recreation to the site. None of the existing activities would continue, even on an informal basis. This option is similar to the policy now maintained by the Providence Water Supply Board at the Scituate Reservoir. The public boat ramp at Zeke's Bridge would be closed under this option as it falls within site boundaries (See Section I-E, page 10). This ramp provides access for boating and fishing not only to the Big River but to the very popular Flat River Reservoir as well. The future demand generated by the existing use of the Big River Site would have to be absorbed on an activity by activity basis as described in Section VI-A.

b. Option II

This limited use option has been proposed to illustrate how a range of recreation activities can be included on the Big River Site. (See Figure 9.) These activities have been carefully sited to maximize the use and protection of unique features. This option has also been designed to minimize any impact on the water quality of the reservoir by placing intensive recreation use activities outside the watershed. Most of the demand projected for the Big River Site for future years without construction of the reservoir will be satisfied by Option II. This option therefore represents a successful combination of all three design parameters previously discussed.

Option II provides opportunities for boating, fishing, hiking, horseback riding, hunting, picnicking and swimming at four use areas. The most intensive recreational development will be at Zeke's Bridge, downstream of the reservoir and outside of the public water supply watershed. The Big River Reservoir recreation area, located on the east shore of the impoundment, is reached via the New London Turnpike interchange on I-95. A smaller-scale recreation area is proposed at Carr Pond near the Big River Reservoir recreation area. The fourth area accommodates seasonal access for hunting south of the Big River Reservoir. These sites are identified in Figure 9.

The Zeke's Bridge area would be developed for boating, fishing, picnicking, and swimming. These activities would be centered on the shores of the Flat River Reservoir, northeast of Harkney Hill Road. Additional upland area outside of the public watershed, to be used as a borrow area for the dam, would also be incorporated into this recreation area to provide scenic vistas. Facilities proposed include parking and restroom facilities, 14 picnic tables and fireplaces, two boat ramps, and 250 feet of beach. On a peak or design day in the year 2020 it is estimated that a total of 605 people would use this site.

The Big River Reservoir recreation area, located near the east shore of the impoundment, would serve as an activity center for picnicking, shoreline fishing, and access to a multi-purpose trail system. An office, storage shed, restroom, and parking facilities would also be provided. Eight picnic tables are planned here. The height of land could offer scenic views to the west of the Big River Reservoir. Approximately six miles of trails could provide access to Carr Pond, the southeastern end of the site, and the powerline easement along the west end of the site. This multi-purpose trail system could be used by hikers, horseback riders, and cross country skiers. On a peak day in the year 2020 it is estimated a total of 340 people would enjoy activities centered at the Big River Reservoir recreation area.

At Carr Pond facilities would be limited to the construction of a parking lot and the development of a picnic area. Five picnic tables and fireplaces are proposed. As mentioned above, trails could connect the pond with other use areas on the site. Shoreline fishing along Carr Pond would be permitted. Restroom facilities would be located at the nearby Big River Reservoir recreation area. On a peak day in the year 2020, 83 recreationists could enjoy this site.

Parking facilities south of the reservoir could be open only during the hunting season. This would allow better control of access to the Big River Site during the rest of the year. Three parking areas have been identified on Figure 9. There are 2,000 acres of land suitable for hunting in this section. As indicated in Section III-B, the Division of Fish and Wildlife has future plans for wildlife and waterfowl management. On a peak day during the hunting season in the year 2020, this area could support 350 hunters.

c. <u>Option III</u>

This option has been proposed to illustrate how a maximum development recreation plan can be incorporated into the design and management of the Big River Reservoir. Option III would satisfactorily meet the projected demand for the Big River Site for the year 2020 design day (with reservoir construction) for all proposed activities. This option incorporates all of the features proposed under Option II. In addition, camp sites and game fields are also planned. Under Option II recreation activities were centered in four areas. This number is expanded to include three additional sites at Hungry Hill and Harkney Hill, at Phelps Pond, and at the Division Street field. These sites are identified in Figure 9.

Under Option III a design scheme similar to that proposed for Option II is being considered at Zeke's Bridge. A 250-foot beach, two boat ramps, and fishing are proposed on Flat River Reservoir. The number of picnic tables, however, would be reduced from 14 to 9. On the design day in the year 2020 it is estimated that 564 people would enjoy these facilities.

Camp sites and restrooms are proposed under Option III north and south of Zeke's Bridge on Harkney Hill and Hungry Hill. A total of 25 camp sites could be accommodated on the east side of these two hills, located outside of the Big River Reservoir watershed. Campers could enjoy swimming, fishing, and boating at nearby Zeke's Bridge. This site is easily accessible via Harkney Hill Road and the Route 3 interchange on I-95. On the design day in the year 2020, an estimated 100 people would enjoy these facilities.

Under Option III boating and fishing would be permitted on the Big River Reservoir. A boat launch and dock are proposed at the Big River Reservoir recreation area on the east shores of the impoundment. Other facilities included at this site are five picnic tables, access to six miles of multi-purpose trails, an office, storage shed, and parking and restroom facilities. Portions of the trail network could be used by recreation vehicles, motorcycles, and snowmobiles in addition to hikers, horseback riders, and cross-country skiers. On a peak day in the year 2020 it is estimated that 308 people would be engaged in activities centered at this recreation area.

Activities at Carr Pond would be expanded under Option III to include swimming and boating as well as picnicking, fishing, hiking, and horseback riding. Eight picnic shelters and fireplaces are planned. Swimming is proposed since Carr Pond is not a part of the primary reservoir. Use of this facility could be restricted by providing limited parking. Restrooms are proposed at Carr Pond under this option. It is estimated that 563 people would enjoy this area on a peak or design day in the year 2020.

The same design is proposed for hunting access under either Options II or III. Three seasonal parking areas would serve an estimated 350 hunters on the design day in the year 2020.

At Phelps Pond, another secondary water body not directly connected with the Big River Reservoir, swimming and picnicking are proposed under Option III. A 50-foot beach and 5 picnic tables would provide an opportunity for commuters who have parked at the adjacent lot to relax at the end of the day. It is estimated that on a peak day in the year 2020, 88 people would enjoy this handy beach, located at the New London Turnpike interchange on I-95.

3. Supply Analysis

Big River recreational demand, both with and without the construction of the reservoir, was presented in Table 18 for the year 2020. To satisfy these demands for various activities, a series of use level options was proposed. This section analyzes how successfully these options satisfy this recreational demand.

The year 2020 design day demand for boating at the Big River Site without reservoir construction is 207. With construction of the reservoir, however, 300 people are expected to boat at the site. Four boat ramps are required to satisfy the boating needs of these 300 people. Under Option II, the limited use option, two ramps are proposed downstream of the reservoir on the Flat River Reservoir. Option III provides the four required boat ramps, two downstream of the reservoir, one on the reservoir itself, and one on Carr Pond. Option III therefore fulfills the demand while Option II falls far short.

In the year 2020, 100 people would demand camping facilities on a design day with construction of the reservoir. There is no demand for camping without reservoir construction due to the excess of camping facilities in the local area. The demand for 25 camp sites has been met by Option III with the construction of a campground outside of the reservoir watershed. No camping is proposed under Option II.

As indicated in previous sections, the design day fishing demand for the year 2020 is 174 without construction of the reservoir and 300 with reservoir construction. According to these figures, 11,250 feet of shoreline fishing is needed to support 300 fishermen. The supply proposed under Option II far exceeds this figure since the shoreline of the entire reservoir, Carr Pond, and many of the streams on the site will be accessible to fishermen. In addition, boat fishing on Flat River Reservoir also increases the supply. Under Option III boat fishing is permitted on the Big River Reservoir itself, significantly increasing the available supply.

The design day demand for hiking in the year 2020 without construction of the reservoir is 17 and 50 with reservoir construction. One mile of trail would meet the demand with reservoir construction. However, a 6-mile trail system is the minimum that should be considered to provide changes in terrain, trail interest, and vistas. A 6-mile trail system is planned under both Options II and III.

The design day demand for hunting in the year 2020 is 304 without construction of the reservoir and 350 with reservoir construction. The 350 hunters could be supported by approximately 1,200 acres. Both Options II and III provide 2,000 acres for hunting in an area currently managed by the Division of Fish and Wildlife.

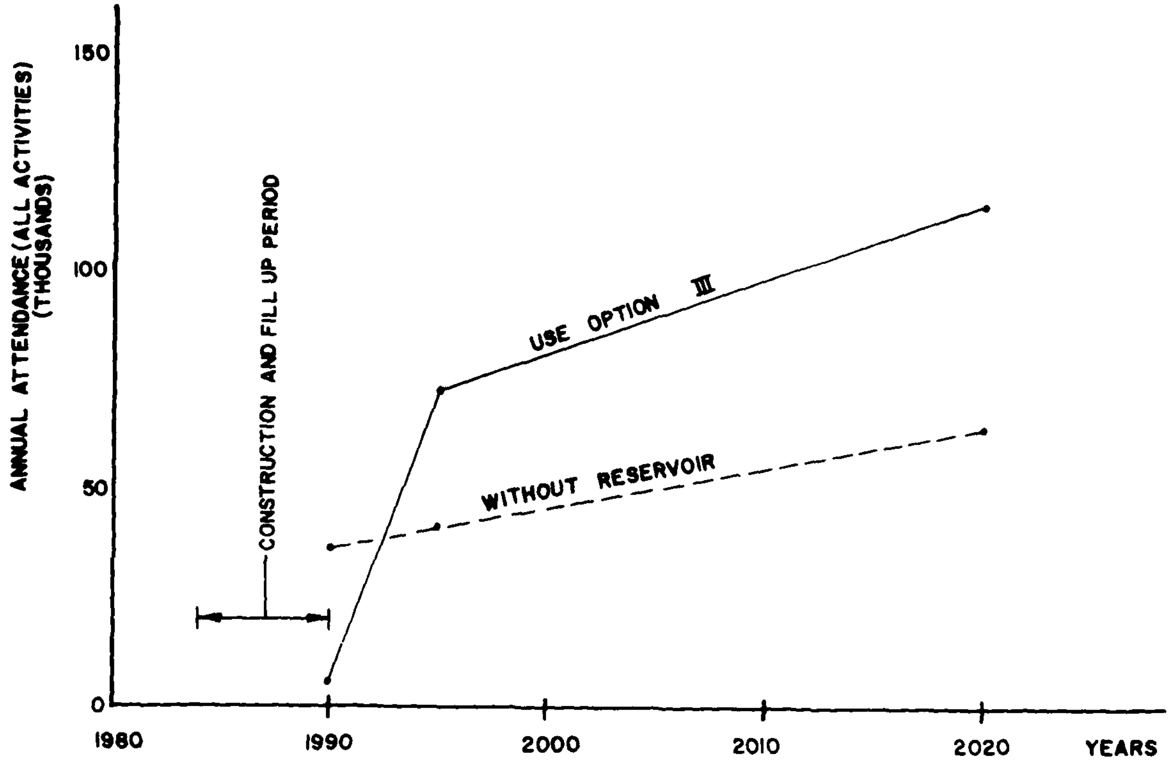
The design day demand for picnicking in the year 2020 is 104 persons without reservoir construction and 200 persons with construction. These 200 picnickers will require 27 picnic tables. Both Option II and Option III provide this number.

The design day demand for swimming in the year 2020 is 401 swimmers without reservoir construction and 800 with reservoir construction. Approximately 700 linear feet of beach is required to support 800 swimmers. Since the highest priority of reservoir management is the assurance of adequate water supply, swimming has been considered only in secondary water bodies or in areas downstream of the reservoir. Under Option II a 250-foot beach is proposed at Flat River Reservoir. This figure is far short of the demand. Option III, however, provides a total of 800 feet of beach at Flat River Reservoir, Carr Pond, and Phelps Pond. No swimming would be permitted under either option on the Big River Reservoir.

C. Outdoor Recreation Attendance

A review of the round trip mileage data for participation in various recreation activities provided in the SCORP indicates that 90 percent of the use of the Big River Site originates within a 30-mile radius. Although data of this type are not available for overnight activity, it is estimated that 50 percent of this use will originate within 40 miles. Further information on market zones broken down by activity can be found in Section IV-A.

Annual attendance at the Big River Reservoir Site was estimated for Options I, II, and III based on expected design day use. By applying the ratio of statewide design day attendance to estimated annual participation for a given activity, annual use was estimated for the Big River Site with and without reservoir construction. It should be noted that design day figures represent peak demand assuming that adequate facilities are provided to support the activity. Figure 10 shows a comparison of growth in demand over time with and without the reservoir.



ANNUAL ATTENDANCE FIGURE 10

The ability of the Big River Site to carry the projected activity levels will be determined by effects on water quality. As discussed in Section I-E, the issue of the effect of recreation on water quality is still a subject of much speculation. It is recommended that studies be conducted at existing water supply reservoirs in Rhode Island to determine the actual safe capacity for recreation. This study analyzes three levels of use based on site characteristics and projected demands to assess impacts on recreation and does not attempt to analyze impacts on water quality.

Annual attendance by activity was estimated for each use level option in order to calculate annual benefits from recreation with and without the reservoir. To facilitate this estimate, values of recreational activities were determined based on existing rates, conversations with local recreation groups, and rates established by federal agencies. For example, a rate of $1.50 per person was established for camping based on the existing rate of $3.00 per camp site charged in Rhode Island state parks assuming use by a minimum of two people per camp site. Activities such as fishing and hunting which do not normally have user fees were estimated according to rates established by federal agencies tempered with a knowledge of the local use of the Big River Site. Values are felt to be representative of the Rhode Island recreationalist's willingness to pay for the major activities occurring at the Big River.

Table 19 shows a breakdown of estimated annual attendance by activity, value of recreation, and annual benefits. Attendance is projected with and without the construction of the reservoir for Options I, II, and III in 1995 and 2020. It is assumed that reservoir construction and fill-up will have been completed by 1990 and that full attendance will be realized in 1995. Apparent from this table is an increase in net annual benefits with an increase in facilities provided. Also apparent is a significant level of negative benefits associated with the extension of the existing no use policy for water supply reservoirs represented by Option I. Net annual recreational benefits are based on a strict comparison of "without" plan conditions verses "with" plan conditions.

All use options for the Big River Reservoir should include natural resource enhancement in the form of tree plantings and landscaping in activity areas, crop planting for wildlife management, animal habitat improvement through the maintenance of open lands and wetlands, and erosion control. These efforts can commence during construction and should be maintained throughout the life of the project.

D. Cost Estimates

Table 20 itemizes costs for recreational facilities associated with Options II and III. Represented are ball park figures for ultimate development to meet projected 2020 design day demands. In the case of Option II, where swimming and boating are limited to areas outside the drainage area of the reservoir, facilities for swimming and boating do not satisfy projected 2020 demand.

TABLE 19

Recreational Benefits

OPTION I	Value of Recreation $	Annual Attendance Without Reservoir 1995	Annual Attendance Without Reservoir 2020	Annual Attendance With Reservoir 1995	Annual Attendance With Reservoir 2020	Net Annual Benefits (Dollars) 1995	Net Annual Benefits (Dollars) 2020
Boating	1.50	5,300	12,200	0	0	- 7,950.00	-18,300.00
Camping	1.50	0	0	0	0	0	0
Fishing	1.00	8,000	10,900	0	0	- 8,000.00	-10,900.00
Hiking	0.75	1,400	1,900	0	0	- 1,050.00	- 1,425.00
Horseback Riding	3.00	2,100	3,700	0	0	- 6,300.00	-11,100.00
Hunting	3.50	5,700	10,500	0	0	-19,950.00	-36,750.00
Picnicking	0.75	4,200	4,200	0	0	- 3,150.00	- 3,150.00
Swimming	2.00	14,600	21,100	0	0	-29,200.00	-42,200.00
TOTAL						-75,600.00	-123,825.00
OPTION II							
Boating	1.50	5,300	12,200	8,800	8,800*	- 5,250.00	- 5,100.00
Camping	1.50	0	0	0	0	0	0
Fishing	1.00	8,000	10,900	12,500	18,750	4,500.00	7,850.00
Hiking	0.75	1,400	1,900	4,400	5,500	2,250.00	2,700.00
Horseback Riding	3.00	2,100	3,700	2,800	4,700	2,100.00	3,000.00
Hunting	3.50	5,700	10,500	6,900	12,100	4,200.00	5,600.00
Picnicking	0.75	4,200	4,200	8,300	8,300**	3,075.00	3,075.00
Swimming	2.00	14,600	21,100	13,200	13,200*	- 2,800.00	-15,800.00
TOTAL						18,575.00	1,325.00

TABLE 19 (Continued)

OPTION III	Value of Recreation $	Annual Attendance Without Reservoir 1995	Annual Attendance Without Reservoir 2020	Annual Attendance With Reservoir 1995	Annual Attendance With Reservoir 2020	Net Annual Benefits (Dollars) 1995	Net Annual Benefits (Dollars) 2020
Boating	1.50	5,300	12,200	8,800	17,600	5,250.00	8,100.00
Camping	1.50	0	0	3,300	6,600	4,950.00	9,900.00
Fishing	1.00	8,000	10,900	12,500	18,750	4,500.00	7,850.00
Hiking	0.75	1,400	1,900	4,400	5,500	2,250.00	2,700.00
Horseback Riding	3.00	2,100	3,700	2,800	4,700	2,100.00	3,000.00
Hunting	3.50	5,700	10,500	6,900	12,100	4,200.00	5,600.00
Picnicking	0.75	4,200	4,200	8,300	8.300**	3,075.00	3,075.00
Swimming	2.00	14,600	21,100	26,300	42,100	23,400.00	42,000.00
TOTAL						49,725.00	82,225.00

* Annual attendance in 2020 is constrained by limited facilities and not by demand.
** *Future picnicking demand is limited; no attendance growth is anticipated in 2020.*

TABLE 20

Tabulation Of Costs

ACTIVITY AREA & COST ITEMS	QUANTITIES Option II	QUANTITIES Option III	UNIT PRICE	COST Option II	COST Option III
1. BIG RIVER RESERVOIR RECREATION AREA					
A. Clearing and Grubbing	1.2 AC	1.5 AC	2,400.00/AC	2,880.00	3,600.00
B. Gravel Parking & Boat Ramp (420 SF/Car)	42,000 SF	50,400 SF	0.50 SF	21,000.00	25,200.00
C. Guard Rail	0	100 FT	14.00/FT	-	1,400.00
D. Docking Facilities	0	120 SF	20.00/SF	-	2,400.00
E. Office & Storage Shed	120 SF	120 SF	50.00/SF	6,000.00	6,000.00
F. Restrooms	240 SF	240 SF	100.00/SF	24,000.00	24,000.00
G. Well	1	1	3,000.00/EA	3,000.00	3,000.00
H. Sewage Disposal System	1	1	10,000.00/EA	10,000.00	10,000.00
I. Picnic Tables with Fireplaces	8	5	300.00/EA	2,400.00	1,500.00
J. Miscellaneous				1,000.00	1,000.00
			SUBTOTAL	70,280.00	78,100.00
2. CARR POND					
A. Clearing and Grubbing	0.5 AC	1.0 AC	2,400.00/AC	1,200.00	2,400.00
B. Gravel Parking Area	5,460 SF	56,700 SF	0.50/SF	2,730.00	28,350.00
C. Beach Construction	0	15,000 SF	0.40/SF	-	6,000.00
D. Picnic Tables with Fireplaces	5	8	300.00/EA	1,500.00	2,400.00
E. Restrooms	0	240 SF	100.00/SF	-	24,000.00
F. Well	0	1	3,000.00/EA	-	3,000.00
G. Sewage Disposal System	0	1	10,000.00/EA	-	10,000.00
H. Miscellaneous				1,000.00	1,000.00
			SUBTOTAL	6,430.00	77,150.00

TABLE 20 (Continued)

ACTIVITY AREA & COST ITEMS	QUANTITIES Option II	QUANTITIES Option III	UNIT PRICE	COST Option II	COST Option III
3. PHELPS POND					
A. Clearing and Grubbing	-	0.5 AC	2,400.00/AC	-	1,200.00
B. Parking Area	Assume Existing Commuter Parking Area Used				
C. Beach Construction, Pond Rehab., and Landscaping	-	1	10,000.00/EA	-	10,000.00
D. Picnic Tables with Fireplaces	-	5	300.00/EA	-	1,500.00
E. Miscellaneous				-	1,000.00
			SUBTOTAL	-	13,700.00
4. ZEKE'S BRIDGE					
A. Clearing and Grubbing	1.2 AC	1 Acre	2,400.00/AC	2,880.00	2,400.00
B. Gravel Parking and 2 Boat Ramps	46,200 SF	42,000 SF	0.50/SF	23,100.00	21,000.00
C. Beach Construction	15,000 SF	15,000 SF	0.40/SF	6,000.00	6,000.00
D. Picnic Tables with Fireplaces	14	9	300.00/EA	4,200.00	2,700.00
E. Rest Rooms	240 SF	240 SF	100.00/SF	24,000.00	24,000.00
F. Well	1	1	5,000.00/EA	5,000.00	5,000.00
G. Sewage Disposal System	1	1	10,000.00/EA	10,000.00	10,000.00
H. Miscellaneous				1,000.00	1,000.00
			SUBTOTAL	76,180.00	72,100.00
5. HUNGRY HILL AND HARKNEY HILL					
A. Clearing and Grubbing	-	2.0 AC	2,400.00/AC	-	4,800.00
B. Parking and Roadways	-	65,000 SF	0.50/SF	-	32,500.00
C. Camp Site Preparation	-	25 Sites	200.00/Site	-	5,000.00
D. Shelters	-	720 SF	15.00/SF	-	10,800.00
E. Fireplaces	-	25	100.00/EA	-	2,500.00
F. Restrooms and Showers	-	1,000 SF	100.00/SF	-	100,000.00
G. Sewage Disposal Systems	-	2	10,000.00/EA	-	20,000.00
H. Wells	-	2	5,000.00/EA	-	10,000.00
I. Miscellaneous				-	2,000.00
			SUBTOTAL	-	187,600.00

TABLE 20 (Continued)

ACTIVITY AREA & COST ITEMS	QUANTITIES Option II	QUANTITIES Option III	UNIT PRICE	COST Option II	COST Option III
6. OUTDOOR GAME FIELDS					
A. Grading	24,200 SY	24,200 SY	0.10/SY	2,420.00	2,420.00
B. Seeding and Fertilizing	24,200 SY	24,200 SY	0.50/SY	12,100.00	12,100.00
			SUBTOTAL	14,520.00	14,520.00
7. HUNTER PARKING AREAS					
A. Clearing and Grubbing	1.5 AC	1.5 AC	2,400.00/AC	3,600.00	3,600.00
B. Gravel Parking Areas	6,300 SF	6,300 SF	0.50/SF	3,150.00	3,150.00
			SUBTOTAL	6,750.00	6,750.00
8. NEW ROADWAYS					
A. Clearing and Grubbing	3.0 AC	3.0 AC	2,400.00/AC	7,200.00	7,200.00
B. Gravel Roadway Construction	6,000 FT	6,000 FT	14.00/FT	84,000.00	84,000.00
			SUBTOTAL	91,200.00	91,200.00
9. NEW PATHS					
A. Clearing and Grubbing	3.0 AC	3,0 AC	2,400.00/AC	7,200.00	7,200.00
B. Path Construction	5 Miles	5 Miles	500.00/Mile	2,500.00	2,500.00
			SUBTOTAL	9,700.00	9,700.00
	TOTAL ESTIMATED CONSTRUCTION COST (1978 Prices)			$275,060.00	$550,820.00

If construction of recreation facilities is performed in two phases, the first to be completed in 1990 and the second in 2005, the following scheduling of construction costs at 1978 prices would pertain.

	Option II	Option III
1987 - 1990	$214,550.00	$429,640.00
2002 - 2005	60,510.00	121,180.00
Total Construction Cost (1978 Prices)	$275,060.00	$550,820.00

Expenditures at these levels would provide adequate capacity over the 30 year period to meet projected recreational demands as indicated for Options II and III. First phase construction, occurring between 1987 and 1990 will satisfy recreational demand until 2005. It is assumed that because demand in 2005 is 78% of demand in 2020, expenditures to satisfy 2005 demand will be 78% of the total construction cost. Annual operation and maintenance costs based on experience with Corps of Engineers facilities are expected to be $25,000.00 for Option II and $55,000.00 for Option III at full development, based on 1978 prices.

VI. IMPACT ANALYSIS OF RECREATIONAL ACTIVITIES

The impact analysis involves an assessment of the effects the proposed reservoir project will have on recreation in the study area. Impacts under the three recreation options (i.e., Option I - no recreation, Option II - limited recreation, Option III - full-scale recreation) are assessed in view of the recreation problems and needs determined from the comparisons of supply and demand discussed in Section IV-A.

A. Big River Site

Recreational demand at the Big River Site is only a small percentage of total statewide demand. Hunting, with the highest percentage of demand, is only four percent of the total for Rhode Island. Consequently, the elimination of recreation at the Big River Site would have, in most cases, minimal impact on the state as a whole. With the inclusion of the recreational facilities falling within the 40-mile study region that are available in Connecticut and Massachusetts, the impact would be even less.

For the local area, however, the elimination of some or all of the recreation which presently takes place on the Big River Site would create a negative impact in some areas. As discussed in Section III-C, data obtained from the diary survey indicate that most of the recreational activities take place within ten miles of home. Elimination of recreation on the Big River Site could thus create shortages of supply along with increased demands on facilities in the surrounding towns. On the other hand, permittal of certain activities could alleviate present or future shortages in the local area.

Each recreational activity on the Big River Site is discussed in conjunction with the three recreational alternatives described above. Where applicable, the comparison of supply capacity with demand is included.

1. Boating

The elimination of the four boat ramps at the Big River Site would reduce the capacity of boating facilities in the local area from 770 to 428 persons. Although the reduction of supply capacity is high, the demand for the Big River Site boat ramps is not. Of the 657 persons boating in the local area on the present design day, only 45 travel to the Big River Site. Thus, should no recreation be allowed on the Big River Site (Option I), the boating facilities in the local area may be only somewhat more crowded on peak days. However, unless additional facilities are provided by 1995, the shortage will be severe. It is important to note that the Zeke's Bridge boat ramp, located within the site, would be eliminated under Option I. This ramp provides public boating (and fishing) access downstream to the Flat River Reservoir as well as upstream to the Big River. According to the Rhode Island Recreation map there is another public boat ramp on the Flat River Reservoir at Route 117 in Coventry.(28)

This shortage of boating facilities could be alleviated by the boat ramps provided by Options II and III. Each boat ramp has a capacity for 86 people. Thus, Option II provides boating facilities for 172 persons, Option III for 344 persons. Although there would still be a shortage of boating facilities in the local area, the deficiencies would be reduced.

2. Camping

The elimination of the limited unauthorized camping activity which occurs on the Big River Site would have no impact on camping in the local area.

The addition of the camping area in Option III would slightly offset the shortage of camping facilities expected for the state by 1995. For the local area, although there are no shortages expected in the foreseeable future, there may be more of a demand for the type camp sites provided at the Big River Site under Option III. These camp sites would provide a rustic setting with a variety of activities, and would be open to the public. Many of the campgrounds inventoried, such as Horsemen's Camp, Beach Pond Camps, and YMCA or scout camps, are special interest camps or are available for only a limited season.

3. Fishing

The elimination of recreation at the Big River Site under Option I would probably impact fishing in the local area. The subtraction of 360 from the total supply capacity of 6,176 for the local area would not appear to create a significant impact. However, the present demand for the Big River Site (100) is almost one-third that of the present demand for the local area (330). Thus, the quality of fishing on the Big River Site is probably superior to that of many lakes and ponds in the local area.

Options II and III allow fishing at Zeke's Bridge and along the shoreline of the proposed reservoir and Carr Pond. Under Option III, fishing is also permitted from boats on Carr Pond and on the reservoir. Assuming the quality of fishing is the same as or superior to present fishing on the Big River Site, many who presently fish the site would continue to go there, as would many others who presently fish in the local area or immediate study region. Those who presently prefer the stream fishing the Big River Site offers may not, however, be satisfied by the lake fishing of the reservoir area. These fishermen would tend to travel to other streams or rivers in the local area. It is not expected that this would create problems or overcrowding.

4. Golf

Should the proposed Big River Reservoir be constructed, the Coventry Pines Country Club would be eliminated. Moreover, there are no provisions in any of the recreation plans for additional golfing facilities, due to the large amount of land and maintenance required. The present capacity of golfing facilities in the local area only slightly exceeds demand. Thus, the 175 to 200 people playing golf on a peak Sunday would be forced to go to other courses, possibly resulting in overcrowding. The market area of Coventry Pines is generally west of Providence and north of Coventry. As most golfers generally prefer to play near home, the other golf courses in those areas would probably experience the greatest impact.

Golfing is the only activity on the Big River Site for which a business is presently operating. All other activities are done on a casual, relatively unsupervised basis. Only golfing requires payment of a fee, or provides employment for other prople. Minimum daily greens fees at Coventry Pines are $3.00 for nine holes and $5.00 for eighteen holes. There are no membership dues. There are five full-time employees, including the owner. The total payroll is approximately $25,000 for the nine-month season. Other facilities include an equipment shop and a snack bar.

Figures for annual revenue are not available. However, the Town of Coventry receives no tax revenue from the golf course, as it is on land owned by the state. Thus, the closing of the golf course would have no impact on the town tax base.

5. Hunting

Should there be no access to the Big River Site, the local area would lose almost 50 percent of its prime hunting area. As approximately 75% of the hunting in the local area takes place at Big River, other management areas and private hunting areas in the local area and immediate study region may experience increased use. Arcadia Management Area would probably receive the greatest number of Big River hunters.

Under Options II and III, many of these potential impacts could be mitigated. Approximately 2,000 acres managed by the Division of Fish and Wildlife would be open to hunters. This area would satisfy most of the demand for the local area projected for 2020. Although the acreage available for this sport would be reduced compared to existing conditions, increased wildlife management techniques would result in increased usage in the future. Despite more intensive recreation development of adjacent areas under Options II and III, use of those areas would be limited during the fall hunting season. Hunting in the designated areas should have no effect upon safety.

6. Model Airplane Flying

Under Options I and II, model airplane flying would no longer be permitted on the Big River Site. Under Option III, however, the open recreation area near Division Street would allow basically the same level of use for model airplane flying as presently exists. Thus, there would be no impact.

7. Outdoor Game Fields

Although the three outdoor game fields presently located on the Big River Site would be eliminated entirely, there should be no impact on surrounding facilities. The Town of Coventry, in which the fields are located, has a number of other outdoor game fields of the same or better quality as those found at the Big River Site. In addition, the open recreation area provided in Option III would allow a number of areas for ball playing and other outdoor games.

8. Picnicking

Under Option I, picnicking on the Big River Site would no longer be permitted. Although there are no picnic facilities presently on the site, those people who picnic in conjunction with other activities probably would tend to go to other recreation areas. Arcadia and Beach Pond State Parks may experience some increased use.

There is presently a surplus of picnic facilities in the local area. The increase in demand up to 2020 is not expected to be large, so the supply would continue to be fairly adequate. In 2020, the demand begins to exceed the supply. Under Options II and III, picnic facilities are provided on the Big River Site with a capacity for approximately 200 persons. These additional facilities should satisfy the demand projected through 2020 and should mitigate any potential impacts. The shortage of facilities throughout the state which currently exists would also be lessened slightly.

9. Swimming

Should swimming not be allowed on the Big River Site, the local area would experience little effect, as there is an adequate supply of beach frontage through 2020. Many of those who presently swim at Carr Pond, however, come from urban areas such as Providence, where a shortage of swimming facilities presently exists. These areas may experience additional overcrowding, as there is already a shortage of facilities.

This impact would be mitigated under Options II and III. Swimming is provided for approximately 250 people at Zeke's Bridge under Option II, and for 800 people at Zeke's Bridge, Phelps Pond, and Carr Pond under Option III. Under the latter plan, the facilities would not only satisfy future demand for the local area, but would also alleviate some of the shortage at the state level as well.

10. Trails

a. Hiking

Due to the extensive number of trails in the local area, there would be no impact on hiking should recreation be prohibited on the Big River Site. Moreover, six miles of multi-use trails are provided under Options II and III, which would increase the supply capacity even more.

b. Horseback Riding

Although over one-third of the demand for horseback riding in the local area occurs at the Big River Site, the extensive number of trails in the area should accommodate the additional demand, if recreation is prohibited. In addition, horseback riding would be permitted on the multi-use trails provided at the site under Options II and III. Thus, no impact would occur for horseback riding.

Should the Big River Reservoir be constructed, the site would no longer be suitable for fox hound hunting. This would affect approximately twenty people.

c. Motorcycling

The sand banks and many of the trails that are popular for motorcycle riding would fall within the flooded area. Although portions of the multi-use trails provided under Option III can be used by motorcycles and recreational vehicles, the trails would not satisfy present demand for a peak day. In addition, they would not provide the open areas and rugged terrain presently enjoyed by motorcyclists. The only other public area in the local area which permits motorcycle riding is Arcadia Management Area, which provides 50 miles of trails for this purpose. This area would probably experience increased use.

d. Snowmobiling

The Big River Site presently provides approximately 30 miles of trails suitable for snowmobiling. This is over 50 percent of the total supply in the local area. Snowmobiling is presently a popular sport at the site, and as only four areas in the local area permit snowmobiling, there would be some impact under Option I or II.

Under Option III, portions of the proposed 6-mile trail could be used for snowmobiling in the winter. This would help to mitigate any potential impact.

11. Winter Activities

Generally, the number of people who participate in winter sports on the Big River Site is limited. Subsequently, there should be little impact on local facilities should recreation not be permitted after construction of the reservoir.

Under Options II and III, the winter activities which presently occur on the Big River Site would still be permitted. Only tobogganing would no longer occur, as there would be no appropriate areas that would be accessible. Ice skating would be permitted at all ponds where swimming is permitted. Cross-country skiing and snowshoeing would be permitted on the multi-use trails.

12. Other Activities

The number of people presently participating in sightseeing, hang gliding, target shooting, dog training, and mushrooming are not substantial, and should not have an impact on local area resources, should recreation not be allowed. Except for hang gliding, there are a number of other areas near the site where these activities could take place.

Under Options II and III, sightseeing would be permitted in all accessible areas. An overlook on Hungry Hill would be provided. The open recreation area proposed under Option III could be used for a variety of activities, including target shooting and dog training. Mushrooming could still be done in the Carr Pond area and along the hiking trails. There would, however, no longer be any areas on the reservoir site which would be appropriate for hang gliding.

B. Alternative Water Supply Diversions

Construction of any of the alternative water supply impoundments or diversions proposed in conjunction with the Big River Reservoir will impact recreation opportunities. Secondary reservoir impoundments are proposed on the Wood River, Bucks Horn Brook, and Moosup River. Water from these impoundments would be transmitted by pipeline to the Big River Reservoir. Only water from the Big River Reservoir will be used directly as a municipal water supply.

Since it has not been determined which agency will operate the water supply facilities, the policies concerning recreation are not known at this time. If no access is permitted at secondary reservoirs, all recreational activities which presently occur on the alternative sites would be prohibited. These activities are described in Section III-B. This could cause significant impacts, particularly at Wood River. Should recreation be permitted, some of these impacts could be mitigated.

From an assessment of the policies of the Rhode Island Water Resources Board and Providence Water Supply Board, it has been assumed that swimming, bathing, and dumping will be prohibited on surface waters of these impoundments, but that boating and fishing will not be restricted. It has also been assumed that camping and hiking will be permitted on the watersheds of these secondary reservoirs. The following assessment of impacts is based upon conceptual stage planning of these reservoirs; a more detailed assessment will not be possible until a detail of the proposed shoreline and roadway access is plotted on an accurate plan of recreation features.

1. Wood River Reservoir

Recreation impacts would be most significant for the 1.4-square mile impoundment at the proposed Wood River Reservoir, where recreational facilities have been developed extensively in Beach Pond State Park and Arcadia Management Area. This impact would be minimized if local access is maintained over Plain Road, an east-west roadway crossing the Wood River, Frosty Hollow Road, a north-south roadway east of the Wood River, and Barber and Old Ten Rod Roads, two east-west roadways in the vicinity of the proposed structure. These roads are used for vehicular access and horse and bike trails. Both the Brook Trail, adjacent to the Wood River, and Midway Trail, extending between Plain Road and Barber Road, would be eliminated by the impoundment. Both are marked horse trails. A section of the Breakheart Trail, a hiking trail, would require relocation where it crosses the Wood River. Other trails may also require relocation.

The Frosty Hollow camping area may require relocation above the water level. Buildings at Beach Pond Camps, however, should not be affected by the impoundment.

Hunting activities should not be disrupted although several of the Division of Fish and Wildlife management fields would be flooded. Rivers and ponds which are stocked with trout will be affected by the proposed impoundment. The Flat River, Wood River, and Frosty Hollow Pond would be changed into lake habitat for fishing. Breakheart Pond would not be affected although a short section of Breakheart Brook would be incorporated within the impoundment.

Adequate flow must be maintained from the impoundment or from the diversion of Wood River to assure that recreational activities downstream of the site are not adversely affected. Recreation facilities on the Wood River, a stocked trout stream between the Arcadia Management Area and Alton, a village in Richmond, include several public fishing areas and state boat launches. The Wood River flows into the Pawcatuck River, a waterway which forms the state line between Stonington, Connecticut and Westerly, Rhode Island. A fish ladder is located on the Pawcatuck River in Westerly.

2. Bucks Horn Brook Reservoir

At this conceptual stage it appears that construction of a reservoir on the Bucks Horn Brook could flood a section of the Trestle Trail, which could disrupt the continuity of the eight-mile trail system. To maintain this continuity, this section would require relocation to the northern shore, closer to Route 117. Since Bucks Horn Brook flows into Moosup River, flow diversion would cause the same downstream effects as those described for the Moosup River below. Any reduced flow on Bucks Horn Brook could also affect the trout habitat along areas of that stream that are stocked.

3. Moosup River Reservoir

Construction of the 0.8-square mile reservoir could affect recreation activities on both the Moosup River and Carbuncle Pond. Recreational activities on these waterbodies would change from river/pond to lake-type. Both are stocked with trout by the Division of Fish and Wildlife. The boat launch on Carbuncle Pond would require relocation to maintain boating access to this reservoir. The Trestle Trial over the Moosup River would not be affected by construction of this facility since it is more than 20 feet above the elevation of the impoundment.

Adequate flow must be maintained downstream of the proposed impoundment to avoid adversely affecting existing recreation facilities on the Moosup River in Connecticut. The Moosup River is stocked with trout in both Rhode Island and Connecticut.(40) The Moosup River flows from the Quinebaug into the Thames River before reaching Long Island Sound at New London.

C. Recreation Impacts During Construction

Construction of the Big River Reservoir and an associated diversion project will take three years. An additional three years will be needed to fill the Big River Reservoir to capacity, elevation 302.5 feet msl. During this six-year period, recreational access on the construction site(s) will be prohibited. The effect upon recreation at the Big River Site would therefore be the same as the long-term impact anticipated under Option I, discussed previously in Section VI-A. If it is the decision of the agency charged with operating the Big River Reservoir to allow recreational use of the site, the recreation impact during construction would be short-term in scope.

Recreation impacts during construction of the alternative diversions also vary according to the agency responsible for operation. If future recreational access will be permitted, construction impacts will be short-term in duration and limited to the immediate construction site. During construction of the impoundments, access would be prohibited in the vicinity of the dam itself and in the area to be flooded where clearing and grubbing operations would be underway. Fishing would therefore be prohibited on the Wood and Flat River, on Frosty Hollow Pond, and on a section of Breakheart Brook at the Wood River Reservoir site. During construction of the Moosup River Reservoir, fishing would be prohibited within the site on both the Moosup River and Carbuncle Pond. Access would also be denied to the Bucks Horn Brook Reservoir construction site. Any trails through the area to be flooded at any of the impoundment sites would require relocation at this time to maintain continuity. Construction of diversion facilities on the Flat River and on the Wood River would cause minimal disruption to recreation.

If recreation is to be prohibited on the impoundments and on adjacent land, impacts during construction would be the same as those previously described in Section VI-B Construction would result in long-term impacts upon recreation. Recreation demand would therefore have to be absorbed by other facilities.

Construction of the dam and associated clearing and grubbing activities could result in adverse water quality impacts downstream of the construction site(s). This short-term impact could affect the quality of water for fishing and swimming in the Flat River Reservoir downstream of Big River and in the Wood or Moosup Rivers or Buck Horn Brook. Any reduction of flow on these water bodies during filling and/or diversion operations could also adversely affect recreation potential downstream.

Due to Rhode Island's high population density, most construction workers will probably live within commuting distance of the Big River Site. Recreation demands during the construction period, therefore, will not be increased by a short-term increase in local population.

REFERENCES

1. Rhode Island Statewide Planning Program, "The Potential Values and Problems in Using Water Supply Reservoirs and Watersheds for Recreational Purposes," Technical Paper #47, Providence, Rhode Island, November, 1974.

2. Peavy, Howard S. and Matney, Claud E., "The Effects of Recreation on Water Quality and Treatability," Drinking Water Quality Through Source Protection, Robert B. Pojasek, Editor, Ann Arbor Science Publications, Inc., Ann Arbor, Michigan, 1977.

3. U.S. Army Corps of Engineers, New England Division, Water Resources Development by the U.S. Army Corps of Engineers, 1977, Waltham, Massachusetts.

4. New England River Basins Commission, Report of the Southeastern New England Study - Regional Report, December, 1975.

5. Rhode Island Water Resources Board, Statement of Policy, Providence, Rhode Island, April, 1978.

6. Calice, Peter, Water Resources Board, Providence, Rhode Island, Telephone Conversation, September 5, 1978.

7. Rhode Island Office of State Planning, Position Paper - Big River Reservoir, Providence, Rhode Island, September 7, 1978.

8. Providence Water Supply Board, Big River Policy Statement, September 7, 1978.

9. University of Rhode Island, "Selected Chronology of the Big River Reservoir," Public Participation Workshop, Providence, Rhode Island, September 7, 1978.

10. Beekman, John, Forester, Providence Water Supply Board, Providence, Rhode Island, Telephone Conversation, September 15, 1978.

11. Rhode Island Statewide Planning Program and Rhode Island Department of Natural Resources, Plan for Recreation, Conservation and Open Space, Report No. 28, Providence, Rhode Island, January, 1976.

12. Lincoln, Frederick C., Migration of Birds, U.S. Fish and Wildlife Service, Washington, D.C., 1950.

13. Griffiths, Lucy W., *One Hundred Years of Rhode Island Agriculture (Statistics and Trends)*, Bulletin 378, January, 1965.

14. Rhode Island Statewide Planning Program, "State of Rhode Island Selected Population and Area Data by Census Tract, for 1960 and 1970," Technical Paper #48, Providence, Rhode Island, January, 1975.

15. Rhode Island Statewide Planning Program, "Rhode Island Population Projections by County, City and Town," Technical Paper #25, Providence, Rhode Island, April, 1975.

16. U.S. Department of Commerce, Bureau of Economic Analysis, *1972, Series E OBERS Projections*, Washington, D.C., 1972.

17. State of Connecticut Department of Environmental Protection, *State Comprehensive Outdoor Recreation Plan*, July, 1978.

18. Rhode Island Statewide Planning Program, "Rhode Island Socio-economic Projections: The State, Cities and Towns and Analysis Zones, 1980-2000," Technical Paper #73, Providence, Rhode Island, July, 1978.

19. New England River Basins Commission, *Report of the Southeastern New England Study 8. Pawtuxet Planning Area Report*, December, 1975.

20. New England River Basins Commission, *Report of the Southeastern New England Study 10. Pawcatuck Planning Area Report*, December, 1975.

21. New England River Basins Commission, *Report of the Southeastern New England Study 9. Narragansett Bay and Block Island Planning Area Report*, December, 1975.

22. New England River Basins Commission, *Report of the Southeastern New England Study 7. Blackstone and Vicinity Planning Area Report*, December, 1975.

23. Massachusetts Department of Natural Resources, *Massachusetts Outdoor Recreation Plan*, Boston, January, 1973.

24. Central Massachusetts Regional Planning Commission, Telephone Conversation, October 3, 1978.

25. Micky Chateau, Metropolitan Area Planning Council, Telephone Conversation, October 4, 1978.

26. Marie Gooch, Southeastern Regional Planning and Economic Development District, Telephone Conversation, October 4, 1978.

27. Massachusetts Office of State Planning, "Massachusetts Population Projections Age Groups and Sex," (master copy, unpublished).

28. Rhode Island Department of Natural Resources, "Rhode Island Recreation Map," undated.

29. Connecticut Department of Environmental Protection, "Map of Connecticut," 1977-1978.

30. Massahcusetts Department of Public Works, "Official Transportation Map," 1977-1978.

31. Rhode Island Department of Economic Development, "Boating in Rhode Island," undated.

32. Commonwealth of Massachusetts Public Access Board, "Public Access to Waters of Massachusetts," 1974.

33. Rhode Island Department of Economic Development, "Camping in Rhode Island," 1978.

34. Connecticut Campground Owners Association, "Connecticut Campgrounds", 1978.

35. Connecticut Department of Environmental Protection, Parks and Recreation Unit, "Camping in Connecticut," undated.

36. Massachusetts Association of Campground Owners, "Massachusetts Camping Guide," 1978.

37. Massachusetts Department of Commerce and Development, Division of Tourism, "Guide to Massachusetts Campgrounds and Recreation Areas," undated.

38. Gutherie, Richard C. and Stolgitis, John A., Fisheries Investigations and Management in Rhode Island Lakes and Ponds, Fisheries Report #3, Rhode Island Division of Fish and Wildlife, February, 1977.

39. Rhode Island Department of Environmental Management, "1978 Rhode Island Fishing Laws."

40. Connecticut Department of Environmental Protection, "Connecticut Hunting, Trapping and Fishing," 1975, 1976.

41. Massachusetts Division of Fish and Game, "Stocked Trout Water in Massachusetts," undated.

42. *The Boston Globe*, "Guide to Fresh Water Fishing," undated.

43. Rhode Island Department of Economic Development, "Golfing in Rhode Island," undated.

44. Connecticut Department of Commerce, "Connecticut Golf Courses," 1978.

45. Massachusetts Department of Commerce and Development, "Massachusetts Golf Courses," 1977.

46. Rhode Island Division of Fish and Wildlife, *A Hunting Guide to Rhode Island Wildlife Management Areas*, undated.

47. Connecticut Department of Environmental Protection, "Wildlife Management Areas," undated.

48. Massachusetts Division of Fisheries and Game, *Guide to Wildlife Management Areas*, Westborough, Massachusetts, undated.

49. Connecticut Department of Environmental Protection, Parks and Recreation Unit, "Pachaug State Forest: Green Falls Area Recreation Map, H.H. Chapman Area, and Frog Hollow Horse Camp," undated.

50. Rhode Island Department of Natural Resources, "Rhode Island's New Snowmobile and Recreational Vehicle Law," 1971.

51. Appalachian Mountain Club, *A.M.C. Massachusetts and Rhode Island Trail Guide*, Boston, 1978.

52. Rhode Island Department of Natural Resources, "Arcadia Management Area: Horse Trail, Foot Trail and Motor Bike Trail Maps," 1975.

53. Connecticut Department of Environmental Protection, Parks and Recreation Unit, "Snowmobiling in Connecticut." undated.

54. Rhode Island Division of Fish and Wildlife, "Trout Hatchery Consideration - Proposed Big River Reservoir."

55. Anderson, Arthur Roy, Coventry Pines Country Club, Telephone Conversation, September 21, 1978.

56. Lapinski, Michael L., "Wildlife Management Proposal for Big River Reservoir," Rhode Island Division of Fish and Wildlife.

57. Rhode Island Water Resources Board and Narragansett Electric Company, Easement Agreement, December 16, 1977.

58. Vermont Agency of Environmental Conservation, Vermont State Comprehensive Outdoor Recreation Plan, 1973.

59. Rhode Island Department of Environmental Management, "Analysis of Rhode Island Diary Surveys," Technical Paper #4, August, 1978.

60. State of Connecticut Department of Planning and Energy Policy, Population Projections for Connecticut Planning Regions and Towns 1980-2000, June, 1976.

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX H

RECREATION AND NATURAL RESOURCES

Section 2 - Aquatic Ecosystem Assessment

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

AQUATIC ECOSYSTEM ASSESSMENT REPORT
BIG RIVER RESERVOIR
RHODE ISLAND

Prepared for

New England Division
U. S. Army Corps of Engineers

Contract #DACW 33-78-C-0362

By

Normandeau Associates, Inc.
Bedford, New Hampshire

Principal Contributors

David M. Coon
Cynthia L. Prior
Dennis Sasseville
Suzanne G. Shevenell
William F. Trumpf

January 1979

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

LIST OF TABLES

AQUATIC ECOSYSTEM ASSESSMENT REPORT
BIG RIVER RESERVOIR
RHODE ISLAND

1.0 INTRODUCTION

The State of Rhode Island has requested the New England Division of the U.S. Army Corps of Engineers to evaluate the feasibility and environmental impacts of constructing a dam across the Big River in southern Rhode Island. The dam would form the Big River Reservoir.

The multi-purpose Big River Reservoir would be located in the towns of Coventry and West Greenwich, Rhode Island, and would provide supplemental water supply for the Providence service area. At the time of this study it is proposed that the reservoir would have a surface area of approximately 5.9 square miles at an elevation of 302.5 ft (msl). It is estimated that approximately 2.5 feet additional storage capacity would be required above the water supply pool for flood control purposes. Preliminary investigations indicate that the dam, located in the vicinity of Harkney Hill Road, would be about 2300 feet long and approximately 65 feet above stream bed.

Water treatment facilities would be provided near the dam and a transmission main would convey furnished water to the West Warwick shaft of the existing Providence Water Supply Board aqueduct.

Storage capacity would also be provided in the Big River Reservoir to store water pumped from several diversion works and would be the central impoundment from which the water supply would be drawn. Diversions under consideration for serving as alternatives to the proposed Big River Reservoir include 1) a diversion from the Flat

River, 2) Wood River Reservoir, 3) Wood River diversion, 4) Bucks Horn Brook Reservoir, 5) Moosup River Reservoir, 6) ground water resources, and 7) no action.

A preliminary inventory of the Big River Reservoir area, which included surveys of the vegetation, wildlife and aquatic biota, was published by KAME (1976). The aquatic biota inventory included sample collections of benthic macroinvertebrates, herptiles and finfish. In addition, the physical characteristics were described at each sampling location.

The present study was designed to evaluate and describe the physical and chemical characteristics of the Big River Reservoir area in addition to other major aquatic parameters which were not evaluated by KAME (1976).

The primary objective, therefore, was to collect information from field surveys in order to accurately describe the existing water quality and physical features of the major streams and ponds and identify any existing or potential sources of point and non-point pollution. In addition, an inventory of the existing aquatic biota was conducted which included analysis of the phytoplankton, periphyton, zooplankton, benthic macroinvertebrate, herptile and finfish communities.

Information obtained from a literature search and from interviews with State agencies supplemented the field data in conducting a comprehensive evaluation of the Big River Reservoir area and the alternate sites.

2.0 DESCRIPTION OF THE PHYSICAL FEATURES AND WATER QUALITY OF THE STUDY AREA

GENERAL

The proposed Big River Reservoir would be located in the towns of Coventry and West Greenwich Rhode Island and would contain a surface water area of approximately 5.9 square miles at 302 ft (msl). The proposed area to be inundated is composed primarily of hardwood and hardwood-softwood mixed forests. The primary rivers within the inundation area include Big River, Carr River, Nooseneck River and Congdon River and their associated tributary streams. In addition, two ponds (Tarbox Pond and Capwell Mill Pond) are also located within the reservoir area.

Kame (1976) established eight sampling locations on the major rivers and ponds within the Big River study area. During the present study, seven sampling locations were surveyed which included six of the original locations identified by Kame (1976). The locations sampled during the present study (Figure 2.0-1) were Flat River Reservoir (Location 1), Tarbox Pond (Location 2), Capwell Mill Pond (Location 3), Big River (Location 4), Carr River (Location 5), Nooseneck River which included Location 6 (within the proposed reservoir area) and Location 7 (outside the boundary of the proposed reservoir area). Subsequently, the sampling locations were classified according to Odum (1971) as lentic habitats (standing water, i.e, lakes and ponds) and lotic habitats (running water, i.e., streams and rivers). Lentic habitats included Flat River Reservoir, Tarbox Pond and Capwell Mill Pond; the lotic habitats were Big River, Carr River and Nooseneck River.

2.1 PHYSICAL CHARACTERISTICS OF THE LENTIC HABITATS

A morphometric survey was conducted on Tarbox Pond and Capwell Mill Pond. Water depths were recorded with a sounding line at regular

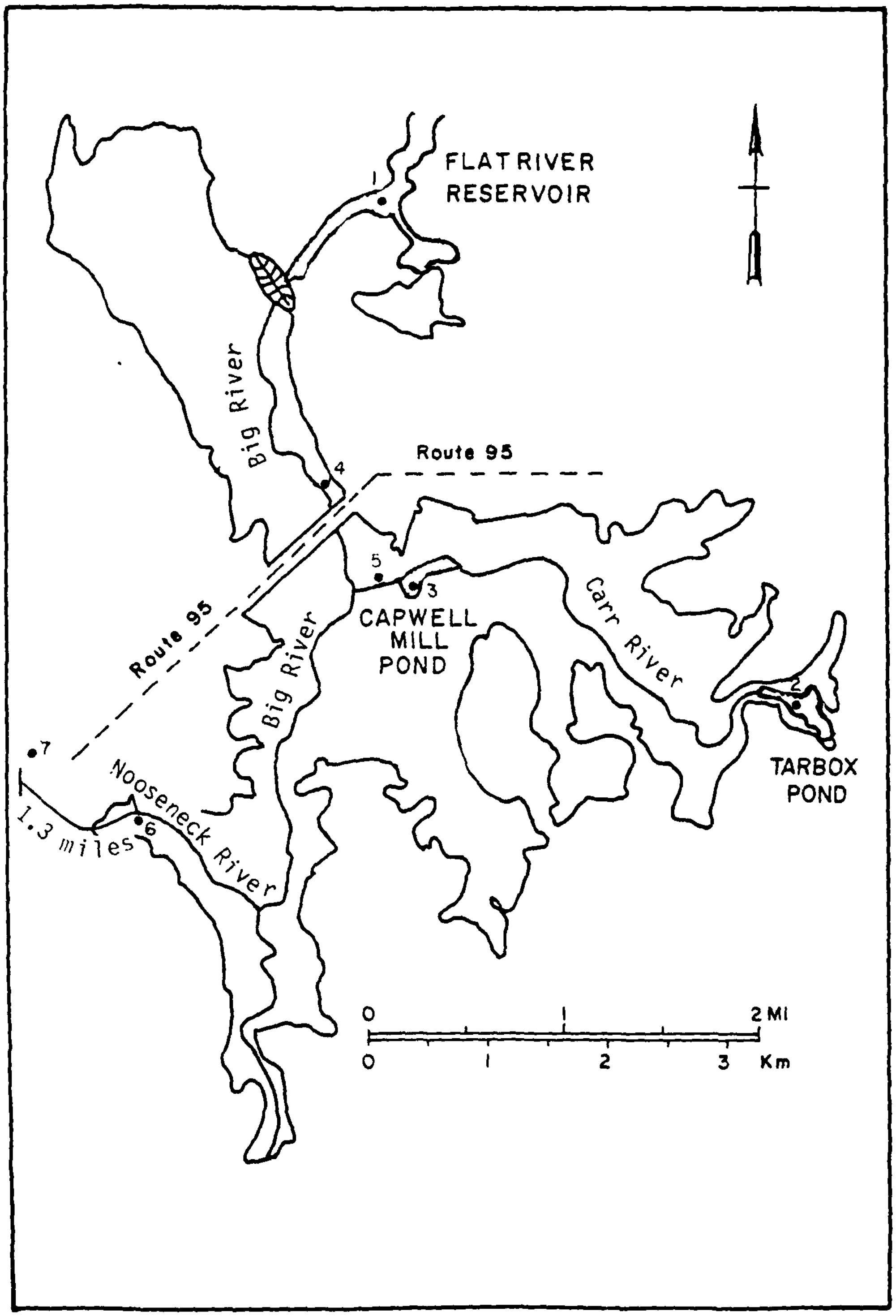


Figure 2.0-1. Sampling locations within the proposed Big River Reservoir area, Rhode Island, 1978.

intervals along several transects of each pond. Bathymetric contours were subsequently plotted and average depth, maximum depth and volume of water were calculated. Surface area was determined from USGS topographic maps. Photographs were taken of the ponds from USGS topographic maps and enlarged approximately 5 times for presentation purposes.

Flat River Reservoir (Location 1)

A recent morphometric survey of Flat River Reservoir by Guthrie and Stolgitis (1977) obviated the necessity of an additional survey during this study.

Sampling was conducted in the southern arm of the reservoir and north of Zekes Bridge. Water quality and aquatic sampling was performed to determine the characteristics of an existing reservoir in order to project the potential physio-chemical and aquatic components of Big River Reservoir.

Tarbox Pond (Location 2)

Tarbox Pond is located in the extreme eastern section of the proposed Big River Reservoir. The pond was formed by the construction of a dam across the Carr River, which flows through the pond. The pond has a surface area of 17.51 acres and is typical of many small Rhode Island ponds (Guthrie and Stolgitis 1977) having an average depth of 3.3 ft, a maximum depth of 10 ft and a water volume of 2,517,000 ft^3 (Table 2.1-1).

The bathymetric contours (Figure 2.1-1) identified a small basin located in the western arm of Tarbox Pond; the remainder of the pond was uniform in depth ($\leq$ 3 ft).

TABLE 2.1-1. MORPHOMETRY DATA OF TARBOX POND AND CAPWELL MILL POND, BIG RIVER RESERVOIR AREA, RHODE ISLAND, AUGUST 1978.

	Surface Area*			Average Depth		Maximum Depth		Volume	
	Ft^2	M^2	Acres	Ft	m	Ft	m	Ft^3	m^3
Tarbox Pond	762800	70860	17.51	3.3	1	10	3	2517000	71300
Capwell Mill Pond	512000	47590	11.76	3.4	1	7	2	1741000	49300

* Measured from USGS topographic map

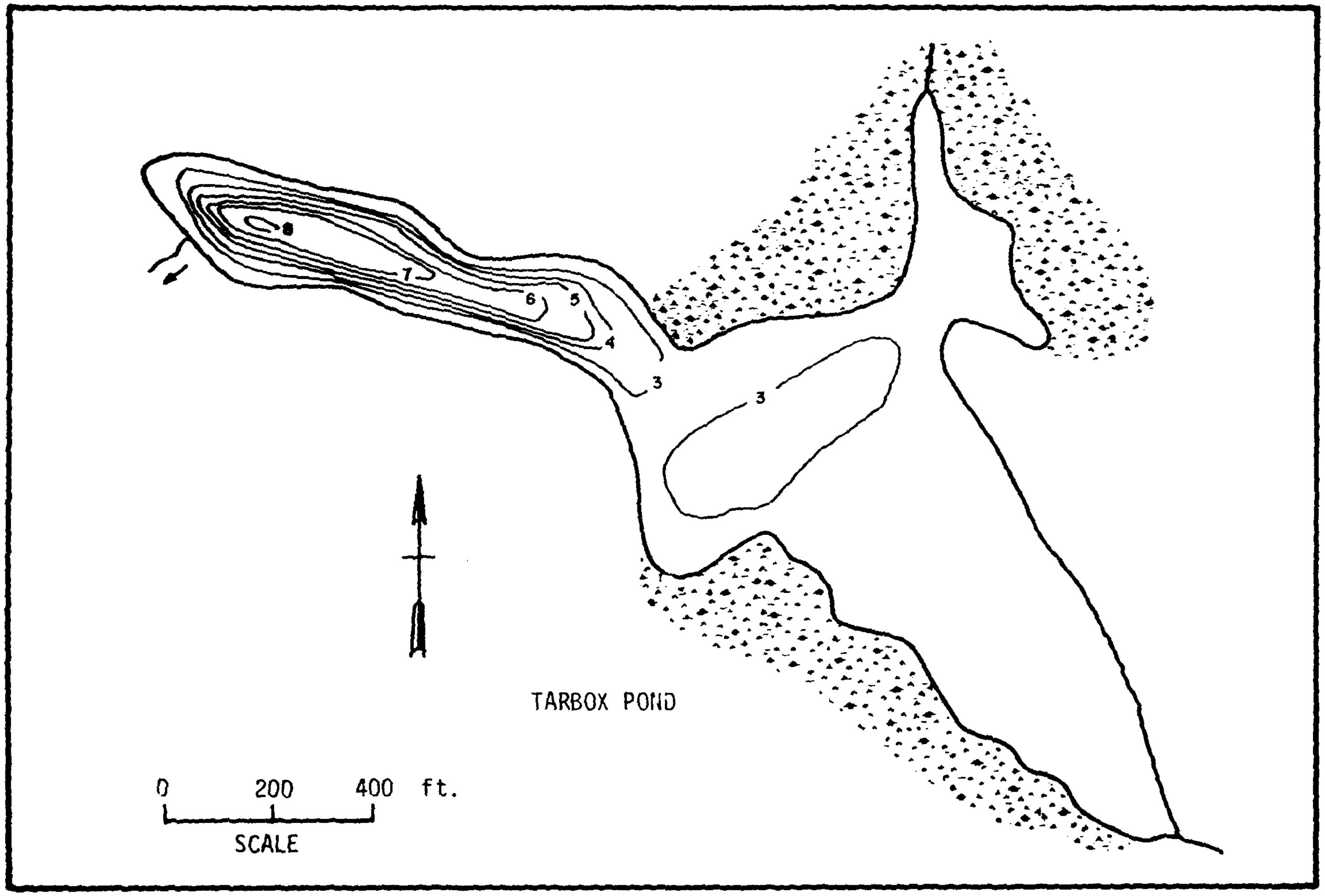


Figure 2.1-1. Bathymetry of Tarbox Pond, Big River Reservoir area, Rhode Island, August 1978. *Contours are given in feet.*

The bottom substrate was composed of silt and fine sand which was overlain with decaying vegetation. The pond apparently serves as a deposition basin for silt carried by the Carr River.

Capwell Mill Pond (Location 3)

Capwell Mill Pond was also formed by the placement of a dam across the Carr River and is located in the north-central section of the proposed reservoir northeast of Tarbox Pond. The pond has a surface area of 11.76 acres, an average depth of 3.4 ft, a maximum depth of 7 ft and a water volume of 1,741,000 ft^3 (Table 2.1-1).

The original channel of the Carr River in Capwell Mill Pond was identified and corresponded to the 5 ft contour (Figure 2.1-2).

The bottom substrate was similar to Tarbox Pond and was composed of silt and sand overlain with decaying aquatic vegetation. Capwell Mill Pond also serves as a settling basin for silt and sand carried by the Carr River; the original river channel was composed of cobble and gravel.

2.2 PHYSICAL CHARACTERISTICS OF THE LOTIC HABITATS

Field surveys were conducted at sampling locations on the Big River, Carr River and Nooseneck River and included determinations of width, depth and river discharge. These measurements were taken on three transects which included a 100 ft section of the river; the upstream and downstream transects were located 50 ft from the center transect. River length and gradient were measured from the USGS topographic maps. Total sediment load was calculated using the river discharge and total suspended solids. Sediment morphology was characterized visually.

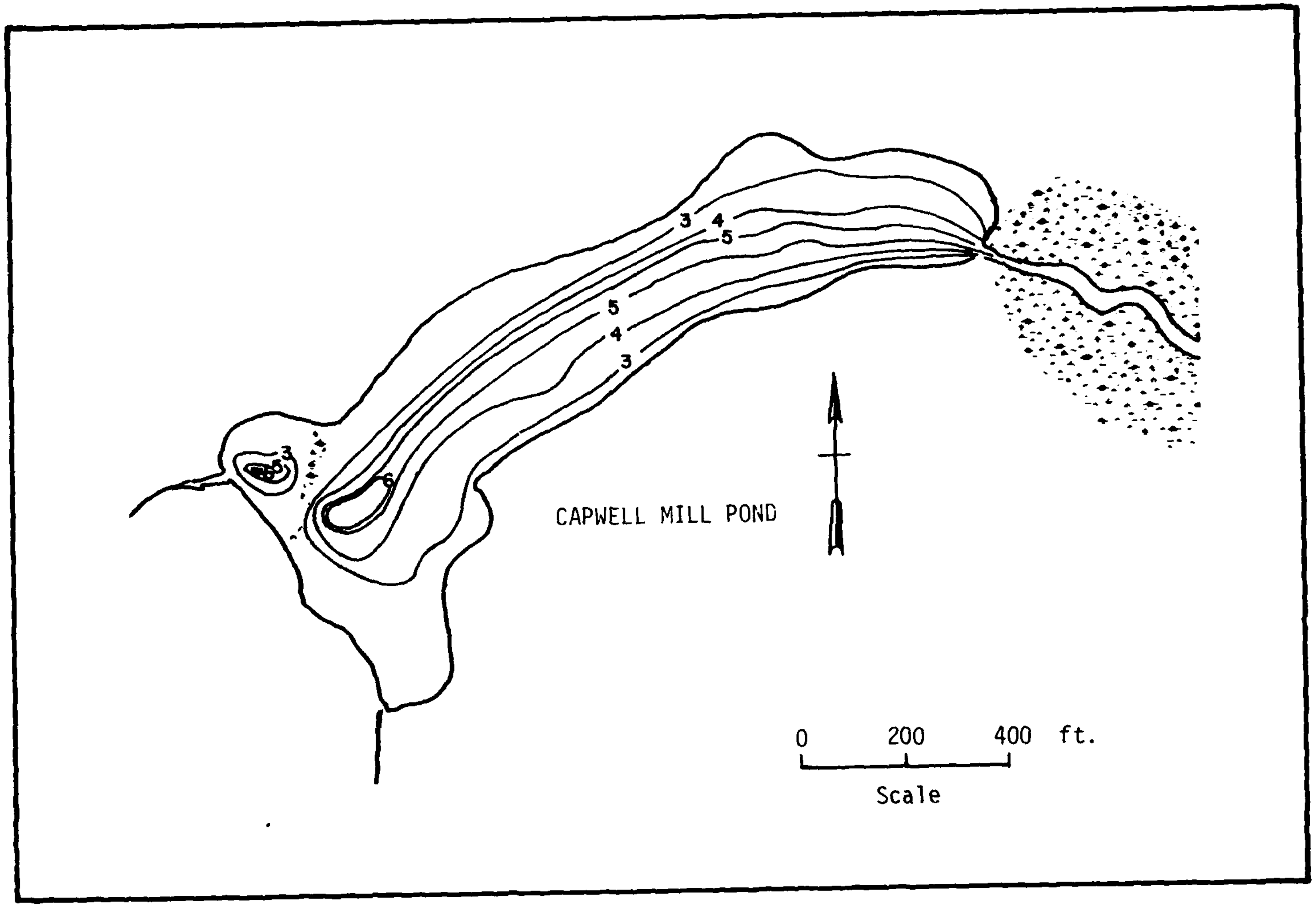


Figure 2.1-2. Bathymetry of Capwell Mill Pond Reservoir area, Rhode Island, August, 1978. Contours are given in feet.

Big River (Location 4)

This sampling site was located on the Big River directly downstream from Interstate 95. The specific sampling location was characterized by a slow-flowing open water area approximately 300 ft in length with well defined banks covered with rip-rap. Between Interstate 95 and the sampling site, the river flowed through dense shrub swamps and was generally not well defined.

The average width of Big River was 36 ft, with an average depth of 2.2 ft and a maximum depth of 4.0 ft (Table 2.2-1). The river discharge (29 cfs), total suspended solids (1.5 mg/l) and calculated total suspended load (107 kg/day) represented the highest values recorded for the four lotic sampling locations.

River discharge calculated for all the lotic sampling locations corresponded to and were within the range of river discharges reported for the Moosup River watershed, Rhode Island (Preble, 1974).

The substrate at this location was generally homogeneous and composed primarily of silt with a mixture of fine sand.

Carr River (Location 5)

This site was located on the Carr River approximately 300 ft downstream from Capwell Mill Pond and Burnt Sawmill Road. The river banks were well defined from the dam at Capwell Mill Pond to the sampling site and for an additional 100 ft before the river entered a shrub swamp.

The Carr River was narrow (15 ft) with a uniform bottom contour and was bordered on both sides by hardwood forest. Average depth was 0.3 ft and maximum depth was 0.9 ft (Table 2.2-1). River discharge (5 cfs) was similar to Nooseneck River (Location 6), however, total suspended solids and total suspended load were substantially less.

TABLE 2.2-1. MORPHOLOGICAL CHARACTERISTICS OF THE LOTIC SAMPLING LOCATIONS, BIG RIVER RESERVOIR AREA, RHODE ISLAND, AUGUST 1978.

LOCATION	Average Gradient*	Station Gradient	Length* (Miles)	Maximum Depth†	Average Depth†	Average Width†	Average Cross-sectional Area†	Discharge	Total Suspended Solids (mg/ℓ)	Total Suspended Load (kg/day)
Big River #4	9.8 ft/mi	9.8 ft/mi	5.1	4.0 ft	2.2 ft	36.0 ft	84.37 ft^2	29 cfs (825 ℓ/sec)	1.5	107
Carr River #5	17.2 ft/mi	<7.2 ft/mi	2.9	0.9 ft	0.3 ft	15.0 ft	4.74 ft^2	5 cfs (150 ℓ/sec)	<0.3	<4
Nooseneck River #6	31.2 ft/mi	<15.5 ft/mi	5.4	1.0 ft	0.6 ft	18.7 ft	10.62 ft^2	5 cfs (150 ℓ/sec)	0.7	9
Nooseneck River #7	31.2 ft/mi	17.6 ft/mi	5.4	3.4 ft	2.0 ft	17.2 ft	34.36 ft^2	<12 cfs (<330 ℓ/sec)	2.1	<60

* gradient and length within proposed reservoir area, except Nooseneck River for which entire length was used.

† Calculated from measurements taken from three transects which equalled a 100 ft section of the river.

The substrate at this location was predominantly coarse sand and gravel with riffle areas composed of cobble and gravel.

Nooseneck River (Location 6)

This sampling site was located on the Nooseneck River in the southern section of the proposed reservoir area. Sampling was conducted approximately 1200 ft downstream from Nooseneck Hill Road. The river flowed through interspersed shrub swamps and contained several bends with associated pool and riffle areas. A mixed pine and hardwood forest bordered both sides of the river. Average width of the river was 18.7 ft, average depth was 0.6 ft and maximum depth was 1.0 ft (Table 2.2-1).

The unique feature of this location was the diversity of aquatic habitat and the variable substrate morphology. The river banks, especially along the bends were undercut and provided good trout habitat. The substrate varied from sand and gravel in the pool areas to cobbles and boulders in the riffle areas.

Nooseneck River (Location 7)

This site was located on the Nooseneck River directly west and outside the proposed Big River Reservoir area. The location was sampled to compare any differences in water quality and aquatic species composition and abundance with Location 6 and to characterize a tributary stream of the proposed reservoir. The sampling area was located downstream from a large cedar swamp through which the Nooseneck River flows. The river at this location consisted of a deep pool and a steep riffle falls. The banks were well defined until the river entered a shrub swamp approximately 400 ft downstream from the cedar swamp.

The river averaged 17.2 ft in width and 2.0 ft in depth with a maximum depth of 3.4 ft (Table 2.2-1) The gradient of the river at this location was the steepest of all the locations surveyed and was a result of the river crossing several contours prior to entering the proposed reservoir boundary.

The substrate varied from silt and detritus in the pool area to cobble and boulders in the riffle-falls area.

2.3 WATER QUALITY

USEPA (1974) guidelines for handling, transport and storage of water quality samples were strictly followed. The samples were packed with ice during transit to the laboratory. Methods prescribed by USEPA (1974) and APHA (1976) were used to analyze the samples for color, turbidity, alkalinity, total suspended solids (measured in duplicate), silica and specific conductance. Dissolved oxygen was measured in the field (duplicates) using the Winkler Method (APHA 1976). Temperature and pH were also measured in the field with an NAI thermistor and a Corning pH meter, both units having been calibrated prior to use. Light extinction coefficients were measured with a Secchi Disc.

Lentic Habitats

Results of the water quality analyses of samples from Flat River Reservoir, Tarbox Pond and Capwell Mill Pond were very similar (Table 2.3-1). Most of the parameters were within the normal ranges for natural surface waters (Hem 1970) and within the water quality criteria established by the USEPA (1976) for the protection of freshwater aquatic life. A study conducted by the U.S. Army Corps of Engineers (unpublished) reported very similar water quality conditions in Flat River Reservoir. The USEPA (1976) defined the pH range of 6.5 to 9.0 as desirable. The European Inland Fisheries Advisory Commission (EIFAC, 1969 in USEPA, 1974) suggested that the pH range of 5 to 9 is not directly lethal to fish but that under more acidic conditions (5 to 6.5), other pollutants,

TABLE 2.3-1. RESULTS OF WATER QUALITY ANALYSES FROM THE PROPOSED BIG RIVER RESERVOIR STUDY AREA RHODE ISLAND, AUGUST 1978.

Location	Temperature (°C)†	pH†	Dissolved Oxygen (mg/1)†	Secchi Disk (ft)†*	Color (Co-Pt Units)	Turbidity (NTU)	Alkalinity (mg Ca CO_{3}/1)	Total Suspended Solids (mg/1)	Silica (mg SiO_{2}/1)	Specific Conductance (umhos)
Flat River Reservoir	21	6.5	8.1	8	40	1.0	4.35	0.9	8.1	96
Tarbox Pond	22	6.2	5.9	10	80	0.6	3.48	0.7	10.9	62
Capwell Mill Pond	22	5.9 (6.3)	8.5	7	70	0.5	2.61	1.7	9.5	114
Big River	18	6.1	7.8	5	50	1.7	5.70	1.5	10.7	98
Carr River	22	4.9° (6.3)	8.2	1	70	0.4	2.83	0.3	9.7	99
Nooseneck River (#6)	18	5.4	9.2	1	50	1.9	7.40	0.7	11.1	120
Nooseneck River (#7)	20	4.7	3.5	3.5	100	0.6	3.70	2.1	9.0	38

† *in situ* measurement

* all secchi disk readings at bottom

° value suspect

() measured October 11, 1978.

especially excess free CO_2, may be more toxic. The pH level 5.9 measured in Capwell Mill Pond is expected considering the drainage from the marsh/swamp area and does not suggest conditions harmful to aquatic life. Guthrie, *et al.* (1973) and Guthrie and Stolgitis (1977) reported similar pH values in the ponds and lakes of Rhode Island.

Color values were moderately high even though the Secchi Disc was visible in the maximum water depths and turbidity and total suspended solids were low. These conditions suggest that the color is due to dissolved organics rather than suspended sediment load. There was a correlation in the ponds between specific conductance and total suspended solids. Silica, a necessary nutrient for diatoms, was found within natural levels of 2 to 14 mg/l (Hem 1970). The low alkalinity levels are to be expected in New England where limestones are rare. The alkalinity of the ponds within the Big River area were generally lower than values in ponds within the Pawcatuck River watershed (Guthrie *et al.*, 1973).

Lotic Habitats

The results of river water sample analysis were very similar to those of the ponds and, for most parameters, within natural levels (Hem 1970). Guthrie, *et al.* (1973), and Preble (1974) reported similar water quality values in their surveys of Rhode Island streams.

The pH and dissolved oxygen levels measured at Location 7 (Nooseneck River) were low and probably reflected the influence from the cedar swamp directly upstream. The pH level measured at Carr River (Location 5) in August was unexpectedly low (4.9). This location was approximately 300 ft downstream from Capwell Mill Pond (Location 3) which had a pH of 5.9. Due to this apparent discrepancy, the pH of Capwell Mill Pond and Carr River was measured again on October 11, 1978 and a pH value of 6.3 was recorded at both locations. A study by the U.S. Army Corps of Engineers (1978) (unpublished data) reported that the pH level of the Carr River near Location 5 ranged from 4.7 to 5.9 during August 1978.

River water samples were moderately colored and exhibited low turbidities such that the secchi disc was visible to the maximum water depth at all locations. A correlation between specific conductance and total suspended solids in the river samples was not evident.

Within the proposed Big River Reservoir area, there are no known sources of point and non-point pollution, nor were any observed during the present study.

3.0 PHYTOPLANKTON

3.1 METHODS

Three whole water, one-liter surface samples were collected during the week of August 28 at each of the seven sampling locations for species composition analyses (Figure 2.0-1). Samples were preserved with 10 mls of Lugol's iodine solution and stored in the dark until laboratory processing.

Samples were allowed to settle for at least 36 hours under the assumption that all phytoplankton would have settled to the bottom during this period. Samples were then concentrated to 33 mls, from which two separate 0.1 ml aliquots were taken and transferred to a Palmer-Maloney (P-M) cell. Each aliquot was examined under a Nikon SKT compound microscope at 200 X. The entire contents of the P-M cell were identified to the lowest practical taxon, counted, and then returned to sample vials. The major taxonomic references used included: Smith (1950) Prescott (1970), and Whitford and Schumacher (1973).

Concurrent with the samples collected for species composition analysis three whole water, one-liter surface samples were collected at each of the seven sampling locations for chlorophyll *a* determinations. Samples were stored on dry ice in the dark to prevent pigment degradation.

Two 0.5 liter aliquots were filtered from each one-liter sample, and chlorophyll *a* concentrations were determined using the fluorometric method (Strickland and Parsons 1968).

Species abundance was expressed as numbers of cells per liter; mean cells per liter were computed from the six separate species/class counts for each location.

Chlorophyll *a* concentrations were expressed in μg per liter, and mean values were computed from the six replicates filtered from each location.

3.2 RESULTS AND DISCUSSION

A species list of phytoplankton collected at each location is presented in Table 3.2-1.

FLAT RIVER RESERVOIR

Green algae (Chlorophyceae), principally *Scendesmus bijuga*, dominated the phytoplankton community in late August with a density of 10.5×10^3 cells/liter (Table 3.2-2). *Scendesmus* sp. is a common, widespread member of freshwater plankton communities (Whitford and Schumacher 1973); in addition, *Merismopedia* sp., the single bluegreen (Cyanophyceae) genus observed is also a frequent member of freshwater pond plankton communities (Smith 1950). Other phytoplankton classes occurred in lower concentrations and included diatoms, (Bacillariophyceae), dinoflagellates (Dinophyceae) and unidentified nannoplankton. A mean chlorophyll *a* concentration of 1.5 µg/l was recorded at Flat River Reservoir (Table 3.2-3).

TARBOX POND

Both green and bluegreen algae species dominated the phytoplankton community with densities of 24.9×10^3 and 18.1×10^3 cells/liter, respectively (Table 3.2-2). *Mougeotia* sp. a common green algae, and *Microcystis* sp., a common summer bluegreen alga constituted the dominant phytoplankton forms in this pond (Smith 1950). Unidentified nannoplankton, diatoms, and dinoflagellates were also observed. The mean chlorophyll *a* concentration of 1.7 µg/l was the highest concentration recorded (Table 3.2-3).

TABLE 3.2-1. PHYTOPLANKTON SPECIES COLLECTED IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

LOCATION 1: FLAT RIVER RESERVOIR

- Bacillariophyceae
  - *Melosira granulata*
  - *Navicula* sp.
- Chlorophyceae
  - *Ankistrodesmus* sp.
  - *Cosmarium* sp.
  - *Mongeotia* sp.
  - *Pediastrum duplex*
  - *Scendesmus bijuga*
  - *Staurastrum* sp.
- Cyanophyceae
  - *Merismopedia* sp.
- Dinophyceae
  - *Ceratium carolinianum*
  - *Peridinium* sp.
- Unidentified Nannoplankton

LOCATION 2: TARBOX POND

- Bacillariophyceae
  - *Melosira granulata*
  - *Navicula* sp.
  - *Tabellaria fenestrata*
- Chlorophyceae
  - *Ankistrodesmus* sp.
  - *Arthodesmus octocornis*
  - *Closterium* sp.
  - *Euastrum* sp.
  - *Hyalotheca mucosa*
  - *Mongeotia* sp.
  - *Scendesmus bijuga*
  - *Staurastrum* sp.
  - *S. leptocladium*
  - *Xanthidium cristatum*
- Chrysophyceae
  - *Dinobryon* sp.
- Cyanophyceae
  - *Merismopedia* sp
- Unidentified Nannoplankton

Continued

TABLE 3.2-1. (Continued)

LOCATION 3: CAPWELL MILL POND

Bacillariophyceae
- *Asterionella formosa*
- *Melosira granulata*
- *Pinnularia* sp.

Chlorophyceae
- *Ankistrodesmus* sp
- *Arthrodesmus incus*
- *A. octocornis*
- *Closterium* sp.
- *Cosmarium* sp.
- *Euastrum* sp.
- *Mougeotia* sp.
- *Scendesmus bijuga*
- *Staurastrum* sp.
- *Xanthidium* sp.

Chrysophyceae
- *Dinobryon* sp.

Cyanophyceae
- *Anabaena* sp.
- *Merismopedia* sp.
- *Microcystis-Polycystis* sp.

Unidentified Nannoplankton

LOCATION 4: BIG RIVER

Bacillariophyceae
- *Asterionella formosa*
- *Navicula* sp.
- *Tabellaria fenestrata*

Chlorophyceae
- *Ankistrodesmus* sp.
- *Closterium* sp.
- *Cosmarium* sp.
- *Euastrum* sp.
- *Hyalotheca mucosa*
- *Mongeotia* sp.
- *Scendesmus bijuga*
- *Staurastrum* sp.
- *S. paradoxum*

Cyanophyceae
- *Merismopedia* sp.

Unidentified Nannoplankton

Continued

TABLE 3.2-1. (Continued)

LOCATION 5: CARR RIVER

Bacillariophyceae
Asterionella formosa
Pinnularia sp.
Tabellaria fenestrata
Chlorophyceae
Ankistrodesmus sp.
Closterium sp.
Cosmarium sp.
Euastrum sp.
Hyalotheca mucosa
Mougeotia sp.
Scendesmus bijuga
Staurastrum sp.
Chrysophyceae
Dinobryon sp.
Cyanophyceae
Merismopedia sp.
Dinophyceae
Ceratium carolinanum
Peridinium sp.
Unidentified Nannoplankton

LOCATION 6: NOOSENECK: within proposed reservoir area

Bacillariophyceae
Navicula sp.
Tabellaria fenestrata
Chlorophyceae
Ankistrodesmus sp.
Closterium sp.
Staurastrum sp.
Cyanophyceae
Spirulina subsalsa
Unidentified Nannoplankton

Continued

TABLE 3.2-1. (Continued)

LOCATION 7: NOOSENECK: outside proposed reservoir area

- Bacillariophyceae
  - *Asterionella formosa*
  - *Navicula* sp.
- Chlorophyceae
  - *Ankistrodesmus* sp.
  - *Closterium* sp.
  - *Euastrum* sp.
  - *Hyalotheca mucosa*
  - *Mougeotia* sp.
  - *Staurastrum* sp.
  - *S. elongaturn* var. *quadratum*
  - *Triploceros* sp.
- Chrysophyceae
  - *Dinobryon* sp.
- Cyanophyceae
  - *Anacystis* sp.
  - *Merismopedia* sp.
  - *Microcystis-Polycystis* sp.
  - *Spirulina* sp.
- Dinophyceae
  - *Ceratium* sp.
  - *C. carolinianum*
  - *Peridinum* sp.
- Unidentified Nannoplankton

TABLE 3.2-2. ABUNDANCE OF PHYTOPLANKTON (CELLS/LITER) IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

LOCATION 1: FLAT RIVER RESERVOIR

CLASS	$\bar{X}$	RANGE
Cyanophyceae	6497.9	0.0-21721.5
Chlorophyceae	10535.9	8632.8-16430.3
Bacillariophyceae	371.3	278.5- 1670.9
Dinophyceae	92.8	0.0- 278.5
Unidentified Nannoplankton	4734.2	3620.3- 5848.1

LOCATION 2: TARBOX POND

CLASS	$\bar{X}$	RANGE
Cyanophyceae	18194.1	1670.9-13088.6
Chlorophyceae	24970.5	15594.9-35088.6
Chrysophyceae	371.3	0.0- 2227.8
Bacillariophyceae	4780.6	0.0-14759.5
Dinophyceae	92.8	0.0- 278.5
Unidentified Nannoplankton	17219.4	7240.5-33974.6

LOCATION 3: CAPWELL MILL POND

CLASS	$\bar{X}$	RANGE
Cyanophyceae	7936.7	2227.8-16708.8
Chlorophyceae	12345.9	4734.1-40936.7
Chrysophyceae	464.1	0.0- 2227.8
Bacillariophyceae	1438.8	0.0- 4455.6
Dinophyceae	46.4	0.0- 278.4
Unidentified Nannoplankton	2042.1	835.4- 3620.2

LOCATION 4: BIG RIVER

CLASS	$\bar{X}$	RANGE
Cyanophyceae	371.3	0.0- 2227.8
Chlorophyceae	6219.4	1949.3- 9189.8
Bacillariophyceae	1299.5	0.0- 4734.1
Unidentified Nannoplankton	1345.9	556.9- 2506.3

Continued

TABLE 3.2-2. (Continued)

LOCATION 5: CARR RIVER

CLASS	$\bar{X}$	RANGE
Cyanophyceae	4270.0	0.0- 7797.4
Chlorophyceae	8586.4	6405.0-11696.2
Chrysophyceae	185.6	0.0- 556.9
Bacillariophyceae	1949.3	0.0- 9468.3
Dinophyceae	185.6	0.0- 556.9
Unidentified Nannoplankton	6405.0	5569.6- 7240.5

LOCATION 6: NOOSENECK - W

CLASS	$\bar{X}$	RANGE
Cyanophyceae	46.4	0.0- 278.4
Chlorophyceae	510.5	0.0- 1113.9
Bacillariophyceae	789.0	278.5- 2227.8
Unidentified Nannoplankton	1299.5	278.5- 1949.3

LOCATION 7: NOOSENECK - O

CLASS	$\bar{X}$	RANGE
Cyanophyceae	341789.0	79367.0-682278.4
Chlorophyceae	5430.3	2784.8- 11139.2
Chrysophyceae	1392.4	0.0- 5569.6
Bacillariophyceae	1392.4	556.9- 2784.8
Dinophyceae	324.8	0.0- 835.4
Unidentified Nannoplankton	13924.0	7797.4- 15316.4

TABLE 3.2-3. CHLOROPHYLL *a* CONCENTRATIONS (μg/l) OF PHYTOPLANKTON MEASURED AT THE SAMPLING LOCATIONS IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

LOCATION	$\bar{X}$	REPLICATE RANGE
Flat River Reservoir	1.51	1.37-1.59
Tarbox Pond	1.67	1.66-1.69
Capwell Mill Pond	1.45	1.41-1.51
Big River	1.40	1.36-1.48
Carr River	1.49	1.44-1.51
Nooseneck: within proposed reservoir area	1.50	1.37-1.66
Nooseneck: outside proposed reservoir area	1.57	1.54-1.60

CAPWELL MILL POND

Desmids, a unique group of green algae, dominated the August phytoplankton at a density of 12.3 x 10^3 cells/liter (Table 3.2-2). *Hyalotheca mucosa*, a common filamentous desmid, was the predominant species observed. Other desmid genera included *Xanthidium* sp., *Staurastrium* sp., and *Euastrum* sp. These algae are characteristic of shallow, permanent waters having a high concentration of organic matter, and a pH between 5.4 and 6.8 (Whitford and Schumacher, 1973). A pH of 5.9 was recorded at the time of sample collection. Various bluegreen algae and diatom genera, along with unidentified nannoplankton were also observed. A mean chlorophyll *a* concentration of 1.45 μg/l was measured at Capwell Mill Pond (Table 3.2-3).

BIG RIVER

Phytoplankton species observed at Big River were typical of the summer plankton communities found in temperate rivers and streams. Green algae, having average densities of 6.2 x 10^3 cells/liter, dominated the population with diatoms occurring in lower numbers (Table 3.2-2). *Scenedesmus* sp. and *Mougeotia* sp. were the dominant green algae, whereas *Tabellaria fenestrata* and *Asterionella formosa* dominated the reduced summer diatom population. Unidentified nannoplankton and sparsely distributed genera of bluegreen algae were also observed. A mean chlorophyll *a* concentration of 1.40 μg/l was the lowest concentration recorded (Table 3.2-3).

CARR RIVER

Green algae, primarily *Scendesmus bijuga* and *Hyalotheca mucosa*, dominated the phytoplankton community of this stream with observed densities of 8.5 x 10^3 cells/liter (Table 3.2-2). Both are common members of freshwater plankton communities (Smith, 1950). *Merismopedia* sp., a common bluegreen alga, and unidentified nannoplankton comprised the remainder of the phytoplankton community. The mean chlorophyll *a* concentration of 1.49 μg/l was recorded at Carr River (Table 3.2-3).

NOOSENECK RIVER (within proposed reservoir area)

The phytoplankton community of this river was numerically dominated by unidentified nannoplankton having an average density of 1.2×10^3 cells/liter (Table 3.2-2). Net phytoplankton was dominated by *Tabellaria fenestrata*, a widespread diatom, and *Ankistrodesmus* sp., a green alga common in summer phytoplankton communities. The mean chlorophyll *a* concentration was 1.50 μg/l (Table 3.2-3).

NOOSENECK RIVER (outside of proposed reservoir area)

Bluegreen algae, principally *Polycystis* sp. and *Anacystis* sp., dominated the phytoplankton community in late August with densities of 341.7×10^3 cells/liter observed (Table 3.2-2). Both genera are common phytoplankton members of permanent freshwater ponds during the summer months (Smith 1950). Unidentified nannoplankton and various desmid species were observed in reduced numbers. The mean chlorophyll *a* concentration was 1.57 μg/l (Table 3.2-3).

3.3 SUMMARY

Various diversity and density combinations of green algae, desmids and bluegreen algae, generally characteristic of summer aquatic communities, were observed throughout the study area. Desmids were evident at all locations and most prevalent at locations having a pH between 5.4 and 6.8.

Green algae dominated both numbers of species and numbers of cells per liter at all locations, except the two Nooseneck River locations. Bluegreen algae dominated the cell numbers at Nooseneck River, (Location 7) whereas low concentrations of nannoplankton typified the clear, fast flowing water of Nooseneck River (Location 6). Bluegreen algae are often dominant in habitats that are chemically and/or physically stressful to other algae (Reid, 1961; Odum, 1971). Physical stresses from currents can restrict net phytoplankton growth in fast-flowing water; therefore, most phytoplankton growth is composed of either attached forms or nannoplankton (Odum, 1971).

Overall, the phytoplankton species observed are typical members of communities found in temperate free-flowing and still-water habitats (Reid, 1961; Odum, 1971).

4.0 PERIPHYTON

4.1 METHODS

Three pre-delineated substrate areas were scraped for species composition analysis at each of the seven sampling locations during the week of August 28 (Figure 2.0-1). Substrate scrapings were taken from submerged rocks and/or logs. Samples were then combined with 9 mls of water and preserved with 1 ml of Lugol's iodine solution. All samples were stored in the dark until laboratory processing.

A 0.25 ml aliquot was withdrawn from each pre-shaken sample, and diluted to 10 mls. Five mls of the diluted sample were then settled in a Wild Counting Chamber. All identifications and counts were made on a Wild M40 inverted microscope at 1000 X and 400 X, respectively. Periphyton abundance was expressed as numbers of cells per square centimeter. Identifications were made to the lowest practical taxon. The major taxonomic references used included: Hustedt (1930), Geitler (1932), Smith (1950), Prescott (1951) and Patrick and Reimer (1966).

Concurrent with the species composition samples, three premarked substrate areas were scraped at each location for chlorophyll *a* measurements. All samples were stored immediately on dry ice and held in the dark to prevent pigment degradation. Chlorophyll *a* determinations were made using fluorometric methods outlined by Strickland and Parsons (1968) and expressed in μg per square centimeter. Mean chlorophyll *a* values were computed from three replicate samples taken from each location.

4.2 RESULTS AND DISCUSSION

A species list of periphyton collected at each location is presented in Table 4.2-1.

TABLE 4.2-1. TAXONOMIC LIST OF PERIPHYTON COLLECTED WITHIN THE PROPOSED BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

FLAT RIVER RESERVOIR

Species

Cylindrospermum alatosporum
Stigonema
Merismopedia glauca
Oscillatoria
Bulbochaeta
Coelastrum microporum
Dictyosphaerium pulchellum
Pediastrum tetras v. *tetraedron*
Scenedesmus bijuga
Scenedesmus quadricauda
Mougeotia
Cosmarium
Closterium
Cryptomonas
Anomoneis vitrea
Cymbella cf.*gracilis*
Eunotia arcus v.*bidens*
Eunotia maior
Eunotia valida
Fragilaria
Frustulia rhomboides
Gomphonema parvulum
Nitzschia acicularis
Nitzschia recta f. *densestriata*
Pinnularia acrosphaeria
Pinnularia dactylus v. *diriana*
Stauroneis phoenicentreron f. *gracile*
Stenopterobia intermedia
Tabellaria flocculosa
Diatoms - Girdle View

CAPWELL MILL POND

Species

Cylindrospermum alatosporum
Stigonema
Merismopedia glauca
Oscillatoria
Scenedesmus bijuga
Mougeotia
Cosmarium
Closterium
Euastrum
Melosira
Actinella punctata v. *punctata*
Anomoneis vitrea
Cymbella cf. *gracilis*
Eunotia arcus v. *bidens*
Eunotia maior
Eunotia valida
Fragilaria
Frustulia rhomboides
Navicula
Nitzschia recta f. *densestriata*
Pinnularia acrosphaeria
Pinnularia braunii var. *braunii*
Pinnularia dactylus v. *diriana*
Tabellaria flocculosa
Diatoms - Girdle View

TARBOX POND

Species

Cylindrospermum alatosporum
Stigonema
Merismopedia glauca
Oscillatoria
Coelastrum microporum
Scenedesmus bijuga

BIG RIVER

Species

Stigonema
Merismopedia glauca
Scenedesmus bijuga
Scenedesmus quadricauda
Closterium
Cryptomonas

TABLE 4.2-1. (Continued)

TARBOX POND (Continued)

Scenedesmus quadricauda
Mougeotia
Cosmarium
Closterium
Euastrum
Melosira
Actinella punctata v. *punctata*
Anomoneis vitrea
Asterionella formosa
Cymbella cf. *gracilis*
Eunotia maior
Eunotia valida
Fragilaria
Frustulia rhomboides
Nitzschia acicularis
Nitzchia recta f. *densestriata*
Pinnularia acrosphaeria
Pinnularia braunii v. *braunii*
Pinnularia dactylus v. *diriana*
Stenopterobia intermedia
Tabellaria flocculosa
Diatoms -- Girdle View

BIG RIVER (Continued)

Melosira
Actinella punctata v. *punctata*
Anomoneis vitrea
Cymbella cf. *gracilis*
Cymbella ventricosa
Eunotia arcus v. *bidens*
Eunotia maior
Eunotia valida
Fragilaria
Frustulia rhomboides
Gomphonema parvulum
Navicula
Nitzschia recta f. *densestriata*
Pinnularia acrosphaeria
Pinnularia braunii v. *braunii*
Pinnularia dactylus v. *diriana*
Stenopterobia intermedia
Surirella
Tabellaria flocculosa
Diatoms -- Girdle View

CARR RIVER

Merismopedia glauca
Mougeotia
Closterium
Cymgella cf. *gracilis*
Eunotia arcus v. *bidens*
Eunoita maior
Eunotia valida
Fragilaria
Frustulia rhomboides
Gomphonema longiceps v. *subclavata*
Tabellaria flocculosa

NOOSENECK RIVER: within proposed reservoir area

Cylindrospermum alatosporum
Stigonema
Merismopedia glauca
Oscillatoria
Bulbochaete
Scenedesmus bijuga
Mougeotia
Spirogyra
Cosmarium
Euastrum
Cryptomonas
Melosira
Actinella punctata v. *punctata*
Anomoneis vitrea
Cymbella cf.*gracilis*
Cymbella ventricosa
Eunotia arcus v.*bidens*
Eunotia maior
Eunotia valida
Fragilaria
Frustulia rhomboides

TABLE 4.2-1. (Continued)

NOOSENECK RIVER: within proposed (Cont'd.)
reservoir area

Gomphonema parvulum
Navicula
Nitzchia acicularis
Nitzschia recta f. *densestriata*
Pinnularia braunii var. *braunii*
Pinnularia dactylus v. *diriana*
Stenopterobia intermedia
Surirella
Synedra ulna
Tabellaria flocculosa

NOOSENECK RIVER: outside proposed reservoir area

Species

Scenedesmus bijuga
Mougeotia
Melosira
Actinella punctata v. *punctata*
Cymbella cf. *gracilis*
Eunotia arcus v. *bidens*
Eunotia maior
Eunotia serra v. *diadema*
Eunotia valida
Fragilaria
Frustulia rhomboides
Gomphonema longiceps v. *subclavata*
Gomphonema parvulum
Navicula
Pinnularia braunii var.*braunii*
Pinnularia dactylus v. *diriana*
Tabellaria flocculosa

TABLE 4.2-2. ABUNDANCE OF PERIPHYTON (CELLS/SQ. CENTIMETER) IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

FLAT RIVER RESERVOIR PERIPHYTON: CELLS/CM^2

	LOCATION REPLICATES		
CLASS	1A	1B	1C
Cyanophyceae	2255	7446	1080
Chlorophyceae	738	357	189
Conjugatophyceae	902	714	81
Cryptophyceae	164	51	0
Bacillariophyceae	16728	21981	10017
Totals	20787	30549	11367
Ave. Total		20901	
Diversity: Simple Shannon Wiener	3.5750	3.1351	2.9774
S. Diversity: Total Species	27	20	20

TARBOX POND PERIPHYTON: CELLS/CM^2

	LOCATION REPLICATES		
CLASS	2A	2B	2C
Cyanophyceae	1750	4633	3220
Chlorophyceae	420	226	70
Conjugatophyceae	490	2825	1750
Bacillariophyceae	37450	59777	35490
Totals	40110	67461	40530
Ave. Total		49367	
Diversity: Simple Shannon Wiener	2.9691	3.0891	3.1619
S. Diversity: Total Species	24	23	22

(Continued)

TABLE 4.2-2 (Continued)

CAPWELL MILL POND PERIPHYTON: CELLS/CM^2

CLASS	LOCATION REPLICATES 3A	3B	3C
Cyanophyceae	3626	1395	5940
Chlorophyceae	296	186	198
Conjugatophyceae	1554	992	1716
Bacillariophyceae	34188	13206	43230
Totals	39664	15779	51084
Ave. Total		35509	
Diversity: Simple Shannon Wiener	2.9336	3.0933	2.1146
S. Diversity: Total Species	21	20	22

BIG RIVER PERIPHYTON: CELLS/CM^2

CLASS	LOCATION REPLICATES 4A	4B	4C
Cyanophyceae	93	0	179
Chlorophyceae	0	808	1074
Conjugatophyceae	465	606	716
Bacillariophyceae	62031	100192	103104
Totals	62589	101808	105252
Ave. Total		89883	
Diversity: Simple Shannon Wiener	2.7901	2.7719	2.5892
S. Diversity: Total Species	19	18	22

(Continued)

TABLE 4.2-2 (Continued)

CARR RIVER PERIPHYTON: CELLS/CM^2

CLASS	LOCATION REPLICATES 5A	5B	5C
Cyanophyceae	210	0	0
Conjugatophyceae	1155	51	0
Bacillariophyceae	62790	35343	94536
Totals	64155	35394	94536
Ave. Total		64678	
Diversity: Simple Shannon Wiener	1.1349	0.1221	0.2051
S. Diversity: Total Species			

NOOSENECK RIVER PERIPHYTON: CELLS/CM^2
WITHIN THE PROPOSED RESERVOIR AREA

CLASS	LOCATION REPLICATES 6A	6B	6C
Cyanophyceae	875	0	156
Chlorophyceae	750	536	286
Conjugatophyceae	1875	1675	390
Cryptophyceae	625	134	0
Bacillariophyceae	96000	39195	12246
Totals	100125	41540	13078
Ave Total		51581	
Diversity: Simple Shannon Wiener	3.2732	3.6719	2.8048
S. Diveersity: Total Species	23	27	22

(Continued)

TABLE 4.2-2. (Continued)

NOOSENECK RIVER PERIPHYTON: CELLS/CM^2
OUTSIDE PROPOSED RESERVOIR AREA

CLASS	LOCATION REPLICATES		
	7A	7B	7C
Chlorophyceae	67	0	51
Conjugatophyceae	134	0	0
Bacillariophyceae	40267	35336	8942
Totals	40468	35336	8993
Ave. Total		28248	
Diversity: Simple Shannon Wiener	2.1012	1.7219	2.1603
S. Diversity: Total Species	13	14	12

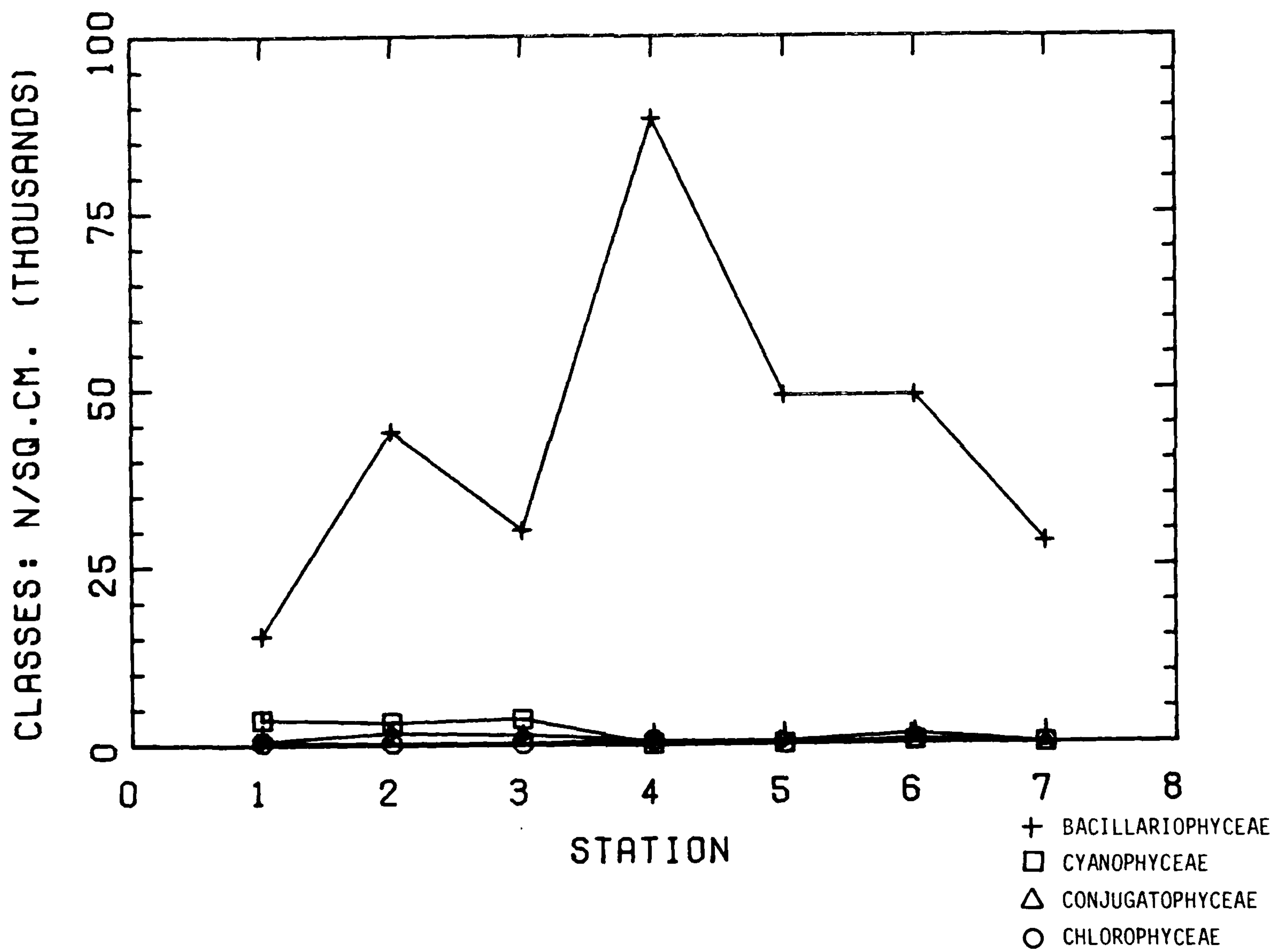


Figure 4.2-1. Abundance of periphyton by classes at the sampling locations within the Big River Reservoir Study Area, Rhode Island, August 1978.

TABLE 4.2-3. CHLOROPHYLL *a* CONCENTRATIONS (μg/l) OF PERIPHYTON MEASURED AT THE SAMPLING LOCATIONS IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

LOCATION	$\bar{X}$	REPLICATE RANGE
Flat River Reservoir	0.83	0.39-1.19
Tarbox Pond	1.50	0.47-2.75
Capwell Mill Pond	0.87	0.61-1.10
Big River	0.99	0.69-1.19
Carr River	1.45	0.89-1.83
Nooseneck Location 6	1.27	0.53-2.20
Nooseneck Location 7	2.56	1.19-4.29

Flat River Reservoir

Diatoms (Bacillariophyceae) dominated the periphyton community with a density of 16.2 x 10^3 cells/cm^2 (Table 4.2-2) (Figure 4.2-1). *Tabellaria flocculosa*, a species found in many habitats, along with *Frustulia rhomboides* and *Eisnotia arcus* var. *bidens*, typified the diatom community. The latter species are usually associated with acidic waters (Whitford and Schumacher 1973). Low densities of bluegreen algae (Cyanophyceae) were represented primarily by *Stigonema* sp. This highly-branched form is usually considered terrestrial, although some forms have been reported growing on wet substrata under acidic conditions (Prescott, 1951). Green algae (Chlorophyceae) were also observed in low densities. Total periphyton abundance averaged 20.9 x 10^3 cells/cm^2, which represented the lowest abundance recorded during the study (Table 4.2-2). The mean periphyton chlorophyll *a* concentration of 0.83 μg/cm^2 (Table 4.2-3) was the lowest concentration recorded.

Tarbox Pond

Diatom species, typical of acidic waters, primarily *Frustulia rhomboides*, characterized the periphyton population of Tarbox Pond. *F. rhomboides* accounted for 19.1 x 10^3 cells/cm^2, or 38% of the total periphyton community which totaled 49.3 x 10^3 cells/cm^2 (Table 4.2-2). Other diatoms associated with acidic waters, included *Anomoneis vitrea* and *Eunotia* spp. Varying abundances of common still-water species such as *Tabellaria flocculosa*, and *Pinnularia* sp. constituted the remainder of the diatom community. *Oscillatoria* sp. was characteristic of a reduced bluegreen algae community, whereas various desmid species dominated the small green algae community (Table 4.2-2). *Oscillatoria* sp. is considered a common standing-water genus (Smith, 1950).

The mean chlorophyll *a* concentration was 1.50 μg/cm^2 (Table 4.2-3) which was the highest periphytic chlorophyll *a* value recorded at the lentic locations.

Capwell Mill Pond

The periphyton community in Capwell Mill Pond was also dominated by diatoms (Bacillariophyceae) (Table 4.2-2). The diatom, *Frustulia rhomboides* characteristic of the acidic waters, represented 49% of the total periphytic community, having an average density of 19.2 x 10^3 cells/cm^2 (Table 4.2-2). Other periphyton groups observed included bluegreen and green algae species, with species and abundances comparable to those found at Flat River Reservoir and Tarbox Pond. Aquatic mosses were also observed in the samples, but were not identified or quantified. A mean chlorophyll *a* concentration of 0.87 μg/cm^2 corroborated the low cell numbers recorded at this location (Table 4.2-3).

Big River

Diatoms, primarily *Frustulia rhomboides* and *Tabellaria flocculosa*, dominated the periphyton community with densities of 88.4 x 10^3 cells/cm^2 (Table 4.2-2). Although *F. rhomboides* is indicative of acidic waters, *T. flocculosa* and *Fragilaria* sp. are ubiquitous diatoms (Whitford and Schumacher, 1973). Desmids, usually abundant within a pH range of 5.4 to 6.8, were present in low concentrations. *Batrachrospermum* sp., a red algae common to acidic bog waters, was observed, but was not quantified. Total periphyton abundance averaged 89.8 x 10^3 cells/ cm^2, and was the highest recorded throughout the study (Table 4.2-2) (Figure 4.2-2). The mean chlorophyll *a* concentration of 0.99 μg/cm^2 was the lowest chlorophyll value observed at the lotic habitats (Table 4.2-3).

Carr River

Diatoms dominated the periphyton community, with *Fragilaria* sp. representing 92% of the total community. This chain-forming diatom

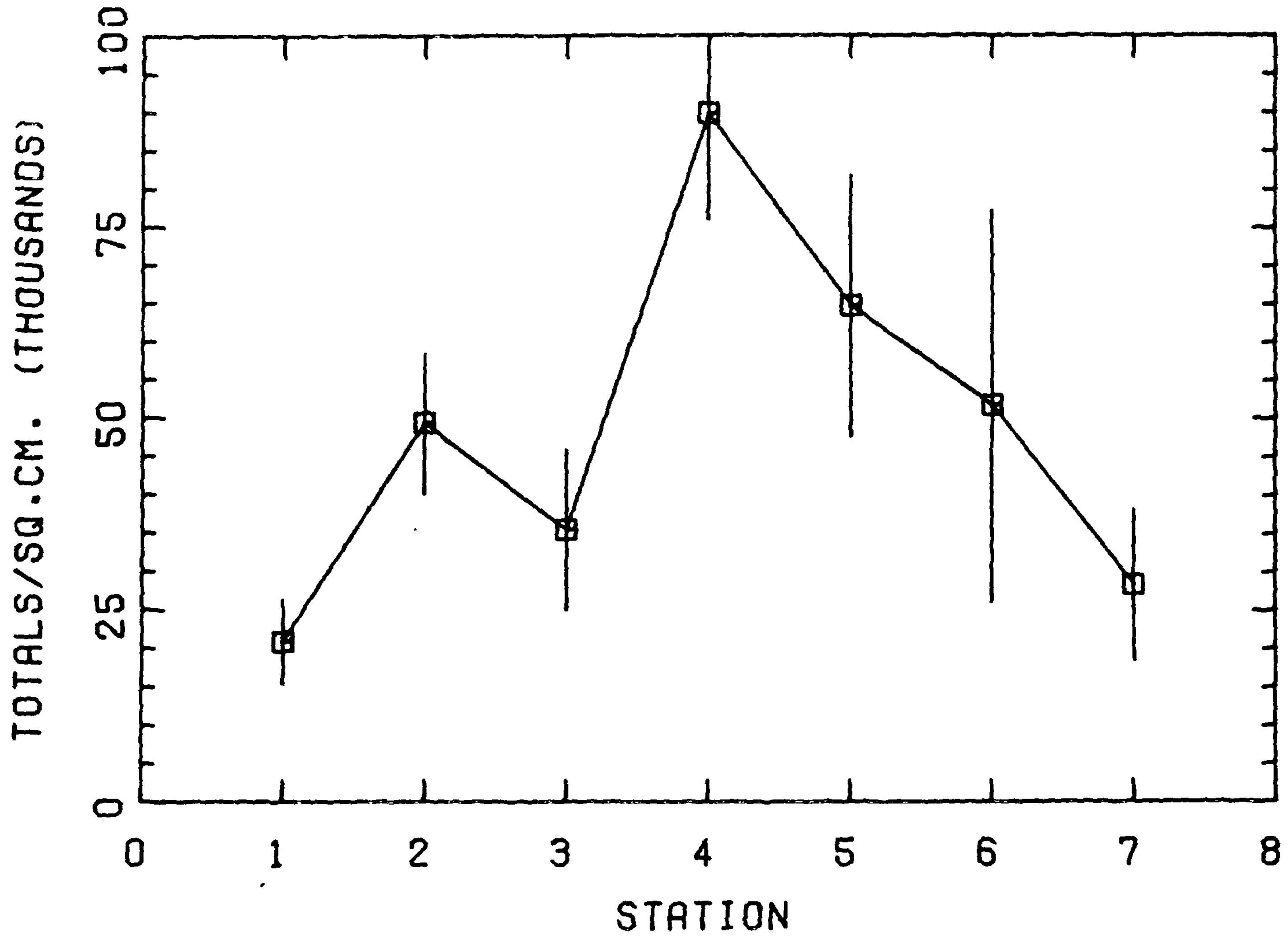


Figure 4.2-2. Total periphyton abundance measured at the sampling locations within the Big River Reservoir Study Area, Rhode Island, August 1978.

is a common member of a slow-flowing stream plankton (Smith, 1950). The red alga, *Batrachrospermum* sp. was also observed at this location. Total periphyton abundance averaged 64.6 x 10^3 cells/cm^2 (Table 4.2-2). A mean chlorophyll *a* concentration of 1.45 μg/cm^2 was observed (Table 4.2-3).

Nooseneck River (within proposed reservoir area)

The periphyton community was dominated by diatoms (averaging 49.1 x 10^3 cells/cm^2), principally *Fragilaria* sp. and *Frustulia rhomboides*, (Table 4.2-2). *Fragilaria* sp. is common to flowing waters, and *Frustulia rhomboides* is primarily found in acidic habitats (Smith, 1950; Whitford and Schumacher, 1973). Various desmid genera were observed, but did not constitute a significant portion of the total community. Aquatic mosses were also observed in the samples, but were not identified or quantified. Total periphyton abundance averaged 51.5 x 10^3 cells/cm^2. The mean chlorophyll *a* concentration was 1.27 μg/cm^2 (Table 4.2-3).

Nooseneck River (outside the proposed reservoir area)

Diatoms dominated the periphyton community representing 99% (28.1 x 10^3cells/cm^2) of the total abundance (Table 4.2-2). *Fragilaria* sp. was the predominant diatom and is characteristic of the slow-flowing waters, with other diatoms, *Eunotia* spp. and *Frustulia rhomboides*, indicative of the low pH. Total periphyton abundance averaged 28.2 x 10^3 cells/cm^2 (Table 4.2-2). Aquatic mosses were also noted in the samples. The mean chlorophyll a value of 2.56 μg/cm^2 (Table 4.2-3) was the highest chlorophyll measurement recorded.

4.3 SUMMARY

Diatom species, adapted to both slow currents and acidic waters, predominated the periphyton community at each location. *Frustulia rhomboides* and *Fragilaria* sp. were the dominant species observed. Small concentrations of desmids and bluegreen algae comprised the remainder of the periphyton community.

Overall, the genera encountered typify temperate soft-water streams and ponds (Prescott, 1951; Whitford and Schumacher, 1973). Since periphyton are considered excellent indicators of long-term water quality (Weber, 1973), the periphyton communities observed within the Big River study area were generally indicative of naturally occurring acidic waters.

5.0 ZOOPLANKTON

5.1 METHODS

Three separate 8-dram net zooplankton samples were collected at each of the seven sampling locations (Figure 2.0-1) for determination of species composition using an NAI-modified 76 μm mesh Clark-Bumpus plankton net. Horizontal surface tows were taken at the lentic locations, whereas stationary nets were set at the lotic locations. Meter revolutions were recorded at each location for each tow to determine the volume of water sampled. Samples were preserved with 2 mls of 5% buffered formalin.

Two aliquots (1 ml) per sample were examined under an Olympus BHB Compound microscope at 100 X. Identifications were made to the generic level using the following major taxonomic references: Pennak (1953) and Edmondson (1966).

Two samples from each location were analyzed for dry and ash-free dry weights (standing crop). The samples were decanted, rinsed from their vials into Pyrex tubes, and centrifuged twice. Samples were then weighed, dried overnight at ∿105°C, cooled, and reweighed for dry weight determination. Finally, the samples were ashed at 550°C in a muffle furnace and reweighed to determine ash-free weights. Zooplankton weights were expressed in mg/l and were computed from replicate net samples. It should be noted that phytoplankton species were also unavoidably present in the samples and that values computed reflect a measurement of total plankton biomass.

Species data were expressed as number of organisms per liter. Mean cells per liter were computed from six separate counts for each location.

5.2 RESULTS AND DISCUSSION

A species list of zooplankton collected at each sampling location is presented in Table 5.2-1).

Flat River Reservoir

Copepod nauplii dominated the zooplankton community (0.19 organisms/liter; Table 5.2-2). These free-living larvae are well-adapted to the slow-flowing, open water habitats, characteristic of small water bodies (Odum, 1971). *Bosmina*, a species typically found in pond communities, was predominant in the cladoceran community. Copepod copepodites and rotifers were also observed. Total zooplankton abundances averaged 0.28 organisms/liter (Table 5.2-2). Mean dry and ash-free dry weights were 0.019 mg/l and 0.003 mg/l respectively, the lowest recorded at the lentic locations (Table 5.2-3).

Tarbox Pond

The zooplankton community of Tarbox Pond was dominated by *Bosmina* sp. with a mean density of 2.48 organisms/liter (Table 5.2-2). These water-fleas are common in the open water areas of ponds and lakes throughout North America (Pennak, 1953; Edmondson, 1966). Copepod nauplii and copepodites were also present. Total zooplankton numbers were the highest recorded at any location, averaging 3.92 organisms/liter (Table 5.2-2). Mean dry and ash-fee dry weights were 0.015 mg/l and 0.010 mg/l, respectively (Table 5.2-3).

Capwell Mill Pond

The zooplankton population at this pond was characterized by *Bosmina* sp. which accounted for 79% of the total community (1.03 organisms/liter; Table 5.2-2). These cladocerans, in addition to cope-

TABLE 5.2-1. ZOOPLANKTON SPECIES COLLECTED IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

LOCATION 1: FLAT RIVER RESERVOIR

Copepoda
- Copepoda copepodites
- Copepoda nauplii

Cladocera
- *Alona* sp.
- *Bosmina* sp.

Rotifera
- *Trichocera* sp.
- *Lecane* sp.

LOCATION 2: TARBOX POND

Copepoda
- Copepoda copepodites
- Copepoda nauplii

Cladocera
- *Bosmina* sp.

Rotifera
- *Lecane* sp.

LOCATION 3: CAPWELL MILL POND

Copepoda
- Copepoda copepodites
- Copepoda nauplii

Cladocera
- *Bosmina* sp.

Rotifera
- *Lecane* sp.
- *Trichocera* sp.

Ostracoda

LOCATION 4: BIG RIVER

Copepoda
- Copepoda copepodites
- Copepoda nauplii

Cladocera
- *Alona* sp.
- *Alonella* sp.
- *Bosmina* sp.

(Continued)

TABLE 5.2-1 (Continued)

Rotifera
- *Keratella* sp.
- *Lecane* sp.
- *Macrochaetus* sp.
- *Synchaeta* sp.
- *Trichocera* sp.
- *Trichotria* sp.

Ostracoda

Tardigrada

LOCATION 5: CARR RIVER

Copepoda
- Copepoda copepodite
- Copepoda nauplii

Cladocera
- *Bosmina* sp.

Rotifera
- *Lecane* sp.
- *Lepadella* sp.
- *Trichocera* sp.
- *Trichotria* sp.

Ostracoda

LOCATION 6: NOOSENECK RIVER

Copepoda
- Copepoda copepodites

LOCATION 7: NOOSENECK RIVER

- Copepoda copepodiates
- Copepoda nauplii

Cladocera
- *Alona* sp.
- *Bosmina* sp.

Rotifera
- *Keratella* sp.
- *Lecane* sp.
- *Monommata* sp.
- *Trichocera* sp.
- *Trichotria* sp.

TABLE 5.2-2. ABUNDANCE OF ZOOPLANKTON (ORGANISMS/LITER) IN BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

	$\bar{X}$	REPLICATE RANGE
LOCATION 1: FLAT RIVER RESERVOIR		
Total Numbers	0.280	0.136 - 0.505
Dominant zooplankter		
Copepoda nauplii	0.199	0.015 - 0.472
LOCATION 2: TARBOX POND		
Total Numbers	3.922	1.207 -10.005
Dominant zooplankter		
Bosmina sp.	2.486	0.923 - 7.820
LOCATION 3: CAPWELL MILL POND		
Total Numbers	1.306	0.217 - 2.673
Dominant zooplankter		
Bosmina sp.	1.033	0.109 - 2.174
LOCATION 4: BIG RIVER		
Total Numbers	0.632	0.299 - 0.973
Dominant zooplankter		
Copepoda nauplii	0.307	0.141 - 0.595
LOCATION 5: CARR RIVER		
Total Numbers	0.187	0.140 - 0.295
Dominant zooplankter		
Copepoda nauplii	0.080	0.023 - 0.147
LOCATION 6: NOOSENECK RIVER: within proposed reservoir area		
Total Numbers	.036	0.0 - 0.220
Dominant zooplankter		
Copepoda copepodites	.036	0.0 - 0.220
LOCATION 7: NOOSENECK RIVER: outside proposed reservoir area		
Total numbers	1.174	0.660 - 1.873
Dominant zooplankter		
Rotifera	0.660	
Lecane sp.	0.257	

AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED NL

3 of 9

TABLE 5.2-3. DRY AND ASH-FREE DRY WEIGHTS (mg/l) OF ZOOPLANKTON FROM BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

	$\bar{x}$ Dry Weight	$\bar{x}$ Ash-free Dry Weight
Location 1: Flat River Reservoir	0.019 mg/l	0.003 mg/l
Location 2: Tarbox Pond	0.015	0.010
Location 3: Capwell Mill Pond	0.059	0.043
Location 4: Big River	1.477	0.043
Location 5: Carr River	0.198	0.022
Location 6: Nooseneck River	0.198	0.077
Location 7: Nooseneck River	0.121	0.066

pod copepodites and nauplii, are adapted to both open and shallow water regions of the pond habitat (Odum, 1971). Total zooplankton abundance averaged 1.30 organisms/ liter (Table 5.2-2).

Mean dry and ash-free dry weights were 0.059 mg/l and 0.043 mg/l, respectively (Table 5.2-3). These biomass values were the highest observed at any lentic location and reflect the abundance of *Bosmina* sp.

Big River

Total zooplankton abundance averaged 0.63 organisms/liter, with copepod nauplii accounting for over 50% of the community (Table 5.2-2). Rotifer genera, *Keratella* sp. and *Synchaeta* sp., which are typical of slow-moving rivers and streams (Whitton, 1975), were also observed. Mean dry and ash-free dry weights were 1.477 mg/l and 0.043 mg/l, respectively (Table 5.2-3).

Carr River

Zooplankton abundances in the Carr River were low with only 0.18 organisms/liter observed; the remainder of the community was composed of various rotifer genera. Copepod nauplii were predominant, having densities of 0.08 organisms/liter (Table 5.2-2). Mean dry and ash-free dry weights were 0.198 mg/l and 0.022 mg/l respectively (Table 5.2-3). These were the lowest biomass values recorded for any lotic location.

Nooseneck River (within proposed reservoir area)

Net zooplankton were sparse at this fast-flowing, clear water location (Table 5.2-2). Copepod copepodites were the only zooplankton observed and are characteristic of swift-flowing stream habitats (Odum, 1971; Whitton, 1975). Mean dry and ash-free dry weights were 0.198 mg/l and 0.077 mg/l, respectively (Table 5.2-3). These comparatively high biomass values were probably a result of the high concentration of brown humic matter collected in the samples.

Nooseneck River (outside of proposed reservoir area)

The zooplankton community was characterized by rotifers, primarily *Lecane* sp., having a density of 0.66 organisms/liter (Table 5.2-2). *Lecane* sp. in addition to *Monommata* sp., *Trichocera* sp., and *Keratella* sp., are rotifers commonly found in littoral regions of slow-moving waters (Edmondson, 1966). Copepod nauplii, and the waterflea (*Bosmina* sp.) were also recorded. Mean dry and ash-free weights were 0.121 mg/l and 0.066 mg/l, respectively (Table 5.2-3).

Summary

Copepod nauplii, rotifers, and *Bosmina* sp. characterized the net zooplankton community throughout the study area. Rotifers, and some copepod nauplii characterized the stream and river communities whereas *Bosmina* sp. was restricted to the open-water habitats.

Bosmina sp. exhibited the greatest overall abundances observed at Tarbox and Capwell Mill Ponds. This cladoceran is common throughout North American ponds and is considered to be an important food source for young carnivorous fish (Reid, 1961; Edmondson, 1966).

Rotifers, primarily *Lecane* sp. and *Keratella* sp., were common within the study area and are the forms considered to be predominant among typical river zooplankton; rotifers are a primary food source for many small fish (Prouse, 1966 cited in Whitton, 1975). The composition and abundance of the zooplankton phyla observed are representative of temperate fresh-water communities (Whitton, 1975).

6.0 BENTHIC MACROINVERTEBRATES

6.1 METHODS

Triplicate quantitative samples were collected with a Ponar grab (523 cm^2) from four sampling locations, and triplicate quantitative Surber samples (0.09 m^2; 1024 μ mesh) were taken at three sampling locations during the week of August 28 (Figure 2.1-1). Ponar samples were collected at Locations 1, 2, 3 and 4; Surber samples were collected at Locations 5, 6 and 7.

Ponar grab samples were washed in the field through a U.S. Standard #30 sieve (600 μ). All samples were preserved in a 10% formalin/ rose bengal solution and returned to the laboratory for processing. In the laboratory, samples were transferred to a white sorting tray and organisms removed by hand picking. The organisms were then placed in a final preservative of 70% ethanol and later counted and identified to the lowest practical taxon using the following major taxonomic references: Usinger (1956); Hilsenhoff (1975); Parrish (1975); Beck (1976); Edmunds, *et al.* (1976); and Wiggens (1977). Chironomid specimens were mounted in polyvinyl-lacto-phenol and identified under a compound microscope. All other organisms were identified using a stereo-dissecting microscope.

Numbers per sample were extrapolated to number per m^2 by direct multiplication based on area sampled. Species richness (number of taxa), percent occurrence of organisms, importance rank and standing crop were calculated for all samples.

Standing crop data (wet weights) were determined by removing organisms from the final preservative, placing them on blotting paper for five minutes, and weighing to the nearest 0.1 milligram on an analytical balance.

6.2 RESULTS AND DISCUSSION

The distribution of stream benthic macroinvertebrates has been shown to be dependent upon the intercorrelated factors of current (Scott, 1958), substrate (Ulfstrand, 1967; Minshall, 1968), detritus accumulation (Nelson and Scott, 1962; Hynes, 1963; Egglishaw, 1964; Minshall, 1967), and macrophytes (Percival and Whitehead, 1930; Minckley, 1963). It was apparent that two distinct habitat types existed during surveys conducted in August 1978 (See Section 2.0).

A checklist of all benthic macroinvertebrates collected and their relative abundance by location are presented in Appendix A. Data extracted from Appendix A are summarized within the text of this section.

LENTIC SITES

Flat River Reservoir

Three Ponar samples yielded an average of 1509 organisms/m^2 (range 1012-2122) representing 15 taxa (Table 6.2-1). The mean wet weight of observed taxa was 0.1703 mg/m^2 (range 0.0527-0.3200). Annelida (50.9%) and Diptera (39.3%) dominated the benthic community (Table 6.2-2). The Chironomid family dominated by *Cricotopus* and *Chironomus*, comprised 37.7% of the observed Diptera; *Chaoborus* was the only other Diptera collected. Molluscan fauna consisted of snails (Gastropoda) and clams (Pelecypoda). Trichoptera were represented by *Lype* and *Hydropsyche*. Other less abundant taxa observed were: Odonata (0.5%), Nematoda (0.5%) and Turbellaria (2.5%) (Appendix A).

Tarbox Pond

Three Ponar samples yielded an average of 267 organisms/m^2 (range 153-344) representing four taxa. The mean wet weight of observed

TABLE 6.2-1. SUMMARY OF BENTHIC MACROINVERTEBRATE COMMUNITY STRUCTURE FROM BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

	Number and type of Quantitative Samples	Mean number of organisms (No./m^2)	Mean Wet Weight (mg/m^2)	Total Number of Taxa	Dominant Taxa IR** Taxon
Flat River Reservoir	3 Ponars	1,509 (1,012-2,122)*	0.1703 (0.0527-0.3200)	15	1. Oligochaeta 2. *Cricotopus* 3. *Chironomus*
Tarbox Pond	3 Ponars	267 (153- 344)	0.0178 (0.0004-0.0301)	4	1. Oligochaeta 2. *Procladius* 3. *Chaoborus*
Capwell Mill Pond	3 Ponars	1,231 (402-2,124)	0.2358 (0.0121-0.3876)	13	1. *Cricotopus* 2. *Asellus* 3. Oligochaeta
Big River	3 Ponars	3,246 (1,607-5,341)	2.0288 (0.9024-3.4331)	34	1. *Hyalella azteca* 2. Oligochaeta 3. Gastropoda
Carr River	3 Surbers	4,520 (3,006-6,375)	2.8222 (1.4322-5.3853)	31	1. *Hydropsyche* 2. *Polypedilum* 3. *Stelemis*
Nooseneck River (Inside)	3 Surbers	1,387 (733-2,383)	0.3375 (0.1288-0.7203)	36	1. *Tanytarsus* 2. *Stenonema* 3. Simuliidae
Nooseneck River (Outside)	3 Surbers	15,651 (9,691-25,557)	5.1015 (3.3614-7.6267)	59	1. *Stenonema* 2. *Hydropsyche* 3. Turbellaria

* Range values in parenthesis

** Importance Rank (based on density)

TABLE 6.2-2. PERCENT COMPOSITION OF BENTHIC MACROINVERTEBRATE TAXA COLLECTED FROM BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

	FLAT RIVER RESERVOIR	TARBOX POND	CAPWELL MILL POND	BIG RIVER	CARR RIVER	NOOSENECK RIVER (Inside)	NOOSENECK RIVER (Outside)
Annelida	50.9	47.8	10.9	21.9	3.6	0.8	2.1
Mollusca	4.7	-	5.7	4.4	0.2	-	3.4
Crustacea	-	-	28.0	51.1	-	-	0.8
Ephemeroptera	-	-	-	6.0	3.3	15.8	27.5
Odonata	0.5	-	1.0	1.1	0.2	0.3	2.0
Plecoptera	-	-	-	-	-	10.0	0.3
Coleoptera	-	-	-	-	6.0	5.4	8.8
Megaloptera	-	-	-	1.8	1.5	3.4	2.2
Trichoptera	1.6	-	0.5	3.2	68.3	21.0	24.1
Diptera	39.3	52.2	53.4	9.9	16.9	42.5	21.6
Other	3.0	-	0.5	0.6	-	0.8	7.2

taxa was 0.0178 mg/m^2 (range 0.0004-0.0301; Table 6.2-1). Diptera (52.2%) and Annelida (47.8%) were the only taxa collected. Observed dipterans included *Procladius, Chaoborus* and *Cricotopus* (Appendix A).

Capwell Mill Pond

Three Ponar samples yielded an average of 1231 organisms/m^2 (range 402-2124) representing 13 taxa. The mean wet weight of observed taxa was 0.2358/m^2 (range 0.0121 - 0.3876; Table 6.^-1). Diptera (53.4%), Crustacea (28.0%), Annelida (10.9%) and Mollusca (5.7%) were the dominant constituents of the benthic community (Table 6.2-2). Chironomids represented the dipterans, with *Cricotopus* dominant. *Cricotopus* was also the most abundant organism from Capwell Mill Pond. The most abundant Crustacean was *Asellus*, although *Hyalella azteca* was also present; these taxa are important in lentic systems as they provide a forage base for endemic fish species. Molluscan taxa included only snails (Gastropoda); other less abundant taxa observed were Odonata (1.0%), Trichoptera (0.5%) and Hydracarina (0.5%) (Appendix A).

Big River

Three Ponar samples yielded an average of 3,246 organisms/m^2 (range 1607 - 5341) representing 34 taxa. The mean wet weight of observed taxa was 2.0288 mg/m^2 (range 0.9024 - 3.4331; Table 6.2-1). Crustacea (51.1%), Annelida (21.9%) and Diptera (9.9%) were the dominant taxa collected (Table 6.2-2). *Hyalella azteca* (the dominant organism from Big River) and *Asellus* comprised most of the Crustacea collected. Observed dipterans included *Polypedilum, Tanytarsus, Guttipelopia* and *Procladius*. The Ephemeroptera, represented by six taxa, are common inhabitants of lentic conditions (*Caenis, Centroptilum, Ephemerella, Hexagenia, Stenonema* and *Paraleptophlebia*). Similarly, the Trichoptera collected were representatives of lentic habitats and included *Ceraclea; Oecetis, Lype* and *Phylocentropus*. Other less abundant taxa observed included Mollusca (4.4%), Odonata (1.1%) and Megaloptera (1.8%) (Appendix A).

LOTIC SITES

Carr River

Three Surber samples yielded an average of 4520 organisms/m^2 (range 3006-6375) representing 31 taxa. The mean wet weight of observed taxa was 2.8222 mg/m^2 (range 1.4322 - 5.3853; Table 6.2-1). Trichoptera (68.3%), Diptera (16.9%) and Coleoptera (6.0%) were the dominant taxa observed (Table 6.2-2). *Hydropsyche* was the dominant genus of the seven trichopteran taxa collected and was also the most abundant organism collected from Carr River. *Polypedilum* was the dominant dipteran taxa collected. *Stelemis* was the most abundant Coleopteran collected. Taxa collected less-frequently included Annelida (3.6%), Mollusca (0.2%), Ephemeroptera (3.3%), Odonata (0.2%) and Megaloptera (1.5%) (Appendix A).

Nooseneck River - Inside

Three Surber samples yielded an average of 1387 organisms/m^2 (range 733 - 2383), representing 36 taxa (Table 6.2-1). The mean wet weight of observed taxa was 0.3375 mg/m^2 (range 0.1288 - 0.7203). Diptera (42.5%), Trichoptera (21.0%), Ephemeroptera (15.8%) and Plecoptera (10.0%) dominated the benthic community (Table 6.2-2). *Tanytarsus* was most abundant of the 13 Diptera taxa collected. *Hydropsyche* was the dominant trichopteran. The Ephemeroptera (5 taxa) were dominated by one taxa (Stenonema) as were the Plecoptera (Leuctra). Other less abundant taxa collected were Annelida (0.8%), Odonata (0.3%), Coleoptera (5.4%) and Megaloptera (3.4%) (Appendix A).

Nooseneck River - Outside

Three Surber samples yielded an average of 15,651 organisms/m^2 (range 9,691 - 25,557) representing 59 taxa (Table 6.2-1). The mean wet weight of observed taxa was 5.1015 mg/m^2 (range 3.3614 - 7.6267). Ephemeroptera (27.5%), Trichoptera (24.1%) and Diptera (21.6%) dominated the benthic community (Table 6.2-2). The Ephemeroptera (5 taxa) and Trichoptera (11 taxa) were each dominated by one taxon, *Stenonema* and *Hydropsyche*, respectively. Dipterans accounted for 18 taxa with *Polypedilum, Tanytarsus, Conchapelopia* and Simuliidae most abundant. Other less-abundant taxa collected were Annelida (2.1%), Mollusca (3.4%) Crustacea (0.8%), Odonata (2.0%), Plecoptera (0.3%), Coleoptera (8.8%), and Megaloptera (2.2%) (Appendix A).

Summary

A greater abundance of benthic macroinvertebrates was observed from the lotic locations than the lentic locations; similar trends were observed for standing crop and species richness (number of taxa). The depauperate density, standing crop, and species richness values observed from Flat River Reservoir and Capwell Mill and Tarbox Ponds may have been caused by either unsuitable environmental conditions (substrate composition) or heavy predation by populations of insectivorous fish species.

The composition of benthic fauna from Flat River Reservoir, Tarbox and Capwell Mill Ponds and Big River was characteristic of lentic habitats whereas benthic fauna from Carr River and Nooseneck River (inside and outside the proposed impoundment) were indicative of lotic habitats. There were no benthic taxa collected within the Big River Reservoir study area that are considered endangered or threatened (USDI 1976).

Classification of observed benthic fauna as clean water, facultative, or pollution-tolerant organisms by location was not entirely appropriate. Although there were pollution-tolerant taxa present from each location, this did not imply gross pollution conditions as supported by the water quality survey (See Section 2.3). Although benthic communities observed from lentic locations contained fewer taxa than those observed from lotic locations, this was attributed to physical (substrate) rather than chemical (pollution) variations between locations.

A review of the literature revealed that one other benthic macroinvertebrate survey has been conducted in the Big River Study area. A preliminary survey conducted by KAME (1976) identified similar benthic taxa to those collected during the present study. However, the total number of taxa observed during this August survey exceeded those reported by KAME (1976).

The location with highest density, standing crop and species richness was the Nooseneck River (outside the proposed impoundment). The water quality parameters, pH (4.7) and dissolved oxygen (3.45 mg/l), measured in a pool upstream from the actual sampling site were indicative of poor water quality. Dissolved oxygen and pH, however, did not appear to be limiting factors at the actual sampling site downstream from the pool as indicated by the abundance and diversity of benthic organisms. Surber samples were taken downstream, approximately 100 feet beyond where the river flowed over a small dam, a 25-foot riffle area, and a small waterfall. In this distance, the moderate to high amounts of water agitation was probably sufficient to increase D.O. concentrations which would be adequate to support benthic fauna. Furthermore, before and during the time of sampling there was consistent rain shower activity which has been shown to be acidic in the northeast region (Schofield, 1972; Dochinger and Seliga, 1976). In addition, leaching of acid soil pore waters during rainfall can temporarily decrease the pH of surface runoff and subsequently the stream system (Miller and Drever, 1977). It is possible that after cessation of the rain, and normal stream flow equilibrium was reached, pH values could have approached the 5.5 to 6.0 range. If it is recognized that these two mechanisms were operating, the reported values may not reflect the true environmental conditions imposed on the benthic communities of the Nooseneck River and may only represent a temporary or short-term condition within the environment.

Overall, the lotic locations supported benthic macroinvertebrate communities of higher densities, standing crop and species richness (number of taxa) than those observed from lentic locations. It was also apparent the lotic habitats supported stable benthic communities of higher diversity and lower faunal repetition than those observed from the lentic habitats. These observations are related to an observed greater substrate microhabitat complexity and a correspondingly complex and diverse association of benthic taxa present within the lotic habitats.

7.0 REPTILES AND AMPHIBIANS

7.1 METHODS

A survey of reptiles and amphibians existing within the Big River Reservoir study area was conducted in conjunction with the aquatic, vegetation and terrestrial field surveys during the period 21 August through 1 September 1978. Likely habitats such as the undersides of decaying logs, rocks, litter, and the edges of water bodies were searched for adults, young, and sign. All reptiles and amphibians observed were identified and enumerated. During the survey, no endangered or threatened species were observed, nor are there any known to exist in Rhode Island (USDI, 1976).

7.2 RESULTS AND DISCUSSION

Two species of reptiles and two species of amphibians were collected during the study period. One snapping turtle (*Chelydra serpentina*) and one eastern painted turtle (*Chrysemys picta picta*) were collected at Tarbox Pond. Four pickerel frogs (*Rana palustris*) were collected along the shoreline of Big River, whereas three green frogs (*Rana clamitans*) were collected along the banks of the Carr River, and one green frog was observed along the shoreline of Nooseneck River, within the proposed reservoir area. The eastern painted turtle and green frog have been reported within the Big River Reservoir area (Kame, 1976). As a supplement to species observed, a comprehensive list of reptiles and amphibians which may be present within the study area was compiled from the literature (Drowne, 1905; Conant, 1975) and is presented in Table 7.2-1.

The existence of a diversity of suitable habitats within the study area suggest that the herptile community is more diverse and dynamic than was apparent from the limited field surveys. Other species of reptiles (snakes and turtles) and amphibians (frogs, toads and salamanders) undoubtedly exist within the wetland, meadow and woodland habitats of the Big River Reservoir study area.

TABLE 7.2-1. CHECKLIST OF REPTILES AND AMPHIBIANS POSSIBLY OCCURRING WITHIN THE BIG RIVER RESERVOIR STUDY AREA.

Snapping Turtle	*Chelydra serpentina*
Bog Turtle*	*Chlemmys muhlenbergi*
Wood Turtle	*Chlemmys insculpta*
Spotted Turtle	*Chlemmys guttata*
Stinkpot	*Sternotherus odoratus*
Diamondback Terrapin	*Malaclemys terrapin*
Painted Turtle	*Chrysemys picta*
Box Turtle	*Terrapene carolina*
Water Snake	*Natrix sipedon*
Garter Snake	*Thamnophis sirtolis*
Ribbon Snake	*Thamnophis sauritus*
Red-bellied Snake	*Storeria occipitomaculata*
Brown Snake	*Storeria dekayi*
Eastern Hognose Snake	*Heterodon platgrhinos*
Worm Snake	*Carphophis amoenus*
Ringneck Snake	*Diadophis punctatus*
Smooth Green Snake	*Opheodrys vernalis*
Racer	*Coluber constrictor*
Rat Snake	*Elaphe obsoleta*
Milk Snake	*Lampropeltis triangulum*
Rattlesnake*	*Crotalus horridus*
Mudpuppie*	*Necturus maculosus*
Red-spotted Newt	*Notophtalmus viridescens*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Dusky Salamander	*Desmognathus fuscus*
Red-backed Salamander	*Plethodon cinereus*
Four-toed Salamander	*Hemidactylium scutotum*
Two-lined Salamander	*Eurycea bislineata*
Eastern Spadefoot Toad	*Scaphiopus holbrooki*
American Toad	*Bufo americanus*
Fowler's Toad	*Bufo woodhousei*
Spring Peeper	*Hyla crucifer*
Gray Treefrog	*Hyla versicolor*
Gray Treefrog	*Hyla chrysoscelis*
Green Frog	*Rana clamitans*
Bullfrog	*Rana catesbeiana*
Pickerel Frog	*Rana palustris*
Wood Frog	*Rana sylvatica*

*Isolated records

8.0 FINFISH

8.1 METHODS

Sampling for adult and juvenile fish was conducted at each of the seven sampling locations (Figure 2.0-1) during the week of 28 August 1978 to determine species abundance, composition and spatial distribution.

A combination of three collection techniques, seining, electrofishing and gill netting was required to adequately sample the various habitats and overcome the selectivity of each individual method. This sampling design was utilized to provide a comprehensive characterization of the existing fishery within the Big River Reservoir study area.

A minimum of four seine hauls were made at each location with a 20 ft x 6 ft straight seine made of 1/8 inch bar mesh. Accessible habitats within a given location (pools, riffles and unobstructed shoreline areas) were seined to more accurately characterize those segments of the population containing young-of-the-year individuals and forage "minnow" species.

Electrofishing was conducted at the lotic habitats (Locations 4,5,6 and 7) using a Honda back-pack electrofishing unit (Model EM400, 110 volts AC). Two of the lentic habitats (Locations 1 and 2) were sampled with a boat-mounted electrofishing unit having an electrical output of 230 volts AC. The third lentic habitat (Location 3), Capwell Mill Pond, was not sampled by either method of electrofishing due to lack of access for the boat-shocker and to the dense growth of aquatic vegetation around the shoreline which negated back-pack electrofishing. A collection effort of 30 minutes electrofishing time was expended within the various habitats at each location. Fish collected by electrofishing were held in tubs of water until processing and then returned to the water.

Gill nets were utilized for collecting fish at Location 2 (Tarbox Pond) and Location 3 (Capwell Mill Pond). The gill nets were 100 ft x 6 ft and constructed of 1/2, 3/4, 1, 1 1/2 and 2 inch (bar measure) monofilament mesh. Two nets were set in the open water areas of each pond overnight for a 15 hour period. The nets were retrieved the following morning and the fish were removed and processed. Gill netting was not conducted at Location 1 (Flat River Reservoir) due to the extensive growths of rooted aqatic vegetation which covered the entire surface of the lower arm of the reservoir.

All fish collected by seining, electrofishing and gill netting were identified to species using appropriate taxonomic keys (Eddy, 1957; Mugford, 1969; and Scott and Crossman, 1973), enumerated, weighed (in grams), measured in total length (mm), and examined for external parasites, disease and physical abnormalities. Fish collected by seining were preserved in 10% formalin and returned to the laboratory for positive identification. In addition, representatives of all species collected were retained for a reference collection.

Analysis for chlorinated insecticides, PCB's and heavy metals in fish tissue was to be performed on two species of fish from each of three selected sampling locations. However, a sufficient quantity (biomass) of fish tissue was only obtained from golden shiner and yellow perch at Location 2, Tarbox Pond. Analysis for the determination of chlorinated insecticides and PCB's was conducted following methods outlined by the U. S. Food and Drug Administration (1971) and AOAC (1970). Analysis for heavy metals (mercury, selenium, cadmium and lead) followed methods outlined by U. S. Environmental Protection Agency (1974) and AOAC (1975).

8.2 RESULTS AND DISCUSSION

Species Abundance, Composition and Spatial Distribution

Scientific and common names of all fishes reported are in accordance with Bailey (1970) and are listed in Table 8.2-1.

A total of 170 individuals representing 15 species of fish, including one hybrid was collected during the sampling period; the majority of fishes representing the minnow and sunfish families (Table 8.2-2). Species diversity was similar between the lentic and lotic habitats (10 and 11 species, respectively), however, species composition differed which was a reflection of the habitat preferences of the various species. During the study no endangered or threatened species (USDI, 1976) were collected.

Lentic Habitats

The most abundant fish collected, in decreasing order of abundance, were largemouth bass, golden shiner, pumpkinseed, yellow perch and banded sunfish. No incidence of external parasites, disease or physical abnormalities was observed.

Species composition and fish abundance were greatest at Location 2 (Tarbox Pond) (Table 8.2-2). This location had a larger area of open water and less dense growth of rooted aquatic vegetation than Locations 1 and 3. These physical features appeared to be the major factors causing the differences in fish collected between these locations since temperature and dissolved oxygen were not limiting and water quality, in general, was similar (See Table 2.3-1).

Only five fish representing three species were collected at Location 1 (Flat River Reservoir). Electrofishing was ineffective and seining was non-productive due to the extensive growths of rooted and floating aquatic vegetation. Flat River Reservoir is undoubtedly more

TABLE 8.2-1. CHECKLIST OF FISHES COLLECTED WITHIN THE PROPOSED BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

Family and Scientific Name	Common Name
Salmonidae - trouts	
Salvelinus fontinalis	Brook trout
Esocidae - pikes	
Esox americanus	Redfin pickerel
E. niger	Chain pickerel
E. americanus X *E. niger hybrid*	Redfin X Chain hybrid
Cyprinidae - minnows and carps	
Notemigonus crysoleucas	Golden shiner
Notropis bifrenatus	Bridle shiner
Semotilus corporalis	Fallfish
Catostomidae - suckers	
Catostomus commersoni	White sucker
Erimyzon oblongus	Creek chubsucker
Ictaluridae -freshwater-catfishes	
Ictalurus nebulosus	Brown bullhead
Centrarchidae - sunfishes	
Enneacanthus obesus	Banded sunfish
Lepomis gibbosus	Pumpkinseed
Micropterus salmoides	Largemouth bass
Percidae - perches	
Etheostoma fusiforme	Swamp darter
Perca flavescens	Yellow perch

TABLE 8.2-2. NUMBERS OF FISH COLLECTED BY SAMPLING METHOD AT THE LENTIC AND LOTIC HABITAT LOCATIONS WITHIN THE BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

	LENTIC HABITAT LOCATIONS								LOTIC HABITAT LOCATIONS										
	1		2			3		Sub-Total Number	4		5		6		7		Sub-Total Number	Grand Total	Percent of Total Catch
	EF[a]	S[b]	EF	S	GN[c]	S	GN		EF	S	EF	S	EF	S	EF	S			
Brook trout	-[d]	-	-	-	-	-	-	0	-	-	-	-	4	-	-	-	4	4	2.3
Redfin pickerel	-	-	-	-	-	-	-	0	-	1	-	-	7	-	-	-	8	8	4.7
Chain pickerel	-	-	1	-	-	-	-	1	-	2	1	-	-	-	-	-	3	4	2.3
Redfin X Chain pickerel	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	0	2	1.2
Golden shiner	-	-	-	-	5	-	6	11	-	-	-	-	-	-	-	-	0	11	6.5
Bridle shiner	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	48	49	50	29.4
Fallfish	-	-	-	-	-	-	-	0	-	-	-	-	5	1	-	-	6	6	3.5
White sucker	-	-	-	-	-	-	-	0	-	-	-	-	5	-	-	-	5	5	2.9
Creek chubsucker	-	-	-	4	-	-	-	4	-	-	-	-	-	-	-	3	3	7	4.1
Brown bullhead	-	-	-	-	-	-	-	0	-	-	-	1	1	-	-	-	2	2	1.2
Banded sunfish	-	-	-	5	-	1	-	6	-	-	-	-	-	-	-	-	0	6	3.5
Pumpkinseed	-	-	7	1	-	-	-	8	-	8	-	-	-	-	-	-	8	16	9.4
Largemouth bass	-	1	4	11	-	3	-	19	-	3	-	1	5	-	-	-	9	28	16.5
Swamp darter	-	3	-	-	-	-	-	3	-	10	-	-	-	-	-	-	10	13	7.6
Yellow perch	-	-	1	-	7	-	-	8	-	-	-	-	-	-	-	-	0	8	4.7
Total No. of Species	0	3	4	5	2	2	1	10	0	5	1	2	6	1	1	2	11	15	
Total No. of Fish	0	5	13	23	12	4	6	63	0	24	1	2	27	1	1	51	107	170	

[a]EF = Electrofish

[b]S = Seine

[c]GN = Gill net

[d]No Fish Collected

diverse in species composition and relative fish abundance than indicated from this study. Guthrie and Stolgitis (1977) list nine species of fish that inhabit Flat River Reservoir and cite it as one of the best largemouth bass fishing areas in the state.

Although only ten fish representing three species were collected at Location 3 (Capwell Mill Pond) it is also likely that this pond is more productive and diverse than the data indicate. Extensive and dense growths of rooted and floating aquatic vegetation inhibited effective sampling by seining and gill netting. Guthrie and Stolgitis (1977) describe several ponds in southern Rhode Island with physical and chemical features similar to those of Capwell Mill Pond. These ponds generally contained from seven to fourteen species with varying abundances.

Flat River Reservoir, Tarbox Pond and Capwell Mill Pond also afford suitable habitats for natural reproduction of various species. This was evident in the collection of young-of-the-year (Age 0) pumpkinseed and largemouth bass from these locations (Table 8.2-3). The determination of Age 0 was assigned on the basis of data presented by Carlander (1977). Determination of the magnitude of successful reproduction and the standing crop of fishes was not within the scope of this study; however, Guthrie and Stolgitis (1977) reported average standing crops to range from 40 to 80 pounds/acre with extremes ranging from 14 to 500 pounds/acre in Rhode Island ponds and lakes.

Considering the major factors responsible for variations in fish standing crops (Bennett, 1971), low fertility and species composition appear to be the primary factors limiting standing crops in Rhode Island. The low fertility of Rhode Island lakes and ponds is related to infertility of the associated watersheds; this condition was well documented in a previous study by Guthrie and Stolgitis (1977). Bennett (1971) cited studies which presented standing crops of fish that averaged 50-150 pounds/acre in natural lakes, whereas in artificial impoundments standing crops averaged from 200-400 pounds/acre. Results of the water quality survey (See Section 2.3) indicated that all of the lentic locations within the study area were of low fertility.

TABLE 8.2-3. SUMMARY OF TOTAL LENGTH, WEIGHT AND NUMBERS OF FISH COLLECTED AT THE LENTIC HABITAT LOCATIONS WITH ALL SAMPLING METHODS COMBINED, BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

Species	Total Number Fish	Total Length (mm)		Weight (g)	
		Mean	Range	Mean	Range
Chain pickerel	1	86	-[a]	<5	-
Redfin x chain pickerel	2	150	75 - 225	@33	<5 - 63
Golden shiner	11	196	184 - 226	105	78 - 231
Bridle shiner	1	24	-	<5	-
Creek chubsucker	4	56	47 - 63	<5	<5
Banded sunfish	6	33	23 - 52	<5	<5
Pumpkinseed	8	42	33 - 46	<5	<5
Largemouth bass	19	61	52 - 95	<5	<5
Swamp darter	3	30	27 - 33	<5	<5
Yellow perch	8	233	218 - 276	168	122 - 280

[a] Not applicable

The relatively low standing crops of fish in Rhode Island lakes and ponds compared to averages exceeding 200 pounds/acre in fertile midwest lakes and reservoirs (Carlander, 1955) can also be considered a function of low species diversity. Imbalance in the food chain structure caused by limited abundance of forage base species (planktivores and herbivores) and a predominance of game species (insectivores and carnivores) can also influence the standing crop and carrying capacity, which in turn may be related to the low levels of fertility within the watershed. It is the interrelationships of the chemical, physical and biological factors which influence and regulate species composition, standing crop and carrying capacity. In their survey of the lakes and ponds of southern Rhode Island, Guthrie, *et al.* (1973) reported that forage base species represented only 30% of the total numbers of fish collected and 19% by weight, whereas carnivores or "predators" represented 22% of the standing crop. Guthrie, *et al.* (1973) applied the single criteria of predator standing crop as an indicator of "pond balance" and conditionally concluded that the predator populations in terms of standing crop, indicate "good pond balance".

The redfin x chain pickerel hybrid, golden shiner, banded sunfish and yellow perch were only collected within the lentic habitats during the present study. Although these species have been reported to occur in Rhode Island streams, they generally exhibit greater standing crops in ponds and lakes (Guthrie *et al.*, 1973). In a previous investigation (Guthrie and Stolgitis, 1977) yellow perch were ranked first in terms of abundance and standing crop in Rhode Island ponds, followed in terms of abundance, by pumpkinseed, bluegill, bridle shiner, golden shiner, chain pickerel and brown bullhead. Species reported as predominant (Guthrie, *et al.*, 1973) by standing crop were bluegill, largemouth bass, brown bullhead, lake chubsucker, pumpkinseed and chain pickerel

Lotic Habitats

The lotic habitats contained a wide diversity of species having low abundances (Table 8.2-2). In decreasing order of abundance, bridle shiner, swamp darter, largemouth bass, pumpkinseed and redfin pickerel collectively represented over 78% of the total numbers. Recently completed surveys (Guthrie *et al*. 1973; Preble, 1974) indicate that 30 species of fish occur in southern Rhode Island fresh-water streams. All stream species of fish collected during the present study have been reported in previous surveys. No incidence of external parasites, disease or physical abnormalities was noted.

Locations 4 (Big River) and 6 (Nooseneck River within the proposed reservoir area) exhibited a greater diversity of species than Locations 5 (Carr River) and 7 (Nooseneck River outside the proposed reservoir area). This was attributed to a greater diversity of habitats at Locations 4 and 6 and to a degree, more favorable water quality conditions. The low dissolved oxygen (D.O.) value (3.5 mg/l) and low pH (4.7) measured at Location 7 may have been limiting factors in terms of species composition and abundance. Although certain species of fish can exist in waters with D.O. values below 4.0 mg/l and pH values below 5.0 for considerable time periods, these conditions can eventually impair normal activity and growth (Jones 1964). The low D.O. and pH values at Location 7 were attributed to the presence of a vast cedar swamp directly upstream from this location. The Nooseneck River flows through this cedar swamp. Guthrie *et al*. (1973) reported D.O. values ranging from 0 to 7 mg/l during the late summer months in Rhode Island streams with an average of over 5.0 mg/l. The D.O. value of 0 mg/l occurred for a two day period when water temperature and BOD values were high and stream flow was low.

The presence of young-of-the-year individuals (Age 0) of chain pickerel, pumpkinseed and largemouth bass (Table 8.2-4) in the collections suggest that natural reproduction is occurring within the lotic habitats. The Age 0 determination was applied using criteria established by Carlander

TABLE 8.2-4. SUMMARY OF TOTAL LENGTH, WEIGHT AND NUMBERS OF FISH COLLECTED AT THE LOTIC HABITAT LOCATIONS WITH ALL SAMPLING METHODS COMBINED, BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

Species	Total Number Fish	Total Length (mm)		Weight (g)	
		Mean	Range	Mean	Range
Brook trout	4	179	140 - 246	73	32 - 165
Redfin pickerel	8	132	57 - 152	@17	< 5 - 22
Chain pickerel	3	94	50 - 170	13	< 5 - 32
Bridle shiner	49	43	22 - 58	< 5	< 5
Fallfish	6	127	72 - 151	@21	< 5 - 35
White sucker	5	176	127 - 200	66	29 - 100
Creek chubsucker	3	35	31 - 38	< 5	< 5
Brown bullhead	2	63	30 - 95	@ 7	< 5 - 12
Pumpkinseed	8	26	22 - 29	< 5	< 5
Largemouth bass	9	50	43 - 60	< 5	< 5
Swamp darter	10	39	28 - 48	< 5	< 5

(1969) and Preble (1974). It is possible, however, that these young-of-the-year individuals may have been migrants from contiguous ponds.

Due to small numbers of individuals in the sample collections, it was not possible to make other meaningful comparisons; this condition may be a consequence of the low standing crops of fishes within the lotic habitats. In general, the overall species composition and abundance of the lotic habitats within the Big River Reservoir study area appears to be less dynamic in comparison to the fisheries surveyed in the surrounding watersheds (Guthrie *et al.*, 1973; and Preble, 1974).

In the present study, brook trout, redfin pickerel, fallfish, white sucker and brown bullhead were only collected within the lotic habitats, however Guthrie *et al.* (1973) and Guthrie and Stolgitis (1977), reported that these species have also been collected in varying abundances throughout the lakes and ponds of Rhode Island. The occurrence and survival of brook trout is limited to only those lakes and ponds which have adequate depth and a sufficient volume of cool, well-oxygenated water, especially during the summer months.

Guthrie *et al.* (1973) classified Rhode Island streams as either cold-water or warm-water. The presence of native brook trout was used as the criteria in this stream classification. Applying this criteria to the study area, Nooseneck River could be classified as a cold-water stream and Big River and Carr River as warm-water streams. However, the limited amount of sampling permitted in the present scope of work precludes conclusive classification of these streams. The observed water temperature (18-22°C) did not appear to be limiting to brook trout within any of the lotic habitats. Brown (1974) reported that brook trout can exist in waters exceeding 22°C, however the preferred optimum temperature for this species is generally below 20°C. One other important factor which directly influences the occurrence and abundance of brook trout in streams is competition by other game species. Guthrie *et al.* (1973) reported, however, that brook trout can successfully coexist with redfin pickerel.

Guthrie *et al.* (1973) collected 14 species of fish from cold-water streams with brook trout being the dominant species in terms of relative abundance followed by redfin pickerel, white sucker, fallfish, longnose and blacknose dace, american eel and brown trout. Brook trout were also ranked first in standing crop followed by redfin pickerel and white sucker.

Fish populations inhabiting the warm-water streams surveyed by Guthrie *et al.* (1973) were represented by 25 species; the most abundant species were redfin pickerel, white sucker, fallfish, brown bullhead and sunfishes. Guthrie *et al.* (1973) and Preble (1974) stated that when large populations of yellow perch and sunfish (primarily largemouth bass and pumpkinseed) were found in warm-water streams, there were usually contiguous ponds nearby. They reported that these fish probably migrate from these ponds, since many of the warm-water streams are considered marginal in terms of their capacity to support yellow perch and sunfish populations.

In summarizing data from all of the streams surveyed by Guthrie *et al.* (1973) the white sucker ranked first in standing crop followed by the brook trout, brown trout, fallfish, yellow perch and redfin pickerel. These species collectively represented 78% of the mean estimated standing crop of 69.9 pounds/acre for all streams.

Sport Fishery Potential

The Big River watershed area is owned and managed by the State of Rhode Island with the exception of a few privately-owned dwellings. Accessibility to all of the ponds and streams within the Big River watershed is very good and is not a factor that would limit utilization by sport fishermen.

Based on the results of this study and a review of the surrounding watersheds, the existing ponds probably afford the best quality sport fishery available within the watershed. Although the ponds do not possess the physical characteristics necessary to support a trout fishery, they do afford suitable habitat and water quality for successful pickerel, sunfish, bass and perch sport fishing. Similar fisheries exist and have been successful within surrounding watersheds. Various pond management techniques have been practiced in Rhode Island including total reclaimation of ponds by eradicating overabundant undesirable species and stunted populations. Some ponds have been successfully stocked with forage species and others fertilized to increase primary productivity and the overall standing crop of fishes.

An undesirable characteristic of the ponds is the dense growths of aquatic vegetation, which limits angling success and the feasibility of offshore fishing. However, eradication of the aquatic vegetation to provide a more accessible and feasible sport fishery may not be cost-effective.

The streams within the Big River watershed offer a very limited sport fishery. Few individuals of a size adequate for consumption were collected and observed during the present study. Larger individuals which were present may have been migrants from nearby ponds and may, therefore, return to these ponds during periods of low water flow and dissolved oxygen.

Guthrie *et al.* (1973) reported that trout and pickerel were the only sport species of "catchable" size to exist in the cold-water streams within the Pawcatuck River watershed. This high quality trout fishery has been dependent upon "put and take" hatchery trout and has been very successful. The native brook trout populations, however, are restricted to the smaller streams and their small size offers little incentive to the sport fisherman. Results of a survey of the Moosup River watershed indicate that native brook trout, hatchery-reared brown trout and chain pickerel were the only "potential" gamefish present in sufficient numbers for sport fisherman utilization (Preble, 1974).

The warm-water streams may offer less sport fishery potential than the cold-water streams. Standing crops of Rhode Island warm-water streams were estimated to range between 9-200 pounds/acre with a mean of 80 pounds/acre (Guthrie *et al.* 1973). Generally when large standing crops of certain species occurred within a particular stream most individuals were less than legal size or of such a small size that sport fishermen were not attracted.

Based on the data collected during the present survey and a review of the surrounding watersheds, the warm-water stream fishery within the Big River watershed is probably of limited value and utilization.

Fish Tissue Analysis

Analysis of golden shiner and yellow perch fish tissue for chlorinated insecticides indicated no detectable contamination (Appendix B). Similarly, no gross contamination of the fish tissue with heavy metals was detected. Average values of 0.20 μg/g and 0.33 μg/g of mercury were recorded for golden shiner and yellow perch, respectively (Appendix B). For comparative purposes, a mean value of 0.37 μg/g and 0.41 μg/g of mercury was reported for golden shiner and yellow perch, respectively collected in the Merrimack River, New Hampshire (Wightman and Newell, 1971). The U. S. Food and Drug Administration (1978) has established a maximum allowable level of 1.0 μg/g mercury in fish flesh for edible consumption.

The amount of cadmium and lead detected in golden shiner and yellow perch from the Big River study area was considered low. Less than 0.1 μg/g of lead was determined in both golden shiner and yellow perch. Normandeau Associates, Inc. (1977) reported 0.33 μg/g of lead in the fish tissue of yellow perch from Lake Winnipesaukee, New Hampshire. The amount of selinium in the fish tissue samples was below the detectable level of 0.03 μg/g.

Although the sample size of fish collected in the Big River study area was small, there was no initial indication of gross contamination of fish tissue by chlorinated insecticides, PCB's or heavy metals.

9.0 WATER SUPPLY ALTERNATIVES

The following watersheds and associated diversions are presently under consideration as water supply alternatives designed to augment the water storage capacity of proposed Big River Reservoir. The alternatives are Flat River diversion, Wood River Reservoir and diversion, Bucks Horn Brook Reservoir and Moosup River Reservoir. The development of groundwater resources is also under consideration as an alternative water supply source. Big River Reservoir would serve as the central impoundment from which the water supply could be drawn to supplement the needs of the Providence, Rhode Island metropolitan area.

A thorough literature search was conducted and state and local agencies contacted in compiling biological and water quality information relavent to the alternate sites. This review of available information indicated that the existing data is not adequate to accurately describe the phytoplankton, periphyton, zooplankton, aquatic macrophyte, benthic macroinvertebrate and herptile communities within the proposed alternate areas. From the brief site visits, these alternate areas appear to be similar in species composition and relative abundance to the Big River Reservoir. Since these watersheds encompass the Big River Reservoir area from the southwest to the northwest, any differences which occur may be of a site-specific nature and of minor significance.

The following summary represents a compilation of four reports (Saila and Horton, 1957; Guthrie *et al*. 1973; Preble, 1974; and Guthrie and Stolgitis, 1977), describing the water quality, physical features and existing fisheries of the proposed alternatives.

Wood River Reservoir and Diversion and Flat River Diversion

The Wood River and Flat River are located southwest of the Big River area and within the Pawcatuck River watershed. A comprehensive description of the watershed is provided by Guthrie *et al*. (1973) and includes an analysis of the topography, climate, soils, geography and ground water, water quality, recreation and a chronology of the fishery.

Thirty species of fish have been reported from the freshwater streams of the Pawcatuck River watershed, the dominant species being the eastern brook trout and the chain pickerel. This watershed contains the largest single trout fishery in Rhode Island with an average of 44,000 trout stocked annually. The primary objective of the trout stocking program is to provide the greatest number of anglers with the optimum number of two-year old fish. The stocking of brook trout, brown trout and rainbow trout provides for a quality trout fishery on a "put and take" basis. The average tag return of 31.7% with a 100% return on some streams indicates that the fishery is being utilized. The overall objective of the Rhode Island Division of Fish and Wildlife is to attain an average of 50% returns. A native brook trout fishery also exists within the watershed, however, since individuals are smaller than the hatchery trout, little fishing pressure occurs. Even though the native brook trout may be smaller in size, they do afford a quality fishery which is available for utilization. Standing crops of native brook trout in streams with no recent stockings range from 4 to 263 pounds/acre and average 49 pounds/acre. The percentage of limit-size (6.5 inches) brook trout ranges from 0.2 to 32.5% and averages 10.3%. The redfin pickerel, which occupies the same habitats as the brook trout, is also an abundant game species in this watershed that is available for sport fishing.

The warm-water stream sport fishery within the Pawcatuck River watershed is not as extensive or productive as the cold-water fishery and contains very few numbers of limit-size game species. Only one of the sixteen warm-water streams surveyed by Guthrie *et al.* (1973) contained sufficient numbers of limit-size game fish (yellow perch, largemouth bass, white perch and bluegill) to be considered a productive sport fishery. Overall, the sport fishing value of the warm-water streams was considered very low due to the small standing crops of all other species.

The ponds and lakes of the Pawcatuck River watershed afford the angler a diverse and productive sport fishery. Yellow perch, white perch, bluegill, pumpkinseed, brown bullhead, largemouth bass, chain pickerel and smallmouth bass comprised nearly 81% of the total weight of fishes collected in 18 ponds surveyed by Guthrie *et al*. (1973). "Catchable" size individuals of these species were present in various ponds with yellow perch, bluegill and largemouth bass offering the greatest potential for sport fishing. The smallmouth bass, considered to be an indigenous species of Rhode Island and once an abundant game species, has declined in abundance during recent years with the introduction of other competitive species such as the largemouth bass and bluegill. Today, the smallmouth bass contributes only a small fraction to angling catches and to the overall standing crop of sport species.

Considering the current trout stocking programs implemented by the Rhode Island Division of Fish and Wildlife, the wide diversity of existing fisheries, and the high utilization of these fisheries by sportsmen, the Pawcatuck River watershed probably represents the most highly utilized and valued sport fishery in Rhode Island.

Moosup River Reservoir and Bucks Horn Brook Reservoir

The Moosup River and Bucks Horn Brook are located northwest of the proposed Big River Reservoir. Preble (1974) reported that the general water quality, bottom types and shoreline characteristics were of high quality and constituted ideal native brook trout habitat. The entire Moosup River system is classified as "A" grade waters with no known point-source discharges of pollution.

Existing sport fish species include native brook trout, hatchery brown trout and chain pickerel. The native brook trout are abundant in the tributaries of the Moosup River and utilize these streams for spawning. Bucks Horn Brook is classified as a major spawning area for native brook trout. Brown trout are most abundant in the lower Moosup

River and because of their presence and the competition they afford, brook trout abundance is limited. Chain pickerel, the only other potential game species, is abundant in the Moosup River and associated tributaries. This species also utilizes the tributaries for spawning.

Although yellow perch, largemouth bass, pumpkinseed and redear sunfish are present within the Moosup River and Bucks Horn Brook, their abundance is very low and not considered sufficient for utilization by anglers.

Preble (1974) proposed recommendations to the state which included rehabilitation of degraded areas along stretches of the Moosup River and Bucks Horn Brook in order to upgrade these areas so the classification "A" grade waters will be retained. He concluded that the "entire Moosup River watershed should be 1) managed as prime quality trout stream habitat, 2) remain unaltered, and 3) zealously guarded against any degradation."

The Moosup River and Bucks Horn Brook areas are therefore also highly valued for their sport fishing potential in Rhode Island.

10.0 IMPACTS OF THE PROPOSED RESERVOIR

The construction of Big River Reservoir would create an impoundment having a surface area of 5.9 square miles (3,776 acres) and a maximum depth of 55 feet. The shoreline would remain in its present undeveloped state consisting of hardwood and hardwood-softwood mixed forests.

Big River Reservoir would be second in size in terms of total surface acres to Scituate Reservoir, an existing water supply impoundment, in Rhode Island. Projection of the limnological characteristics of the proposed Big River Reservoir by means of comparisons with Scituate Reservoir is not possible due to a lack of aquatic research studies on Scituate Reservoir. However, Big River Reservoir may be compared to Beach Pond or Wallum Lake, both of which exhibit similar chemical, aquatic and fishery characteristics as are projected for the reservoir. Moreover, recent limnological and fishery data has been compiled for both areas.

It is expected that the primary productivity of Big River Reservoir would be enchanced during the first few years of impoundment. This would be a direct result of enrichment by the organic matter and associated nutrients contributed by the flooded forest. Concurrently, zooplankton and benthic macroinvertebrate diversity and abundance would also attain maximum standing crops due to the initial abundance of food sources. It has been well documented, however, that the watersheds within Rhode Island are basically infertile. It is expected therefore, that Big River Reservoir would most likely undergo a degression to a state of low fertility due to gradual exploitation of the organic matter and in the absence of continued nutrient enrichment from the surrounding watershed. Throughout the degressive process the plankton (primary producers) and benthic communities would also undergo a reduction in overall production. The initial carrying capacities of aquatic biota attained during the first years of impoundment would be reduced to a new equilibrium.

Due to its dependence upon primary productivity the carrying capacity of the fishery would undergo a similar decline. A concurrent increase in natural mortality and decrease in growth rates would occur due to the decline in productivity and related food sources.

It is anticipated that the reservoir would be thermally stratified and contain a cool, well oxygenated hypolimnion having the potential to support a trout fishery. Beach Pond and Wallum Lake presently exhibit these characteristics. Assuming the reservoir would be available for public use, the Rhode Island Division of Fish and Wildlife would have to decide whether to manage the reservoir as a cold-water or a warmwater fishery. The estimated level of demand for fishing would be a function of the potential fishery yield of Big River Reservoir. This yield is expected to be similar to existing lakes and reservoirs in Rhode Island and would exhibit the characteristics of either a cold-water or warm-water fishery.

The successful development of a quality fishery resource would be dependent upon good management practices and public cooperation and participation throughout the life of the reservoir. The reservoir would offer a more stable, higher quality sport fishery resource than the ponds and streams currently present within the proposed impoundment area. As discussed in Sections 8.0 and 9.0 of this report, the ponds, presently choked with aquatic vegetation, and streams, which support only marginal cold and warm water fisheries, do not appear unique nor do they offer the same quality sport fishery present in adjoining management areas.

Overall, the reservoir would afford greater recreational potential than exists today. Recreational uses which would be enhanced by the reservoir include but are not limited to sport fishing, water sports (boating, swimming, water skiing), waterfowl hunting, picknicking and hiking. These types of recreational activities would in turn provide an added source of revenue to the State. This addition, however, does not imply that the reservoir would be self sustaining in a monetary/

management sense, but that it would most likely contribute an increase in the amount of revenue returned from this area in its current condition.

Some of the irreversible effects of construction of the impoundment would be the loss of existing ponds and naturally free flowing streams along with associated aesthetic features. Relocation of people inhabiting the proposed reservoir area would also be a consideration.

Species composition of the existing biotic communities (including herptiles) would be altered and a new equilibrium established. This would include the elimination of species that could not adapt to the new environment and the introduction or proliferation of those forms inherently adaptable to the new conditions.

Public opinion varies considerably on the issue of aesthetic appeal. There are those who feel that the proposed reservoir area is aesthetically appealing as it presently exists and others who obtain equal gratification from the aesthetic values of a reservoir and its associated amenities. The final decision for the proposed impoundment however, would be predicated partly upon an evaluation of losses versus benefits, but more likely on the consideration of the original intent of the reservoir, that is to serve as a water supply source for the Providence, Rhode Island area.

11.0 LITERATURE CITED

APHA, AWWA, and WPCF. 1976. Standard methods for the examination of water and wastewater. 14th edition, Washington, D.C. 1193 pp.

Association of Official Analytical Chemists (AOAC). 1970. Official methods of analysis of the Association of Official Analytical Chemists. 11th edition, Washington, D.C.

__________. 1975. Official methods of analysis of the Association of Official Analytical Chemists. W. Horwitz, [Ed.]. 12th edition, Washington, D.C. 1094 pp.

Bailey, R.M., Chairman. 1970. A list of common and scientific names of fishes from the United States and Canada. Spec. Publ. No. 6. Am. Fish. Soc., Washington, D.C. 150 pp.

Beck, W.M., Jr. 1976. Biology of the larval chironomids. Fla. Dep. Environ. Reg. Tech. Series. 2(1).

Bennett, G.W. 1971. Management of lakes and ponds. Van Nostrand Reinhold Company, New York. 375 pp.

Brown, H.W. 1974. Handbook of the effects of temperature on some North American fishes. American Electrical Power Services Corp. 524 pp. and Appendix.

Carlander, K.D. 1955. The standing crop of fish in lakes. J. Fish. Res. Board Can. 12(4):543-570.

__________. 1969. Handbook of freshwater fishery biology. Vol. I. Iowa State University Press, Ames, Iowa. 752 pp.

__________. 1977. Handbook of freshwater fishery biology. Vol. II. Iowa State University Press, Ames, Iowa. 431 pp.

Conant, R. 1975. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston. 429 pp.

Dochinger, L.S. and T.A. Seliga. 1976. Proceedings of the first international symposium on acid precipitation and the forest ecosystem. USDA Forest Service. General Technical Report. NE-23.

Drowne, F.P. 1905. The reptiles and batrachians of Rhode Island. Roger Williams Park Museum. Monograph No. XV. Providence, R.I. 24 pp.

Eddy, S. 1957. How to know the freshwater fishes. Wm. C. Brown Co. Publ., Dubuque, Iowa. 286 pp.

Edmunds, G.F., Jr., S.C. Jensen, L. Berner. 1976. The Mayflies of North and Central America. Univ. of Minnesota, Minneapolis. 330 pp.

Edmondson, W.T. 1966. Freshwater biology. 2nd Edition. John Wiley & Sons, Inc. New York 1248 pp.

Egglishaw, H.J. 1964. The distributional relationship between the bottom fauna and plant detritus in streams. J. Anim. Ecol. 33:463-476.

Geitler, L. 1932. Cyanophyceae. Rabenhorst, L. (ed). Kryptogamen-Flora von Deutschland, Osterrelen und der Schweiz.

Guthrie, R.C., J.A. Stolgitis and W.L. Bridges. 1973. Pawcatuck River watershed fisheries management survey. R.I. Dep. Nat. Resour. Div. Fish and Wildl. Fish Rep. No. 1. 61 pp. and Appendices.

__________ and J.A. Stolgitis. 1977. Fisheries investigations and management in Rhode Island lakes and ponds. R.I. Dep. Nat. Resour. Div. Fish and Wild. Fish Rep. No. 3. 256 pp.

Hem, J.D. 1970. Study and interpretation of the chemical characteristics of natural water, USGS Water-Supply Paper 1473, Washington, D.C. 338 pp.

Hilsenhoff, W.L. 1975. Aquatic insects of Wisconsin with generic keys and notes on biology, ecology and distribution. Wis. Dep. Nat. Resour. Tech. Bull. No. 89.

Hustedt, F. 1930. Bacillariophyta (Diatomeae). A Pascher, "Die Susswasser-Flora Mitteleuropas, Heft 10, 466 S., 875 Fig. Sweite Auflage. Gustav Fischer, Jena.

Hynes, H.B.N. 1963. Imported organic matter and secondary production in streams. Proc. Int. Congr. Zool. 16:324-329.

Jones, J.R.E. 1964. Fish and river pollution. Butterworth and Co., Ltd. London. 203 pp.

KAME Report. 1976. Preliminary inventory of vegetation, wildlife and aquatic biota in Big River study area. Keys Associates and Metcalf & Eddy, Inc. A Joint Venture. 87 pp. and Appendices.

Miller, W.R. and J.I. Drever. 1977. Water chemistry of a stream following a storm, Absaroka Mountains, Wyoming. Geol. Soc. Am. Bull. 88:286-290.

Minckley, W.L. 1963. The ecology of a spring stream. Doe Run. Meade County Kentucky. Wildl. Monogr. 11:1-124.

Minshall, G.W. 1967. Role of allochthonous detritus in the trophic structure of a woodland springbrook community. Ecology 48:139-149.

__________. 1968. Community dynamics of the benthic fauna in a woodland springbrook. Hydrobiologia 32:305-339.

Mugford, P.S. 1969. Illustrated manual of Massachusetts freshwater fishes. Mass. Div. Fish and Game. Westborough, Mass. 127 pp.

Nelson, D.J. and D.C. Scott. 1962. Role of detritus in the productivity of a rock-out rock community in a piedmont stream. Limnol. and Oceanogr. 7:396-413.

Normandeau Associat s, Inc. 1977. Lake Winnipesaukee trace metal survey analysis of surficial sediment, rooted vegetation, and fish for mercury, lead, copper, zinc and cadmium content. Draft report prepared for Lakes Region Planning Commission, Meredith, New Hampshire. 26 pp.

Odum, E.P. 1971. Fundamentals of ecology. 3rd Edition. W.B. Saunders Co. Philadelphia, Pa. 574 pp.

Parrish, F.K. (ed). 1975. Keys to water quality indicative organisms of the southeastern United States. U.S. EPA Aquatic Biology Section, Cincinnati, Ohio.

Patrick, R. and C. W. Reimer. 1966. The diatoms of the United States. Monogr. Acad. Nat. Sci., Phila. 1(13):688 pp.

Percival, E. and H. Whitehead. 1930. Biological Survey of the River Wharfe. II. Report on the invertebrate fauna. Ecology. 18:286-302.

Pennak, R.W. 1953. Freshwater invertebrates of the United States. Ronald Press Co., New York. 769 pp.

Preble, D.E. 1974. Fishery investigations-stream surveys. Job completion report, Project No. F-20-R-15. R.I. Div. Fish and Wildl. 13 pp.

Prescott, G.W. 1951. Algae of the western Great Lakes area. Wm. C. Brown Co., Dubuque, Iowa. 977 pp.

__________. 1970. The freshwater algae. Wm. C. Brown Co., Dubuque, Iowa. 348 pp.

Reid, G.K. 1961. Ecology of inland waters and estuaries. Van Nostrand Reinhold Company, New York. 375 pp.

Saila, S.B. and D. Horton. 1957. Fisheries investigations and management in Rhode Island lakes and ponds. R.I. Div. Fish and Game. Fish Publ. No. 3. 134 pp.

Schofield, C.O., Jr. 1972. The ecological significance of air-pollution-induced changes in water quality of dilute-lake districts in the Northeast. Pages 98-111 (in) P.C. Neth (chairman) Trans. N.E. Fish. Wildl. Conf. May 14-17, 1972.

Scott, D. 1958. Ecological studies on the trichoptera of the River Dean, Cheshire. Arch. für Hydrobiol. 54:340-392.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966 pp.

Smith, G.M. 1950. The freshwater algae of the United States. 2nd Edition. McGraw-Hill Book Co., New York. 719 pp.

Strickland, J.D.H. and T.R. Parsons. 1968. A practical handbook of seawater analysis. Fish. Res. Board Can. Bull. 167. 311 pp.

Ulfstrand, S. 1967. Microdistribution of benthic species (Ephemeroptera, Plecoptera, Trichoptera, Diptera: Similidae) in Lapland Streams. Oikos. 18:293-310.

U.S. Army Corps of Engineers. 1978. Study of water quality in the area of the proposed Big River Reservoir, eight stations. August 8 and 16, 1978. Waltham, Massachusetts (unpublished data).

U.S. Department of the Interior. 1976. Endangered and threatened wildlife and plants. Federal Register, Part IV. 41(208):47181-47198.

U.S. Environmental Protection Agency. 1974. Methods for chemical analysis of water and wastes. EPA-625/6-74-003. Washington, D.C. 298 pp.

__________. 1976. Quality criteria for water. EPA-440/9-76-023. Washington, D.C. 256 pp.

U.S. Food and Drug Administration. 1971. Pesticide Analytical Manual. 2nd Edition. Vol. 1.

__________. 1978. Administrative Guidelines Manual, Division of Regulatory Guidance, Bureau of Foods. Chapter 8, Fish and Seafood Industry. Guideline No. 7408.09, Issued 6/27/78.

Usinger, R.L. (ed). 1956. Aquatic insects of California with keys to North American genera and California species. Univ. California Press, Berkeley. 508 pp.

Weber, C.I. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. EPA-670/4-73-001. July 1973.

Whitton, B.A. 1975. River ecology. Univ. of California Press, Berkeley. 725 pp.

Whitford, L.A. and G.J. Schumacher. 1973. A manual of freshwater algae. Sparks Press. Raleigh, North Carolina. 324 pp.

Wiggens, G.B. 1977. Larvae of the North American caddisfly genera (Trichoptera). Univ. of Toronto Press, Toronto. 401 pp.

Wightman, P.H. and A.E. Newell. 1971. Habitat and resident species survey -- Anadromous fish restoration in the Merrimack River. Job Progress Report, Project AFS-10. July 1, 1970 to June 30, 1971.

APPENDICES

APPENDIX A. BENTHIC MACROINVERTEBRATES (ORGANISMS/m^2)* COLLECTED FROM BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, AUGUST 1978.

	Flat River Reservoir	Tarbox Pond	Capwell Mill Pond	Big River	Carr River	Nooseneck River-Inside	Nooseneck River-Outside
Nematomorpha	31.7			3.6			226.3
Platyhelminthes							
Turbellara	6.3					11.0	861.0
Annelida							
Oligochaeta	612.0	127.6	127.6	706.3	161.3	10.7	326.7
Hirundinea	6.3		6.3	3.6			
Mollusca							
Gastropoda	32.0			125.7			14.3
Ancylidae							
Ferrissa sp.				3.6			
Pelecypoda	23.7		70.3	14.7			514.3
Arthropoda							
Crustacea							
Amphipoda							
Gammaridae							
Gammarus sp.					7.3		
Talitridae							
Hyallela azteca			38.3	1514.0			18.0
Copepoda				50.3			
Isopoda							
Asellidae							
Asellus spp.			306.0	90.0			82.3
Decapoda				3.6			21.7
Arachnoidea				3.6			
Adult							
Hydracarina			6.3	3.6			10.7
Insecta							
Ephemeroptera							
Baetidae							
Baetis spp.						3.6	
Centroptilum sp.				54.[illegible]		14.3	46.7
Caenidae							
Caenis sp.				21.6			
Ephemerellidae							
Ephemerella spp.				14.3			82.7
Ephemeridae							
Hexagenia sp.				25.3			
Heptageniidae							
Stenonema spp.				3.6	147.3	190.3	3738.7
Leptophlebiidae							
Habrophlebia spp.							262.0
Paraleptophlebia sp.				75.7		7.3	179.3
Siphlonuridae							
Isonychia sp.						3.6	

(Continued)

APPENDIX A (Continued)

	Flat River Reservoir	Tarbox Pond	Capwell Mill Pond	Big River	Carr River	Nooseneck River-Inside	Nooseneck River Outside
Odonata							
Anisoptera							
Aeshnidae							
Boyeria sp.					3.6	3.6	36.0
Corduliidae							
Tetragoneuria sp.	6.3		6.3	21.7			10.7
Gomphidae							
Dromogomphus sp.			6.3				28.7
Hylogomphus sp.				3.6			
Stylogomphus sp.							240.7
Zygoptera							
Calopterygidae							
Calopteryx sp.					3.6		
Coenagriodidae							
Enallagna sp.				11.0			
Plecoptera							
Leuctridae							
Leuctra sp.						125.0	46.3
Perlidae							
Acroneuria sp.						14.3	7.3
Hemiptera							
Corixidae				3.6			
Coleoptera					36.0		
Adult					18.0	7.3	172.7
Elmidae							
Ancyronyx variegatus							7.3
Dubraphia sp.							43.3
Optioservus sp.					28.7	10.7	165.0
Promoresia sp.							82.3
Stenelmis spp.					183.0	50.0	724.7
Gyrinidae							
Gyrinus sp.					3.6		
Psephenidae							
Psephenus sp.						7.3	186.7
Megaloptera							
Corydalidae							
Nigronia sp.					68.3	14.7	305.3
Sialidae							
Sialis sp.				57.3		32.7	43.7
Lepidoptera							3.6
Paraponyx sp.				3.6			

(Continued)

APPENDIX A. (Continued)

	Flat River Reservoir	Tarbox Pond	Capwell Mill Pond	Big River	Carr River	Nooseneck River-Inside	Nooseneck River-Outside
Trichoptera							
Pupae				3.6	21.7	11.0	32.3
Helicopsychidae							
Helicopsyche sp.							18.0
Hydropsychidae							
Cheumatopsyche sp.					97.0		767.7
Diplectrona sp.						39.3	
Hydropsyche spp.	12.7				2849.0	136.3	1898.0
Hydroptilidae							
Larvae					7.3		
Pupae					3.6		
Leptoceridae							
Ceraclea sp.				7.3			50.3
Oecetis sp.				25.0			39.3
Limnephilidae							
Neophylax sp.					7.3		32.3
Pycnopsyche sp.							3.6
Odontoceridae							
Psilotreta sp.							165.3
Philopotamidae							
Chimarra spp.					107.7	18.0	721.3
Dolophilodes sp.						3.6	
Wormaldia sp.						75.3	
Psychomyiidae							
Lype sp.	6.3		6.3	36.0			25.3
Phylocentropus sp.				32.3			
Rhyacophilidae							
Rhyacophila sp.						7.3	18.0
Diptera							
Adult							
Pupae					54.0	10.7	190.3
Ceratopogonidae							
Palpomyia sp.							35.7
Chaoboridae							
Chaoborus sp.	19.0	43.7					
Chironomidae							
Chironominae							
Chironomus spp.	293						
Cladotanytarsus sp.					14.3	50.3	118.3
Cryptochironomus sp.			12.7				
Parachironomus sp.	6.3						
Polypedilum spp.	25.3			106.7	326.7	46.3	585.0
Tanytarsus sp.				85.3	14.3	199.0	394.7

(Continued)

APPENDIX A. (Continued)

	Flat River Reservoir	Tarbox Pond	Capwell Mill Pond	Big River	Carr River	Noosenеck River-Inside	Noosenеck River-Outside
Orthocladiidae							
Cardiocladius sp.					7.3	3.6	
Cricotopus spp.	363.0	12.7	586.7				147.:
Eukiefferiella sp.					151.0		179.7
Heterotrissocladius sp.						18.3	7.3
Krenosmittia sp.							46.7
Stenochironomus							7.3
Tanypodinae							
Conchapelopia sp.						3.6	782.0
Guttipelopia sp.			32.0	36.0			
Procladius sp.	63.7	83.0	25.7	86.0			
Empididae					10.8		
Hemerodromia sp.					18.0	7.3	10.8
Rhagionidae							
Atherix variegata						11.0	28.7
Simuliidae					10.8		
Larvae					111.3	140.0	678.3
Pupae					39.7	46.7	75.3
Tabanidae							
Crysops sp.				7.3			
Tipulidae							
Antocha sp.							
Dicranota sp.						49.3	36.0
Hexatoma sp.					3.6	3.6	25.0
Tipula sp.					3.6		43.3
TOTAL	1,508.9	267.	1230.8	3245.8	4519.7	1386.9	15,651.1

* Represents mean value of 3 replicates

APPENDIX B. SUMMARY OF ANALYSES FOR CHLORINATED INSECTISIDES, PCB'S AND HEAVY METALS IN FISH TISSUE TAKEN FROM GOLDEN SHINER AND YELLOW PERCH COLLECTED IN TARBOX POND, BIG RIVER RESERVOIR STUDY AREA, RHODE ISLAND, 1978. ALL VALUES (μg/g) DETERMINED ON A WET WEIGHT BASIS.

SPECIES	NUMBER	MEAN TOTAL LENGTH(MM)	MEAN WEIGHT(g)	CHLORINATED HYDROCARBONS INSECTICIDES [b]	PCB	HEAVY METALS [a] Hg μg/g	Se μg/g	Cd μg/g	Pb μg/g
Golden shiner	3	205	142	<0.005[c]	<0.01	0.20	<0.03	0.10	<0.1
Yellow perch	3	241	187	<0.005	<0.01	0.33	<0.03	0.14	<0.1

[a]Average of duplicate laboratory samples.

[b]Insectisides tested for included: DDE, DDD, DDT, Dieldrin, BHC, Lindane, HCB, Endrin, H.E.

[c]<0.005 μg/g value reported for each insecticide.

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX H

RECREATION AND NATURAL RESOURCES

Section 3 - Terrestrial Ecosystem Assessment

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

TERRESTRIAL ECOSYSTEM ASSESSMENT REPORT

BIG RIVER RESERVOIR,

RHODE ISLAND

Prepared for

NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS

Contract #DACW 33-78-C-0362

by

NORMANDEAU ASSOCIATES, INC.
Bedford, New Hampshire

PRINCIPAL CONTRIBUTORS

Michael M. Grubb
Dennis W. Magee

January 1979

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

LIST OF TABLES

TERRESTRIAL ECOSYSTEM ASSESSMENT REPORT
BIG RIVER RESERVOIR,
RHODE ISLAND

1.0 INTRODUCTION

The New England Division of the U.S. Army Corps of Engineers, has proposed to construct a dam across the Big River in the town of Coventry, Rhode Island. The resulting reservoir, located in the towns of Coventry and West Greenwich would have a surface area of approximately 5.9 square miles at a pool elevation of 302.5 feet above mean sea level. The purpose of the reservoir would be to provide a water supply for Providence, Rhode Island. Possible alternate reservoir sites include the Wood River reservoir in West Greenwich and Exeter with a proposed pool of approximately 1.4 square miles, the Bucks Horn Brook reservoir in Coventry with a proposed pool of approximately 0.8 square mile and the Moosup River reservoir in Coventry with a proposed pool of approximately 0.8 square mile. Figures 1 and 2 depict the location of the study area in Rhode Island and the location of the alternate sites. Figure 2A shows the outline of the proposed reservoir in relation to major water bodies.

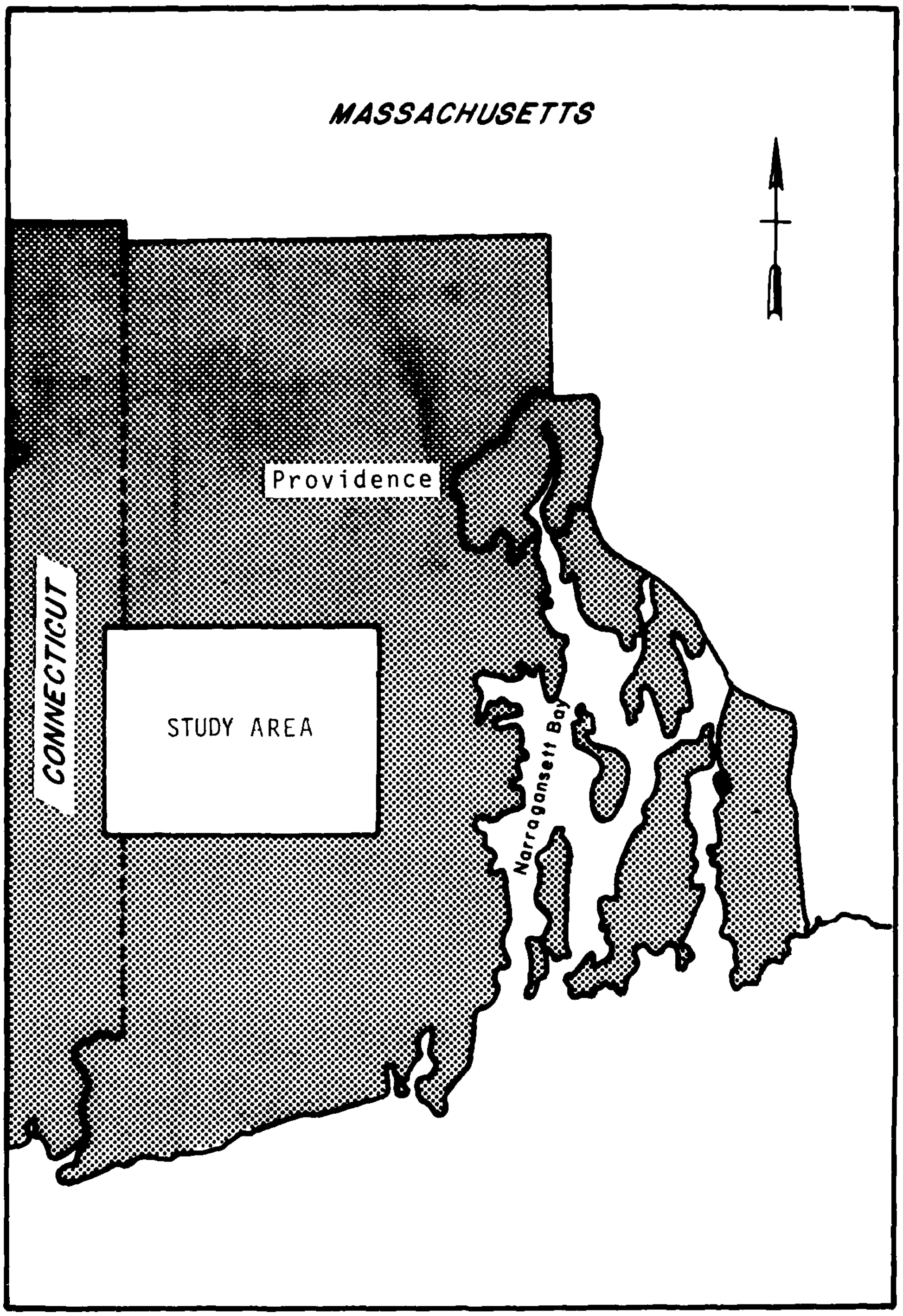


Figure 1. Location of study area in Rhode Island. Big River Terrestrial Ecosystem Analysis, 1978.

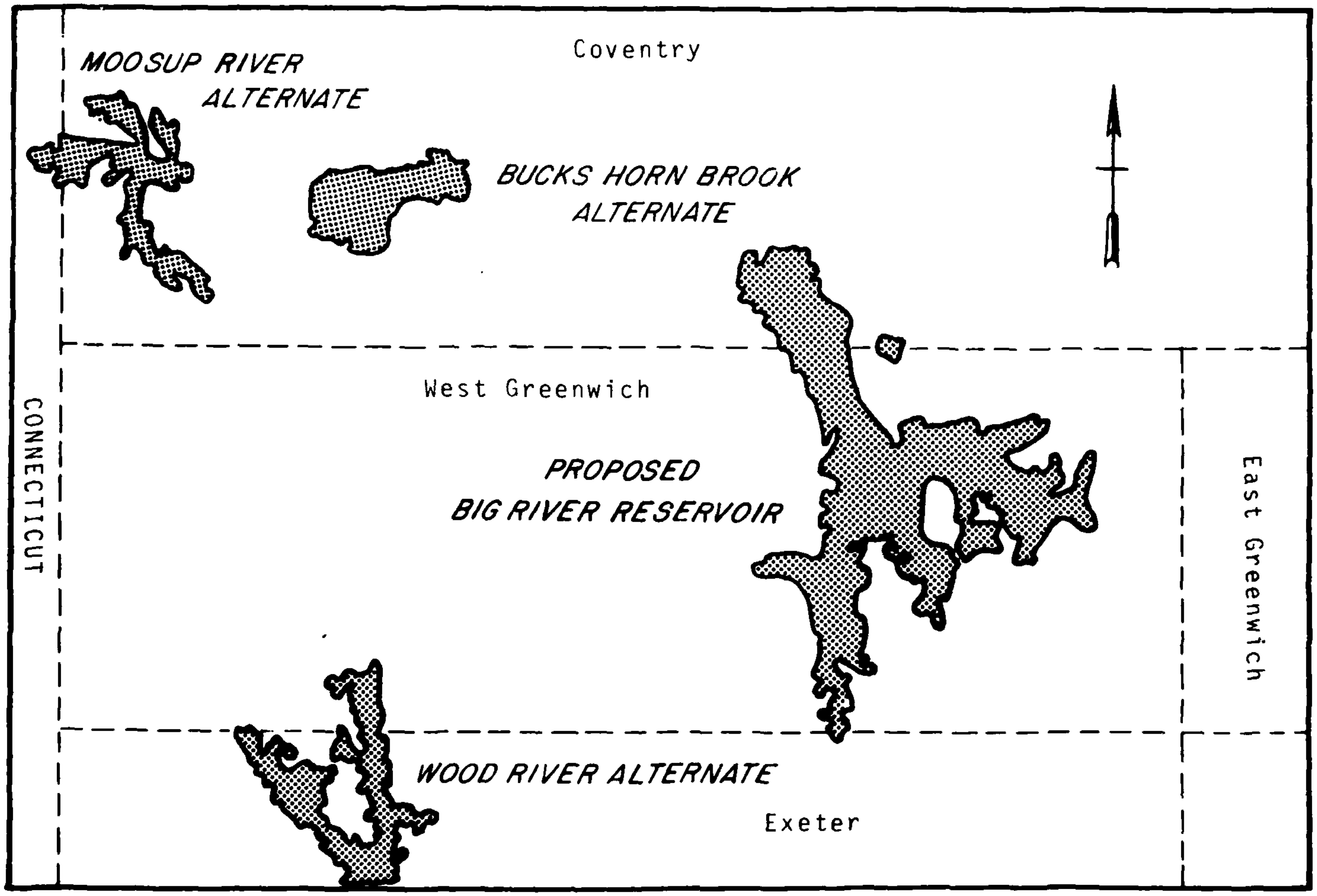


Figure 2. Location of proposed Big River Reservoir and alternate sites. Big River Terrestrial Ecosystem Analysis, 1978.

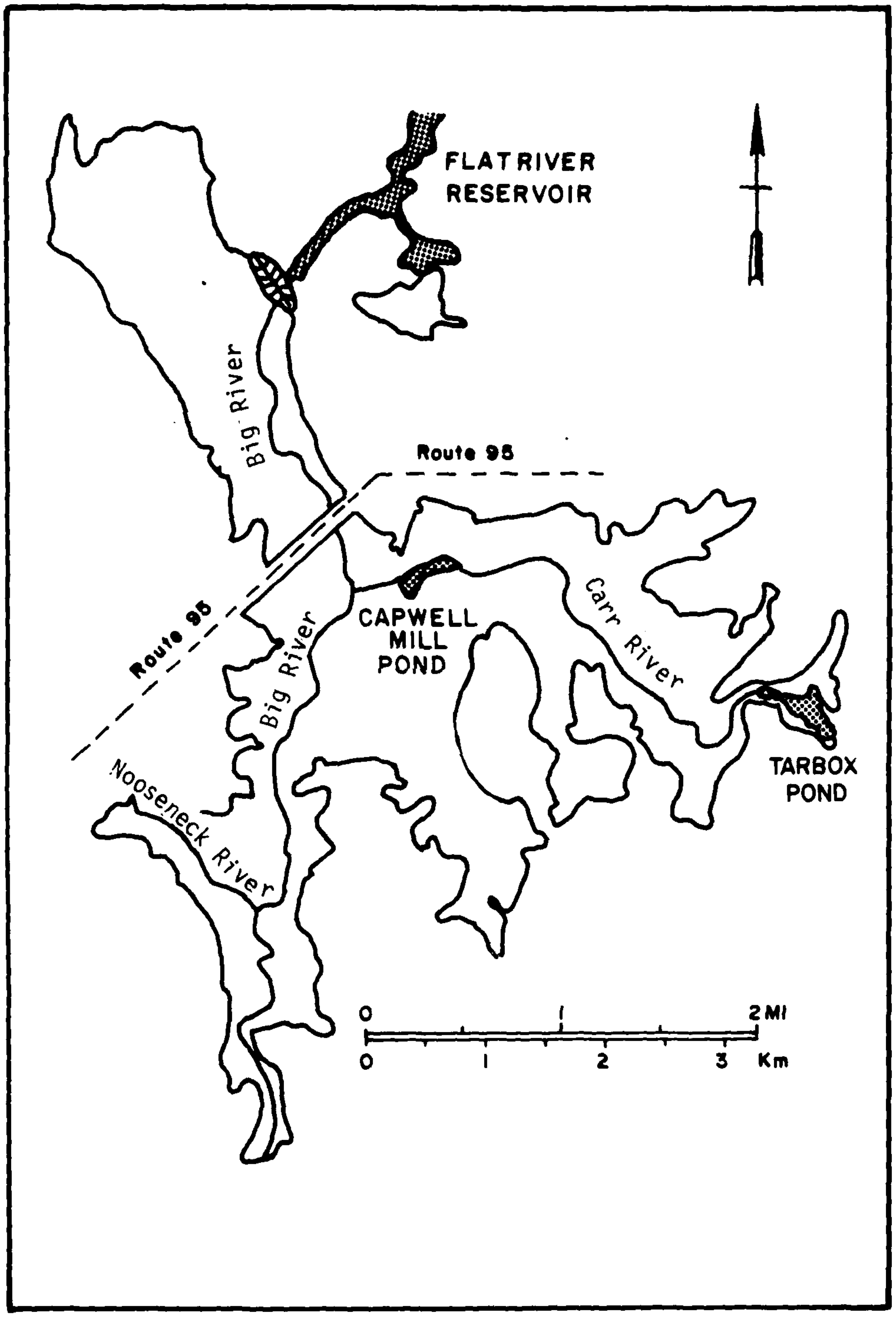


Figure 2A. Proposed Big River Reservoir. Big River Terrestrial Ecosystem Analysis, 1978.

2.0 METHODS

Time limitations necessitated an intensive short-term study. As such, field observations were limited to a one week period. Additional data for the study area were gathered through literature reviews and contacts with state and federal agencies.

2.1 FLORA

2.1.1 Review of Existing Information

A search was made of the available literature pertaining to: 1) the structural and species compositional characteristics of the regional plant communities and 2) development sequences of the regional plant communities. The regional description provided a framework for relating the structural and functional characteristics of plant communities present in the study area to the surrounding vegetative complex as discussed by Odum (1969). Understanding this relationship provided a means of assessing: 1) adjustment of site vegetative communities to the regional environment and relative susceptibility to natural perturbations such as diseases and insect depredations, 2) importance of site vegetation to wildlife which utilize both the study area and surrounding areas, 3) importance of site vegetation to surrounding natural and human-influenced environments in terms of such important ecological functions as storm water retention and pollution attenuation, (Evans 1976) and 4) impacts of loss of site vegetation both to the study area and the surrounding region.

The literature was also researched for records of occurrences of rare or endangered plant species and unusual populations of plants in the vicinity of the site. In addition, Dr. Stuckey, University of Rhode Island Forestry Department (retired), was interviewed to obtain information regarding known occurrences of rare or unusual flora in the study area.

Estimates of the total acreages of each of the five cover types (Section 2.1.3) currently existing in Rhode Island were obtained from existing sources. These estimates provided a basis for assessing the significance of the projected losses of vegetative cover in terms of percentages of the statewide totals.

Botanical sections of the recently completed Big River Reservoir baseline study [Keyes Associates and Metcalf and Eddy (KAME), 1976] were reviewed for information applicable to the present scope of work. Lists of the plant species found on the site were modified to include only those species actually observed during the present survey.

2.1.2 Field Study Methods

Each of the five cover types was characterized in the field by visiting seventeen representative stands and areas and tallying all identifiable species of trees, shrubs and herbs. The relative abundance of each species at the various locations within each cover type was visually assessed as dominant, common or occasional; the most representative condition from all sites visited within each habitat type was expressed as the final result. In addition, Capwell Mill Pond and Tarbox Pond were qualitatively surveyed by canoe to determine aquatic macrophyte abundance and distribution.

Total acreage of all cover types was computed from the KAME maps with a digitized planimeter. The interior of each type as well as segments of edge between cover types, roadsides, railroad grades, stream edges, and other potentially dynamic or unstable areas were carefully scrutinized for the presence of rare plant species and unusual populations of plants.

The value of areas visited within each type as repositories of plant genetic material was visually appraised by noting (Frankel and Bennett, 1970, and National Research Council, 1978): 1) the presence of stands with large numbers of individuals having appearances which reflect favorable genetic characteristics (e.g., straightness, good growth form, etc.) 2) the presence of unusual groups of plants such as relic or disjunct populations, and 3) overall plant species diversity.

Three vegetation types were field checked on transect segments described in the existing study (KAME, 1976) for accuracy of plant community description. Such parameters as species composition and relative abundance were compared with independent observations made during the present survey. Classification and distribution of representative selected stands were checked at several locations along their perimeters and compared to the stand symbols and boundaries shown on the existing maps.

The vegetative complexes on the three alternate sites, Wood River, Mossup River and Bucks Horn Brook were inventoried in a general manner by utilizing information contained on USGS topographic maps in combination with visits to sites representative of the major categories of vegetation such as forest, wetland, and open land. During such site visits, the plant species present and their relative abundances were recorded. Six sites at each of the Wood River and Mossup River alternates and eight sites in the Bucks Horn Brook area were inventoried during site visits.

2.1.3 Mapping

In order to identify the type, location and abundance of the vegetative resources present, as well as to determine habitat interspersion, it was necessary to prepare a cover map (see inside back cover). This map was based upon previous work (KAME, 1976). Because cover type characterization of the KAME maps was too detailed and complex, the delineated habitat types were combined into one of the following five types: hardwood forest, softwood forest, mixed forest, wetland and open land. Table 1 lists this combination of cover types.

TABLE 1. COVER TYPES COMBINED FROM "KAME" REPORT FOR USE IN NAI REPORT. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

KAME COVER TYPE	NAI COVER TYPE
White oak	Hardwood
Red oak	Hardwood
Gray birch	Hardwood
Red oak-white oak	Hardwood
White oak-red maple	Hardwood
Mixed oak-red maple	Hardwood
Pitch pine	Softwood Forest
White pine	Softwood Forest
Red cedar	Softwood Forest
Pitch pine-white pine	Softwood Forest
White pine-cedar	Softwood Forest
White pine-red oak-white oak	Mixed wood
White pine-white oak-red maple	Mixed wood
Pitch pine-mixed oak-red maple	Mixed wood
White pine-red oak	Mixed wood
White pine-white oak	Mixed wood
White pine-red cedar-red maple	Mixed wood
Pitch pine-red oak	Mixed wood
Pitch pine-white oak-red maple	Mixed wood
Pitch pine-white oak	Mixed wood
Red maple	Wetland
White pine-red maple	Wetland
Pitch pine-red maple	Wetland
Wooded swamp	Wetland
Pond	Wetland
Cleared field	Open
Dump	Open
Gravel pit	Open
Farm	Open
Golf course	Open

2.2 FOREST RESOURCES

2.2.1 Review of Existing Information

Forest inventory procedures and harvest practices were reviewed from recent forestry literature to identify those field sampling methods and forest product harvest alternatives that would be most applicable to the study area (Smith, 1962 and Forbes, 1961). Current market values for board foot and cordwood stumpage were obtained through conversations with the state forester responsible for managing forests in the vicinity of the Big River area (Tom Dupre, Rhode Island Division of Forest Environment personal communication).

2.2.2 Forest Inventory

A forest inventory was conducted within the study area to estimate the standing stock of hardwood and softwood trees in terms of board feet, cubic feet and cords both on a per-acre basis and for the entire site. The minimum merchantable size for sawtimber was considered to be a log ten feet in length with a top diameter of four inches; board-foot content was determined only on trees having logs this size and larger. For trees and saplings having less than a four inch top diameter, which yield cordwood rather than sawlumber as a saleable product, cubic foot volumes were determined. Talleys for board feet and cubic feet were computed for each tree species.

Board-foot estimates were obtained from log length and top diameter measurements using the International Log Rule for 1/4-inch kerf. There are several different log rules in current use throughout various regions of the country but use of the International Log Rule for 1/4-inch kerf is steadily increasing both as an official standard for individual states and by the U.S. Forest Service. This log rule is also used to a great extent by private owners of forest land in estimating standing timber. Cubic feet volumes were determined for smaller trees and saplings using Huber's Formula (Forbes, 1961); these volumes were also expressed as number of cords by dividing by the cubic foot volume of a single cord.

To conduct the survey 40 one-tenth acre (37.24' radius) plots were established at random intervals along compass transects through representative stands of hardwood, mixed wood and softwood forest (Figure 3). For trees having at least one log conforming to the minimum height and top diameter standard established for saw timber, height and top diameter were determined for each log in the tree by means of two independent visual estimates. Trees and saplings having a minimum height of six feet and an average diameter of at least two inches were tallied separately as cordwood.

To determine per-acre volumes, board foot, cubic foot and cordwood data obtained on each one-tenth acre plot were expanded by a factor of ten. Standing stocks for the entire study area were estimated by computing relative frequency (f) for each species within the study plots, multiplying relative frequency by the per-acre volumes, and then multiplying this result (Column 1, Table 3) by the estimated acreage of the type in which the species was found. Relative frequency was computed for both board feet and cubic feet by dividing total occurrences of a given species by total occurrences of all species. Due to the small sample size, variability in per-acre and area-wide volume estimates may be quite high.

2.3 FAUNA

2.3.1 Review of Existing Information

Information concerning wildlife populations in the proposed reservoir area was collected through literature reviews and contact with state, federal and private organizations.

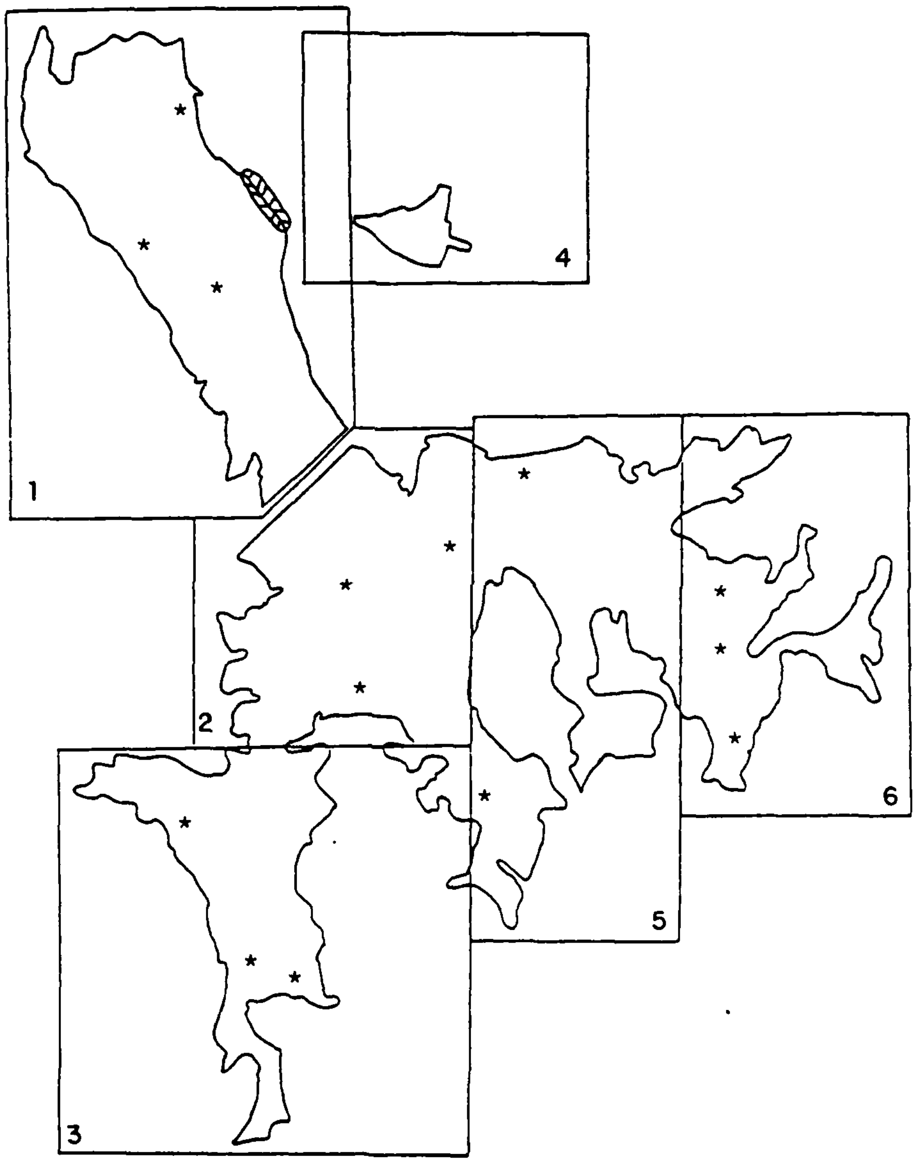


Figure 3. Location of forest inventory transects. Big River Terrestrial Ecosystem Analysis, 1978.

Reports and published papers were reviewed and, if appropriate, abstracted. Contact was made with the Rhode Island Department of Conservation, the U.S. Fish and Wildlife Service, the Audubon Society of Rhode Island and the University of Rhode Island to obtain information on rare and endangered wildlife, critical habitats and wildlife populations.

2.3.2 Field Studies

2.3.2.1 Bird Transects

Field surveys were conducted in the proposed Big River reservoir area to determine avian species composition, relative abundance and habitat utilization. Census operations were designed so that estimates could be made regarding relative abundance of bird species in each habitat type.

Six different census transects were established. Each transect covered the interior of one or more of the major habitat types (hardwood forest, softwood forest, mixed forest, wetland, open land) as well as the ecotones between each habitat type. Location of the transects and habitat types censused were as follows (Figure 4):

Transect 1: directly south of Division Road and 0.6 mile west of Hopkins Hill Road; softwood forest, open land and wetland

Transect 2: near the intersection of the Carr River and the New London turnpike; softwood forest and wetland

Transect 3: 1.[illegible] mile south of I-95 and just west of Burnt Sawmill Road; hardwood forest

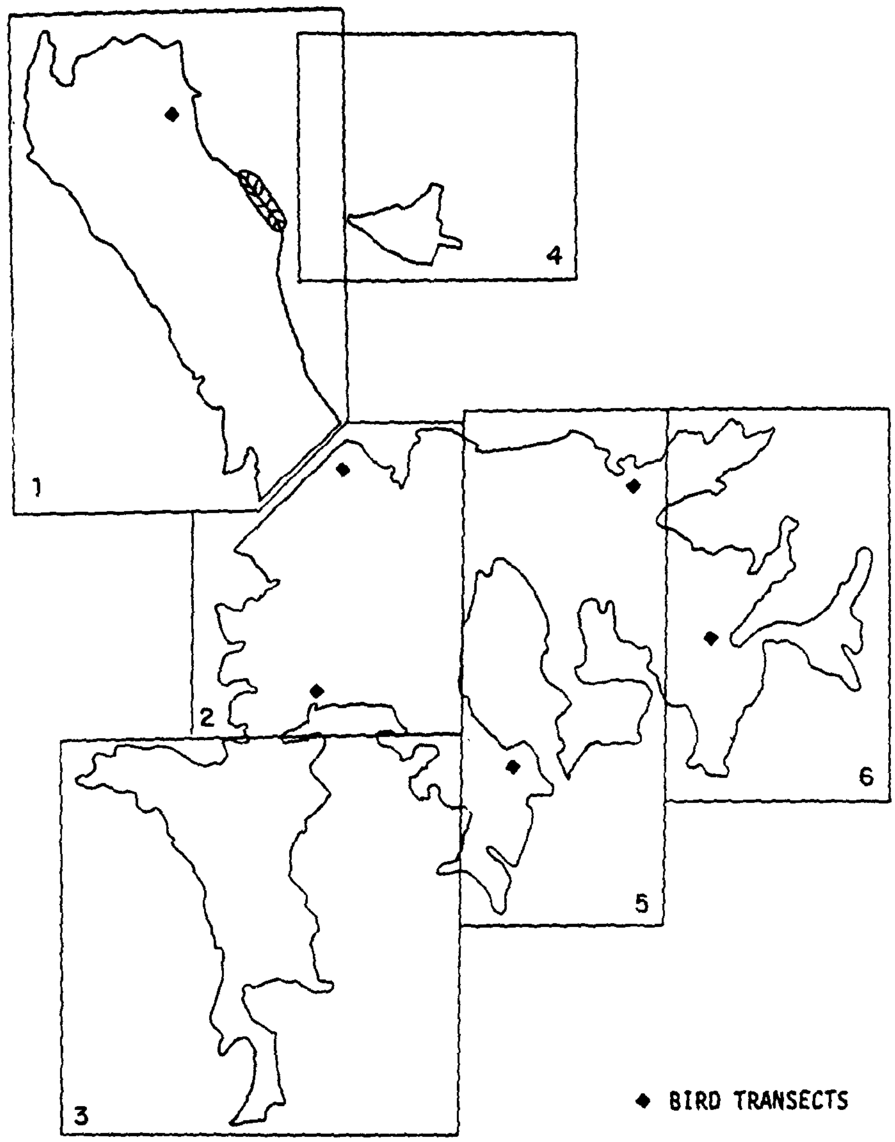


Figure 4. Location of bird census transects. Big River Terrestrial Ecosystem Analysis, 1978.

Transect 4: 0.4 mile south of I-95 and directly west of Burnt Sawmill Road; softwood forest, mixed forest, open land

Transect 5: directly around Sweet Pond; softwood forest, mixed forest and wetland

Transect 6: Harkney Hill Road, 1.5 miles west of Route 3; softwood forest, mixed forest, open land.

Each transect was censused four times during a one week period in late summer. Surveys were conducted twice daily; the morning survey began at dawn and lasted two hours; the evening survey began two hours before sunset and concluded at dusk.

Observers slowly walked the transects, stopping every 15-20 ft to look and listen for birds. Birds seen or heard were counted and identified to species. Records were kept noting the habitat type in which the bird was observed. Birds observed flying over the area were not counted unless they were raptors which were considered to be utilizing the habitat for hunting.

In order to standardize census operations, observations within each habitat type were restricted as follows:

Hardwood, softwood and mixed forest:	40 feet on each side of observer
Wetland:	100 feet on each side of observer
Open land:	100 feet on each side of observer

Previous experience had indicated these distances were those within which birds could be accurately censused. The results of the census operations were used to classify species as abundant, common, occasional or rare. Classification was based on obvious divisions in total numbers within the habitats.

In addition to the transect counts, any birds noted during travel to and from the census sites and while engaged in non-census related study tasks were noted as to species and habitat utilization. This procedure was adopted to decrease the chance of overlooking a species which may have been utilizing habitat in the study area but which was not recorded in the transect counts.

2.3.2.2 Mammals

Field data concerning mammal populations in the study area were collected through sightings of individuals, presence of tracks and other signs of habitat use. Attention was focused on muddy areas for tracks and on ecotones for droppings and other signs.

2.3.2.3 Habitat Evaluations and Carrying Capacity Estimates

Wildlife habitat evaluations were conducted in conjunction with the botanical studies at each of: 1) the 17 terrestrial sites in the proposed Big River reservoir area, 2) six terrestrial sites in each of the Wood and Moosup River alternates and 3) eight terrestrial sites in the Bucks Horn Brook alternate. Parameters noted included cover type, overstory vegetation, shrub layer and understory vegetation, vegetative structural diversity, presence of wildlife food-producing plants, soil conditions, presence of water and surrounding habitat. Any wildlife or wildlife sign observed was noted and at least one photograph of the area taken.

In addition to these sites, major water bodies in the proposed Big River reservoir area (Capwell Mill Pond, Tarbox Pond, Reynolds Pond and two stretches of the Big River) and in the alternate areas (Carbuncle Pond, Roaring Brook and Moosup River) were assessed for value as waterfowl habitat. Where necessary, a canoe was used to travel through the area, noting abundance and type of vegetation, depth of water,

water-vegetation interspersion, amount of cover and species of wildlife observed.

The results of the habitat evaluations were utilized in estimating carrying capacity (the maximum number of animals a given area of habitat can support at a given time) of the proposed Big River Reservoir area for certain selected wildlife species discussed in Section 3.2.1.5. A literature search was conducted to compile carrying capacity estimates for these species in habitat types similar to those found in the Big River study area. Applicable parameters (i.e. presence of mature hardwoods, vegetative interspersion etc.) mentioned in these reports were compared to the Big River study area; estimates for the study area were then extrapolated based on a comparison between the study area and the published reports. The alternate sites and surrounding areas were also field checked to determine their value as wildlife habitat relative to the Big River area.

3.0 RESULTS AND DISCUSSION

3.1 FLORA

3.1.1 Regional Vegetation

The study area is part of the White Pine-Hemlock-Hardwood Forest Region and is located near the southern boundary of the New England Section of this region (Lull, 1968). This plant association is characterized by the presence of oaks,[1] hickory, and occasional yellow poplar in the southern part of the region. Species composition at different sites varies with soil characteristics and land use history. Sites which have been abandoned after farming for example, often tend to be dominated by white pine, while on sandy soils pitch pine may form a large proportion of the stand. Where fires frequently occur, such as on dry, sandy sites, pitch pine and scrub-oak are dominant. Wetlands vary considerably in species composition depending on water depth and movement. Wooded swamps for example, are generally dominated by red maple, elm, and ash, while near the coast white cedar becomes an abundant swamp species (Braun, 1972).

3.1.2 Vegetation of the Big River Study Area

The vegetation found in the study area fits well with the regional vegetation as it is presently understood. Each stand is a member of either a mature community or a successional sequence and is, therefore, structurally related to the regional complex of plant communities which comprise the association. There were no anthropogenic communities such as plantations or nurseries observed.

---

[1] Refer to Appendix Tables 1, 2 and 3 for scientific names of all plant species.

The general observations of this field investigation corroborate many of the summary statements regarding site vegetation made by the previous investigators (KAME, 1976). The uplands were dominated by oak forest, white pine stands and mixtures of upland hardwood, pine, and wetland species. Open areas such as farmland, old fields, and sand or gravel areas contained plant communities in various stages of development from grassland to shrubland.

Review of the botanical journal Rhodora for the 1968-1978 period pertaining to the occurrence of rare or endangered plant species or unusual populations, and conversations with Dr. Stuckney, University of Rhode Island, indicated that there were no known flora on the site that are of critical concern in terms of being rare, endangered or unusual. During the field investigations no plants of critical concern were observed.

3.1.2.1 Hardwood Forest

The upland hardwood forests on the study area were characterized by an overstory composed of white oak, red oak, and black oak with sparse scattered white pine and occasional red maple and gray birch. The shrub layer consists mainly of oak and pine seedlings with occasional highbush blueberry, beech, sheepberry, and chestnut occurring in variable heights and densities. The ground cover was dominated by black huckleberry, with lowbush blueberry, sheep laurel, and Prince's pine also abundant; these species formed dense, scattered patches. A complete list of the species observed and their relative abundance is shown in Appendix Table 1.

The hardwood forest type represents the climax community given the existing climatic and soil conditions. White pine saplings in the understory will not survive to maturity due to their intolerance of shading, but the oak seedlings will survive to replace overstory plants that become scenescent and "unthrifty." Mature oak forests are well adapted to the environment and resistant to the many pests and parasites which infest it. Although not especially valuable as a genetic repository, this type performs several ecological functions of major importance. It functions as part of the regional system in biogeochemical cycling, and in holding soil in place. The crops of acorns produced yearly and the abundant browse in the understory are utilized by various wildlife. For further discussion of wildlife habitat utilization, refer to Section 3.2.1.4.

3.1.2.2 Softwood Forest

Softwood forests of the Big River Study Site varied somewhat in species composition of the overstory in relation to soil characteristics. Where the soils consist of medium fine sand, white pine was dominant in the overstory. Here, the intermediate layer consisted of white oak, red oak, and white pine saplings occurring in variable heights and densities. Chestnut, black cherry, and highbush blueberry were also occasionally found in this layer. The ground cover was composed of huckleberry and lowbush blueberry, forming dense, scattered patches with low densities of Prince's pine, pinesap, bracken fern, wintergreen, and pink lady's slipper. Where soils were composed of coarse dryer sand, overstory dominance generally had shifted in favor of pitch pine. In such areas, the shrub layer was irregular in height and density consisting of white and pitch pines, trembling aspen, scrub oak, red oak, sweet fern and black cherry. A list of the species found in the softwood forests and their relative abundances is shown in Appendix Table 1.

The white pine stands represent the next to last stage in the sequence of vegetation maturation on the site. Over time, oak seedlings will mature and dominate the site. The pitch pine-scrub oak stands on the other hand, represent a climax condition caused by recurring fires due to the droughty soils. The pine forests are not as stable as the upland hardwoods in terms of resistance to disease and insects. A serious pest in white pine stands, for example, is the white pine blister rust. In certain stands large trees with particularly good form were observed. These white pine populations represent valuable genetic repositories. As wildlife habitat, the softwood forests are important to only certain species, generally far fewer than occur in upland hardwoods.

3.1.2.3 Mixed Wood Forest

The mixed wood forests throughout the study area were mostly composed of varying proportions of white oak, black oak, red oak and white pine with scattered red maple. On coarse droughty soils, pitch pine with sparse scrub oak and white oak formed stands 8-15' in height. The intermediate layers varied in height range and density, and were composed of white pine and oak saplings, sheep berry, chestnut, and greenbriar. The ground cover was composed of dense scattered patches of black huckleberry, lowbush blueberry, sheep laurel, wintergreen, and occasional pink lady's slipper. Droughty openings in the pitch pine were vegetated by patches of little bluestem. A complete list of the plants inventoried in the mixed wood forests and their relative abundance is shown in Appendix Table 1.

Pitch pine-oak forests represent a different type of climax than upland pine and oak forests; the former develops as a result of droughty soils and recurrent fires. The upland pine and oak climax forest will continue to perpetuate itself by means of the hardwood seedlings and saplings in the understory since these species are capable of growing in shade. This forest is stable and well adapted to the cycles of disease, insects, and other natural perturbations. Individual stands are valuable as genetic repositories due to high diversity of species and to the presence of trees, particularly pine, having good size, form and vigor. The mixed forests are an integral part of the regional system and they perform important functions as a part of that system, such as soil binding and cycling of nutrients between soil and living components. Climax systems are important for their stabilizing influence and ability to offset the unstable, artificial environments created by man. The mixed forests also provide habitat for a large number of different wildlife owing to the high plant species and structural diversity present throughout the stands.

3.1.2.4 Wetlands

A total of five different categories of wetlands were observed during the field investigations. These include wooded swamp, shrub swamp, open water/deep marsh, shallow marsh, and bog. Appendix Table 1 lists plant species found in each of these habitat types.

The wooded swamps on the site were typically dominated by an overstory of 40-50' tall, multiple-stemmed red maple. On elevated hummocks, red oak, white oak and yellow birch were occasionally found, and in many of the swamps observed, white pine and pitch pine are frequent stand components. Shrub growth was generally fairly dense beneath the red maple overstory and commonly included species such as highbush blueberry, pepperbush, arrow-wood, spicebush, swamp-azalea, and skunk cabbage.

Shrub swamps are generally marshes that have become dominated by shrub species during development of the community. In addition to shrubs, emergent and floating-leaved herbacious plants are commonly found in areas of deeper water. Common shrub species identified in the study area included buttonbush, sweet gale, silky dogwood, and leatherleaf. In patches and interspersed with the shrub growth such herbs as pickerelweed, cattail, blue-joint grass, sedge, and rush were frequently found. Along the edges and in dryer areas red maple and white cedar were often abundant.

Open water/deep marsh and shallow marsh are earlier stages in the development of a wetland. Deep marsh is characterized by large areas of open water and by a predominance of floating leaved species such as pond lily and pondweed. Near shore, these areas are dominated by emergent vegetation, such as cattail and rush which are confined to the immediate shoreline, and pickerelweed which extended approximately to the three foot bathymetric contour. Interspersed with the emergent species and extending to the four foot contour was floating leaved vegetation, dominated by waterlily with floating heart and pondweed also present. Bladderwort was the dominant species in the open water area with water milfoil also occurring. Figures 5 and 6 depict general locations of these vegetative zones in Capwell Mill and Tarbox Ponds; Appendix Table 2 lists species of vegetation found in these zones.

Shallow marshes contain less open water and a higher proportion of emergent species. The most common species observed in the Big River study area include burreed, rush, sedge, and blue joint grass.

Bogs are characteristically acid environments caused by impeded drainage and are vegetated by species which are particularly adapted to such conditions. Water is confined to small open patches and the bog surface is dominated by low herbacious and shrubby growth. The bog vegetation observed in the field included sphagnum moss, leatherleaf, beak-rush, cotton grass and sundew.

The sequence of plant community development in wetlands typically begins with standing water such as a pond. Initially, floating-leaved and submerged plants form sparse growths in the open water but as the water becomes shallower through natural siltation and buildup of organic material, emergent plants and eventually shrubs dominate the wetland. The last stage in the development of the community is wooded swamp. In many situations this sequence does not occur. In a wet meadow, for example, where tussock forming plants have become established, the low areas may be colonized directly by red maple and the tussocks by white pine or oak. The result is wooded swamp containing oak or white pine.

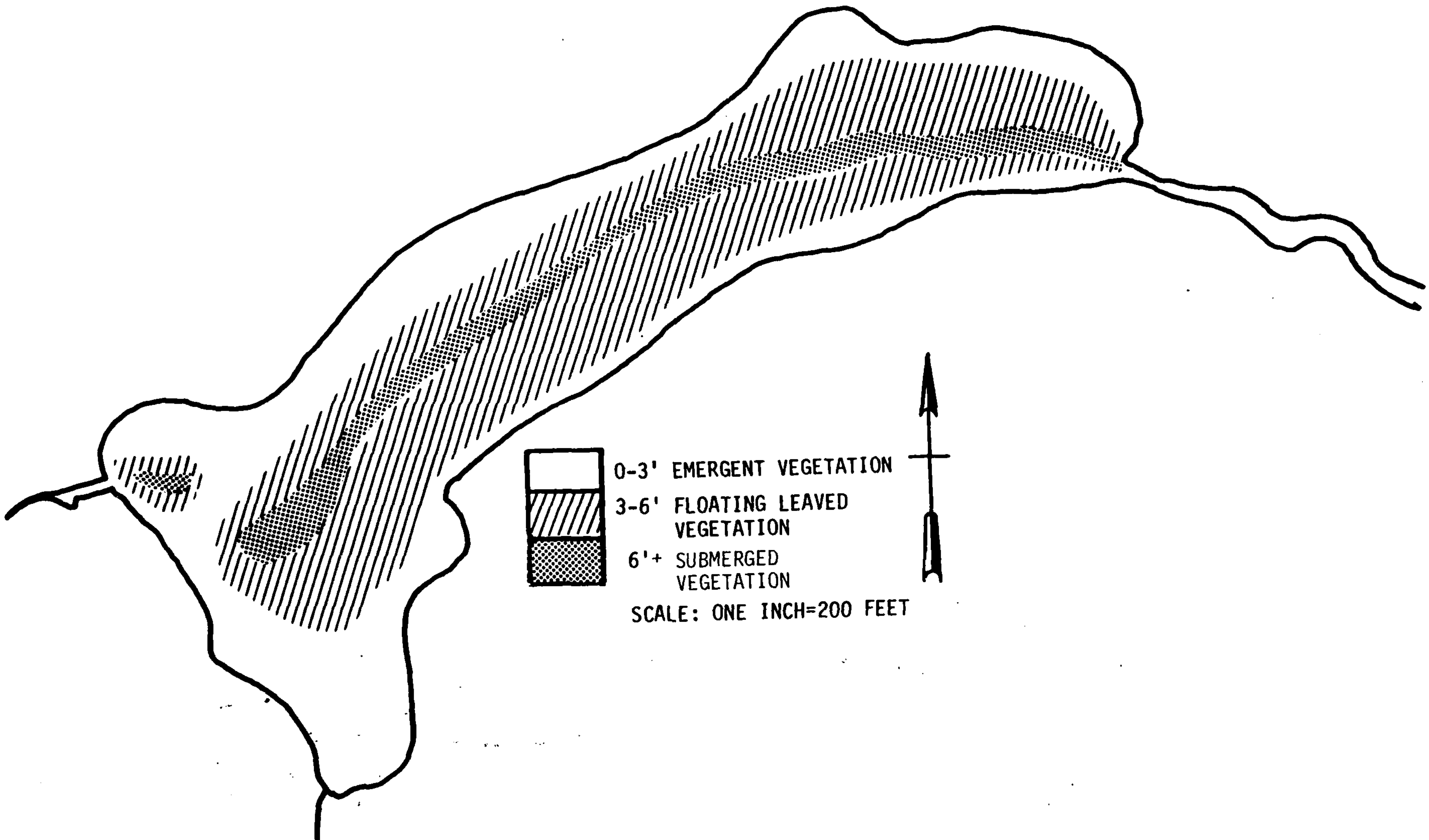


Figure 5. Areal distribution of aquatic macrophytes in Capwell Mill Pond, Rhode Island, August 1978. Big River Terrestrial Ecosystem Analysis, 1978.

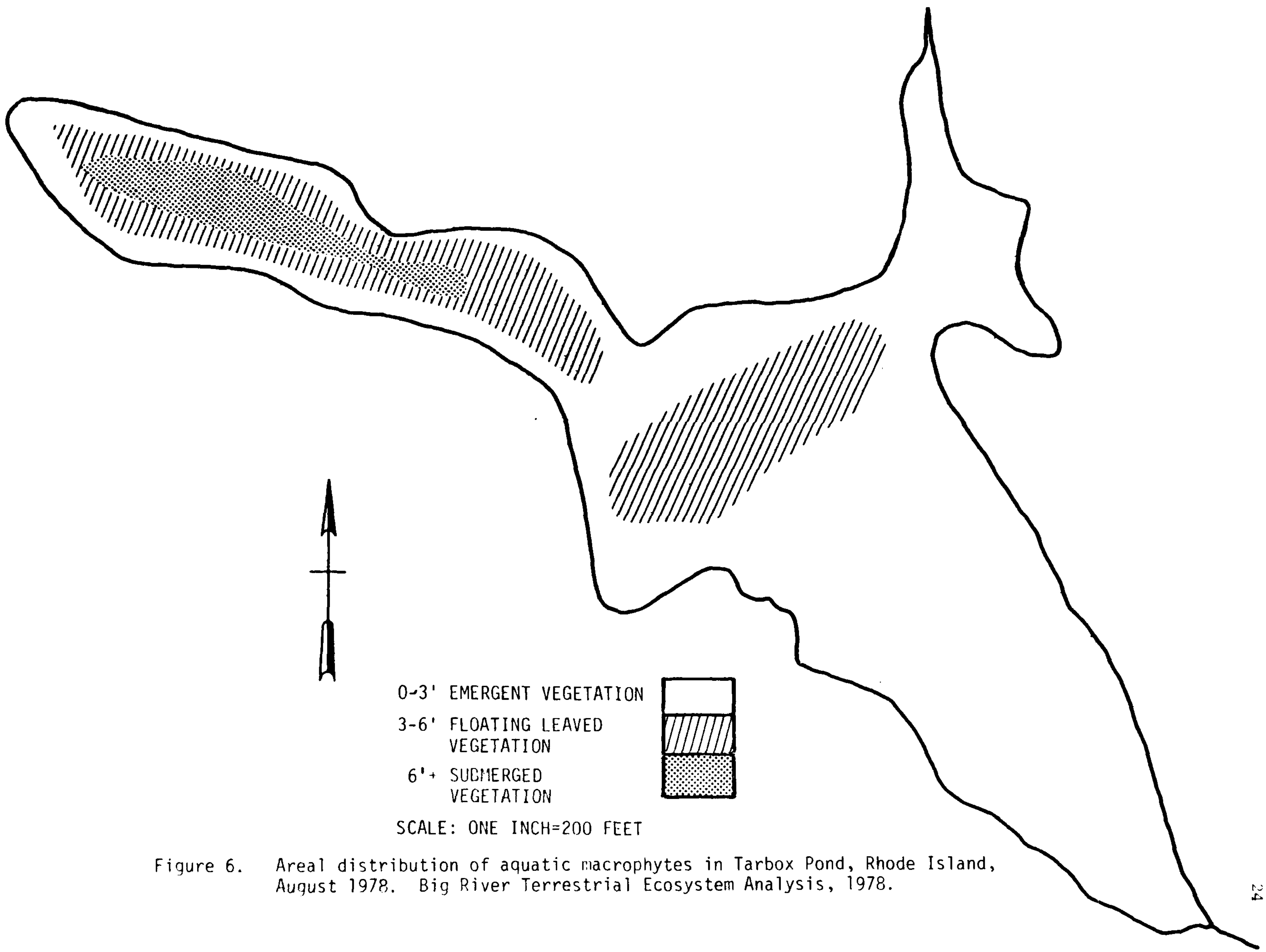


Figure 6. Areal distribution of aquatic macrophytes in Tarbox Pond, Rhode Island, August 1978. Big River Terrestrial Ecosystem Analysis, 1978.

Wetlands, while stable in terms of being adapted to such perturbations as diseases and insect depredations, are quite sensitive to changes in water level. A major increase or decrease in water elevation can completely destroy any of the types described above and all specialized functions attributed to them. Recent research, for example, has shown that wetlands purify polluted water by removing nutrients and other compounds in large quantities (Valiela *et al.*, 1975). Genetic repository value is quite high in shallow marshes, shrub swamps and wooded swamps due to high species diversity. Wetlands are critical as habitat to many species of wildlife which depend completely upon certain wetland stages for feeding or nesting habitat.

3.1.2.5 Open Land

All areas designated Open Land throughout the study area have either been recently disturbed or are disturbed on a recurring basis as a result of mowing, agriculture, or trampling. The flora in such areas typically contains high proportions of grasses, forbs, and pioneer woody species or high proportions of annual and alien species. Common species observed in early abandoned fields included hawkweed, quack grass, timothy, barnyard grass, cinquefoil, and yarrow. Little bluestem, bush clover, dewberry, thistle, and ragweed were found to be typical in sandy or gravelly areas. Refer to Appendix Table 1 for list of species found in open land areas.

Given sufficient time, the open areas will eventually support upland mixed or hardwood forest, or pitch pine and scrub oak communities depending upon soil characteristics. At this early stage of development, however, the plant community possesses few of the values attributable to a stable and efficiently functioning ecosystem. Genetic repository, forest resource, and wildlife habitat values are low. Further, the ecological services performed such as soil binding, runoff control, and the general stabilizing influence on unstable environments are few compared to more mature systems.

3.1.2.6 Acreages of Each Cover Type Affected

Figure 7 depicts the distribution of the five cover types in the Big River study area. The greatest amount of area is covered by softwood forest, followed closely by hardwood forest with mixed forest, wetlands and open land comprising lesser amounts (Table 2).

Comparisons with similar statistics for the State of Rhode Island show the Big River study area to consist of a higher percentage of forest land and a lower percentage of open land than the state as a whole. Of particular note is the much higher percentage of wetland in the Big River study area.

3.1.3 Verification of Previous Work

Field checking of plant communities described in the KAME baseline report was conducted within three transect segments through the following vegetative cover types: white pine-white oak, white oak-red oak, and white oak-red maple-white pine. In all three areas field observations of the major overstory and understory species and their relative abundance and distribution corroborated the general descriptions of these transect segments provided in the report. Visual checking of the species density data yielded results that were similarly corroborative. Comparison of the lists of understory species with field observations however, revealed several discrepancies that are most likely attributable to errors in identification. In checking the classification and distribution of various randomly selected stands, major discrepancies were also found in several situations.

Based on these observations, it seems reasonable to conclude that in locations where field studies were carried out by the previous investigators, plant community designations and descriptions are accurate for the most part, but where vegetative types were delineated by aerial photographs and not field checked, the likelihood of error appears to be quite high. The accuracy of the cover type maps in Appendix Figures A-1 through A-5, therefore, cannot be guaranteed.

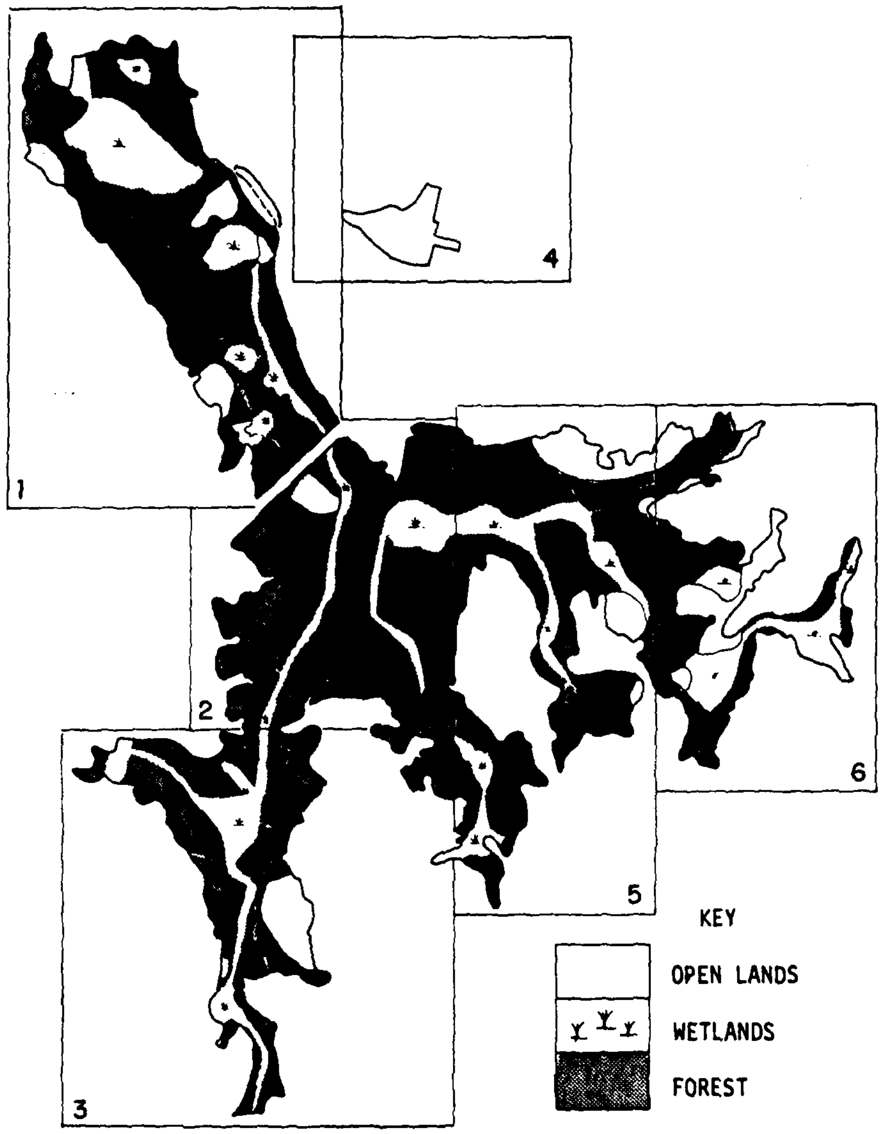


Figure 7. Vegetative cover types in proposed Big River reservoir. Big River Terrestrial Ecosystem Analysis, 1978.

TABLE 2. ACREAGE OF EACH HABITAT TYPE IN THE PROPOSED BIG RIVER RESERVOIR. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

HABITAT	BIG RIVER STUDY AREA		STATE OF RHODE ISLAND	
	ACREAGE	PERCENT	ACREAGE	PERCENT
Hardwood Forest	832	26	311,700[1]	46
Softwood Forest	872	28	54,000[1]	8
Mixed Forest	601	19	38,500[1]	6
Wetland	524	17	not available	1.5[2]
Open Land	325	10	32,000[1]	5
Total	3154	100	671,400[1]	[3]

[1]From Peters and Bowers, 1977

[2]From Rhode Island Dept. Natur. Resour., 1976

[3]Remaining land is classified as urban, industrial and other miscellaneous categories.

3.1.4 Forest Resources of Big River Study Area

Results of the forest inventory, summarized by species within the mixed forest, hardwood forest and softwood forest types, are presented in Table 3. Current commercial value of each species within each of the three types is shown in Table 4. This estimate is based on the inventory data generated from the present study and, as discussed below, may be somewhat conservative.

These data indicate the softwood type contains the highest volumes of sawtimber followed by mixed forest and hardwood forest. In general, cordwood volumes appear to be quite low in all three types although cordwood is somewhat more abundant in the hardwood and mixed forests than in the softwood forests. Accordingly, the bulk of the forest resource value is contained in the sawtimber, approximately two-thirds of which consists of white pine.

In the softwood forest, the dominant species was white pine with pitch pine also present. Individual trees averaged 40-50 feet in height, contained one and one-half to two 20-foot sawlogs, and were of good growth form. General observations indicated that rot, deformity and other defects are probably not of sufficient magnitude to significantly diminish the commercial value shown in Table 4. Stands of pitch pine contained individuals having an average height of 25-30 feet and an overall scrubby form and appearance. The quality and volume of the sawtimber produced by this species would be low. While cordwood volumes of softwood species, particularly white pine, tended to be quite high, their commercial value would be low, derived mainly from products such as wood chips.

In the mixed forest, the dominant species was white pine, represented by individuals having the same physical characteristics as those found in the softwood forest. Among the hardwoods, white oak and

TABLE 3. SUMMARY OF TIMBER STANDING STOCK VALUES IN THE BIG RIVER STUDY AREA. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

	$\bar{x}$ BD´/ACRE	f	SITE TOTAL	$\bar{x}$ CUBIC´/ACRE	f	SITE TOTAL	$\bar{x}$ # CORDS/ACRE	SITE TOTAL
Hardwood Forest								
White oak	279	.304	232,128	22.22	.291	18,487	.173	144.43
Red oak	397	.304	330,829	16.31	.250	13,570	.127	106.01
Black oak	116	.130	96,911	2.15	.083	1,788	.016	13.97
Red maple				.775	.125	645	.006	5.04
Gray birch				.422	.041	351	.003	2.74
White pine	91	.217	76,189	7.01	.208	5,832	.054	45.56
Pitch pine	11	.043	8,944					
Softwood Forest								
White pine	4,206	.423	3,667,632	20.21	.379	17,623	.158	137.68
Pitch pine	202	.153	176,144	6.12	.103	5,336	.047	41.68
Atlantic white cedar	52	.038	45,344			.		
Hemlock	194	.038	169,168	4.05	.034	3,531	.031	27.58
White oak	72	.076	62,784	2.42	.206	2,110	.019	16.48
Red oak	10	.038	8,720	.193	.034	168	.001	1.31
Black oak	15	.076	13,080	.397	.068	346	.003	2.70
Red maple	218	.115	190,532	4.39	.172	3,828	.034	29.90
White ash	34	.038	29,822					
Mixed Forest								
White oak	542	.259	325,949	15.87	.292	9,537	.123	74.50
Red oak	403	.194	242,398	4.36	.138	2,620	.034	20.46
Black oak	92	.090	55,388	1.26	.076	757	.009	5.91
Swamp white oak	5	.012	2,740					
Red Maple	134	.103	80,783	6.93	.138	4,164	.054	32.53
Beech				.027	.015	16	.000	.125
Gray Birch				.151	.015	90	.001	.703
Blue beech				.234	.015	140	.001	1.09
White pine	935	.220	562,067	15.76	.246	9,471	.123	73.99
Pitch pine	106	.090	63,934	2.00	.061	1,202	.015	9.39
Grand Total	2,794		6,441,486	44.68		101,612	.344	793.77

$\bar{x}$ BD´/Acre = average (adjusted) number of board feet per acre, computed by multiplying the unadjusted mean board feet per acre by relative frequency (f).

$\bar{x}$ cubic´/Acre = average (adjusted) number of cubic feet per acre, computed by multiplying the unadjusted mean cubic feet per acre by relative frequency (f).

$\bar{x}$ # cords/Acre = average number of cords per acre, computed by dividing cubic feet/acre by the cubic foot volume of a single cord.

f = frequency of species occurrence in form suitable for sawtimber or cordwood.

Sample calculation for white oak in hardwood forest:

Board Feet: 918 (unadjusted $\bar{x}$ Bd´/acre) x .304 (f) = 279 (adjusted $\bar{x}$ Bd´/acre) x 832 (acres of hardwood forest) = 232,128 (total number of board feet in hardwood forest).

Cubic Feet: 73.11 (unadjusted $\bar{x}$ cubic´/acre x .291 (f) = 22.22 (adjusted $\bar{x}$ cubic´/acre) x 832 (acres of hardwood forest_ = 18,487 (total number of cubic feet in hardwood forest).

Cords: 22.22 ($\bar{x}$ cubic´/acre) ÷ 128 (cubic´ volume/cord) = .173 (cords/acre). 18,487 (total number of cubic feet in hardwood forest) ÷ 128 (cubic´ volume/cord) = 144.43 (total number of cords in hardwood forest).

TABLE 4. SUMMARY OF TIMBER COMMERCIAL VALUES (1) IN THE BIG RIVER STUDY AREA. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

	ACRE DOLLAR VALUE		SITE DOLLAR VALUE	
	SAWTIMBER	CORDWOOD	SAWTIMBER	CORDWOOD
Hardwood Forest				
White oak	16.74	6.92	13,927	5,757
Red oak	23.82	5.08	19,818	4,226
Black oak	6.96	.64	5,790	532
Red maple		.24		199
Gray birch		.12		99
White pine	5.46		4,542	
Pitch pine	.66		549	
Softwood Forest				
White pine	252.36		220,057	
Pitch pine	12.12		10,568	
Atlantic white cedar	3.12		2,720	
Hemlock	11.64		10,150	
White oak	4.32	.76	3,767	662
Red oak	.60	.04	523	209
Black oak	.90	.12	784	104
Red maple	13.08	1.36	11,405	1,185
White ash	2.04		1,778	
Mixed Forest				
White oak	32.52	4.92	19,544	2,956
Red oak	24.18	1.36	14,532	817
Black oak	5.52	.36	3,317	216
Swamp white oak	.30		180	
Red maple	8.04	2.16	4.832	1,298
Beech				
Gray birch		.04		24
Blue beech		.04		24
White pine	56.10		33,716	
Pitch pine	6.36		3,822	
Grand Total			386,321	18,308

[1]Based on an average market value of $60./1000 board feet for all sawtimber species and $40./cord for hardwood cordwood (Tom Dupre, RI Division of Forest Environment, personal communication). Commercial value of products such as sawdust and wood chips derived from small-diameter softwood species, was not calculated due to high statewide variability in value and the small contribution to the site total that this value would represent.

red oak were the most abundant species and occurred in average heights of 40 feet with one to one and one-half 20-foot sawlogs per tree. The trees were generally straight and of good form. The oaks, particularly white oak, and white pine contributed to the next-to-highest cordwood volumes of the three types.

The hardwood forest was dominated by red oak and white oak. Average height range of the trees was 35 - 50 feet and there were one to one and one-half 20-foot sawlogs per tree. Individuals were generally straight and of good form; as in the softwood and mixed forest types deduction for rot, deformity and other defects would probably be quite low. Cordwood volumes in the hardwood stands were the highest of the three types but very low compared to the sawtimber volumes.

Comparison of these results with preliminary inventory data obtained from the Rhode Island Division of Forest Environment (Tom Dupre, personal communication) for the Big River site indicates that the 6.5 million board foot total estimated from the present study may be somewhat conservative and that this total might be nearer nine million board feet. There are two primary reasons for this difference: 1) small sample size necessitated by the limited scope of the present field study, and 2) use of different base maps. The forest inventory currently being conducted by the Division of Forest Environment is based upon vegetative delineations checked by ground control while the present study was based upon the Kame Vegetation map which was found to contain several major discrepancies (see Section 3.1.3).

3.1.5 Vegetation of the Alternate Sites

Field inventories of representative upland, wetland, and open land areas on the four alternate sites revealed little difference among the alternates with respect to structural and species compositional characteristics.

The hardwood-dominated upland forests were characterized by a predominance of red oak and white oak in the overstory with scattered scrub oak and white pine. The trees ranged from 25 to 40' in height with diameters of 7-9"; crown closure was nearly complete. The intermediate layers were of variable height and density, and contained scattered black cherry, highbush blueberry, lowbush blueberry, sheep laurel and wintergreen. This type of climax growth will continue to perpetuate itself as such.

Softwood-dominated upland forests typically contained a predominance of pitch pine and white pine, with white oak and red oak scattered throughout the overstory. These stands generally ranged from 15 to 25' in height with diameters of 8" and nearly complete aerial coverage. The intermediate layer contained scrub oak, black cherry, and greenbriar in addition to oak and pine seedlings. Density and height in this layer was variable. The ground cover was similar to that found in hardwood stands, but the following species were also frequently found: sweetfern, dewberry, bearberry, and pink lady's slipper. Where white pine was dominant in the overstory, the softwood forests will eventually be replaced by oak-dominated stands. However, where pitch pine was dominant on sites having coarse droughty soils, and where fires were recurrent, this cover type will continue to perpetuate itself.

Three different stages of wetlands were observed; wooded swamp, shrub swamp, and open water. The wooded swamps were characterized by an overstory of multiple-stemmed red maple having diameters of 8-10" and forming stands 30-40' tall. The overstory also contained scattered white pine, white cedar and black gum. The intermediate layers varied in height and density in relation to the density of the canopy layer and presence of openings. The predominant shrub species were highbush blueberry, holly and swamp honeysuckle. The ground cover was composed largely of skunk cabbage, tussock sedge, sensitive fern and sphagnum. In shrub swamps, species composition was quite similar to that of the wooded swamps except that red maple were often present as saplings in scattered patches. The open water areas typically contained growths of emergent species such as pickerelweed, soft rush, arrowhead and floating heart along the edges. The trend of development in these wetlands was toward increasing dominance by woody species representative of shrub swamps and wooded swamps, eventually culminating in the mature wooded swamp community.

The open land occurring on the alternate sites was composed largely of old fields and abandoned pasture and cropland. The predominant species were little bluestem, steeplebush, black cherry, ticklegrass, path rush, and dewberry. Pitch pine, white oak, and juniper were early invaders present as scattered individuals and in small patches.

A complete list of all species observed on the alternate sites along with relative abundance is presented in Appendix Table 3. Acreage of open land, wetland and forest land (combined softwood, hardwood and mixed wood) for the Big River site and three alternates appear in Table 5.

3.2 FAUNA

3.2.1 Fauna of the Big River Study Area

3.2.1.1 Birds

A total of 49 species of birds were observed in the study area, including 41 observed during the transect counts (Table 6) and

TABLE 5. ACREAGE OF HABITAT TYPES FOR PROPOSED BIG RIVER RESERVOIR AND ALTERNATE SITES. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

AREA	FOREST		OPEN		WETLAND		TOTAL ACRES
	ACRES	PERCENT	ACRES	PERCENT	ACRES	PERCENT	
Big River Reservoir	2306	73	325	10	524	17	3154
Wood River Alternate	691	78	26	3	166	19	883
Moosup River Alternate	333	62	47	9	159	29	539
Bucks Horn Brook Alternate	294	62	6	1	178	37	478
State of Rhode Island	--	65[1]	--	5[2]	--	1.5[1]	--

[1]From Rhode Island Dept. Natur. Resour., 1976.

[2]From Peters and Bowen, 1977.

TABLE 6. RELATIVE ABUNDANCE OF AVIAN SPECIES OBSERVED IN EACH HABITAT TYPE. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

SPECIES	HABITAT				
	SOFTWOOD FOREST	HARDWOOD FOREST	MIXED FOREST	WETLAND	OPEN
Broad-winged hawk	---	R	---	---	---
Kestrel	---	---	---	---	R
Mourning dove	R	---	---	R	O
Whip-poor-will	R	---	---	---	---
Belted kingfisher	---	---	---	R	---
Common flicker	R	R	C	C	---
Downy woodpecker	R	---	O	---	R
Eastern kingbird	O	---	---	---	C
Eastern phoebe	---	R	---	R	R
Alder's flycatcher	R	---	---	---	---
Tree swallow	R	---	---	---	---
Blue jay	A	A	A	C	O
Common crow	---	O	---	---	O
Black-capped chickadee	A	A	A	R	---
White-breasted nuthatch	R	---	R	---	---
House wren	---	---	---	---	R
Mockingbird	---	---	---	---	O
Catbird	C	R	C	C	C
Brown thrasher	---	---	---	---	R
Robin	R	---	C	R	O
Wood thrush	---	---	O	---	---
Cedar waxwing	---	---	---	---	R
Black and white warbler	R	---	R	---	---
Tennessee warbler	R	---	---	---	---
Nashville warbler	R	---	R	R	R
Yellow warbler	R	R	---	---	---
Black-throated green warbler	R	---	---	R	---
Pine warbler	R	---	---	---	---
Ovenbird	R	R	---	R	---
Yellowthroat	R	R	R	O	R
Wilson's warbler	---	---	---	R	---
House sparrow	---	---	---	---	R
Common grackle	R	R	---	---	---
Cardinal	R	---	---	R	---
American goldfinch	O	---	R	---	C
Rufous-sided towhee	C	---	C	R	---
Grasshopper sparrow	---	---	---	R	---
Chipping sparrow	---	C	---	O	O
Field sparrow	O	---	---	---	A
White-throated sparrow	---	R	---	R	---
Song sparrow	R	---	---	---	---

A = Abundant

C = Common

O = Occasional

R = Rare

eight additional species observed while engaged in non-census tasks (Table 7).

Black-capped chickadees,[2] blue jays and catbirds were generally the most abundant and widespread species observed. Rankings within habitats showed the following species to be the most abundant in each of the habitat types: 1) softwood forest: blue jay, black-capped chickadee, catbird and rufous-sided towhee; 2) hardwood forest: blue jay, black-capped chickadee and chipping sparrow; 3) mixed forest: common flicker, blue jay, black-capped chickadee, catbird and rufous-sided towhee; 4) wetland: common flicker, blue jay and catbird and 5) open areas: eastern kingbird, catbird, American goldfinch and field sparrow.

In addition to those species listed in Tables 6 and 7, the Rhode Island Department of Conservation lists ring-necked pheasants, ruffed grouse, common snipe, woodcock and bobwhite quail as occurring in the study area.

The census operations were conducted in late August. As such, most, if not all, of the species observed probably nested in the study area. Because of the time of year, males were not singing; it is likely, therefore, some species which bred in the area were not observed. These species, as well as fall and spring migrant and resident species which may occur in the study area, are listed in Appendix Tables 4 and 5.

---

[2]Refer to Appendix Tables 4, 5 and 6 for scientific names of all wildlife species mentioned in text.

TABLE 7. BIRD SPECIES OBSERVED DURING MISCELLANEOUS OBSERVATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978. (Miscellaneous observations occurred during non-census activities as discussed on Page 15).

	HABITAT				
SPECIES	SOFTWOOD FOREST	HARDWOOD FOREST	MIXED FOREST	WETLAND	OPEN
Mallard				X	
Wood duck				X	
Red-tailed hawk				X	
Osprey				X	
Great blue heron				X	
Green heron				X	
American bittern				X	
Black-billed cuckoo				X	
Belted kingfisher				X	
Rough-winged swallow				X	
Brown creeper		X			
Red-eyed vireo				X	

3.2.1.2 Mammals

Seven species of mammals were observed during the field studies (Table 8). Most commonly observed were red squirrels, gray squirrels and chipmunks. Softwood forests exhibited the highest number of mammalian observations while mixed forests and wetland yielded the lowest.

The Rhode Island Department of Conservation lists white-tailed deer, snowshoe hare and cottontail rabbit as mammals occurring in the study area. Other species which may occur appear in Appendix Table 6.

3.2.1.3 Rare and Endangered Species

The Big River study area is within the range of the Indiana bat, eastern cougar, bald eagle and peregrine falcon, all listed as endangered species by the U.S. Department of the Interior (Federal Register 1976). There are no known sitings of these species within the area. Bald eagles and peregrine falcons may occur during migration and utilize the area as resting and feeding habitat.

3.2.1.4 Habitat Evaluation

I. HARDWOOD FOREST

Hardwood forests were dominated by white and red oaks, with smaller amounts of red maple and white pine present. The understory consisted of young oaks as well as thick growths of huckleberry and lowbush blueberry. Structural diversity varied, depending upon the thickness of the shrub layer in each stand. Figure 8 depicts typical hardwood forest habitat.

TABLE 8. MAMMALS OBSERVED IN BIG RIVER STUDY AREA. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

	HABITATS				
SPECIES	SOFTWOOD FOREST	HARDWOOD FOREST	MIXED FOREST	WETLAND	OPEN
Raccoon	X				
Striped skunk					X
Red fox			X		
Eastern gray squirrel	X	X		X	
Red squirrel	X	X	X	X	
Eastern chipmunk	X	X			X
Eastern cottontail	X				X

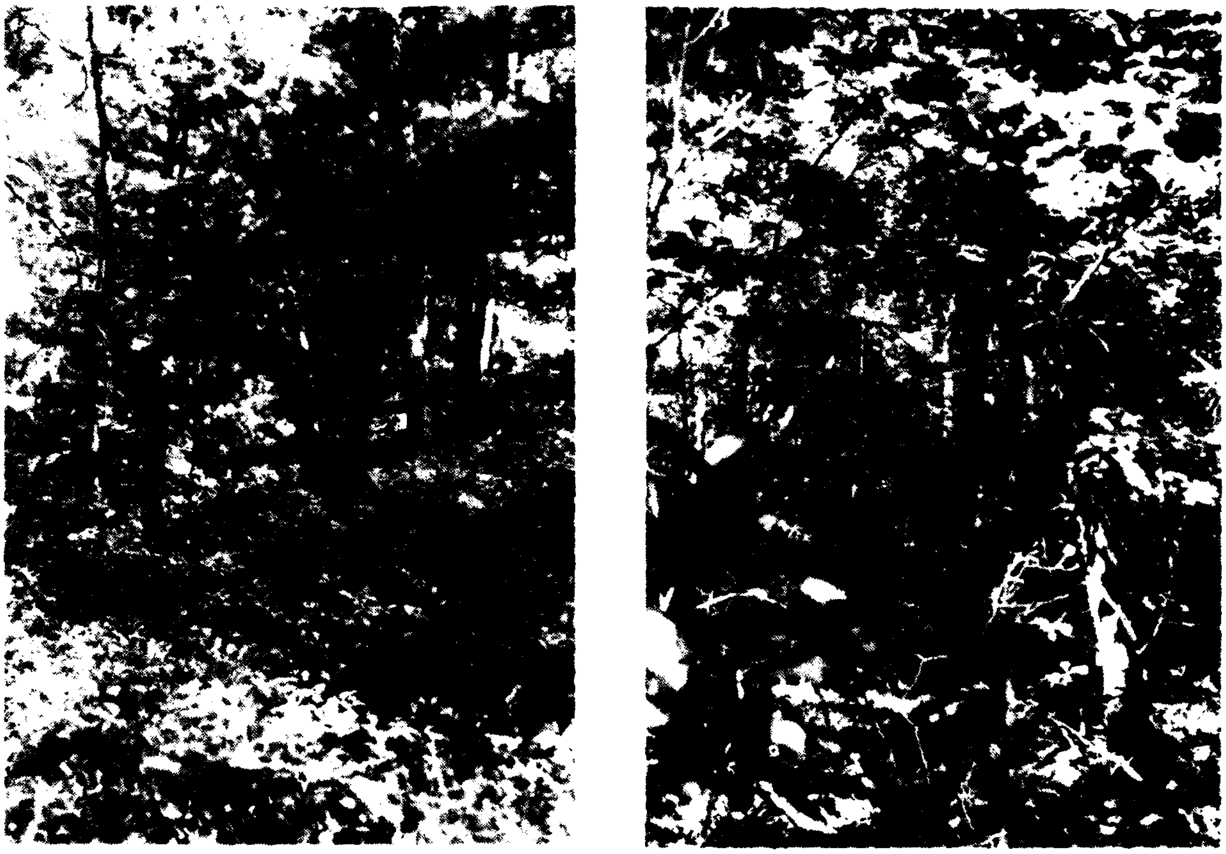


Figure 8. Hardwood forest habitat. Big River Terrestrial Ecosystem Analysis, 1978.

The hardwood forest stands evaluated were generally of higher wildlife value than the softwood stands. This was due primarily to the large amounts of acorns produced and greater density and diversity of food producing plants in the understory. Acorns are of high value to wildlife, being utilized by gray squirrels, white-tailed deer, white-footed mice, raccoons, bobwhite quail, blue jays and many songbird species (Martin *et al.*, 1951). The foliage, twigs and bark of the oaks and maples in the shrub layer, as well as the foliage of sweet fern are important as food for deer, cottontail rabbit and showshoe hare (Skinner and Telfer, 1974; Martin *et al.*, 1951) while fruits of huckleberry and blueberry are utilized by ruffed grouse, raccoons and many small mammals and songbirds (Martin *et al.*, 1951).

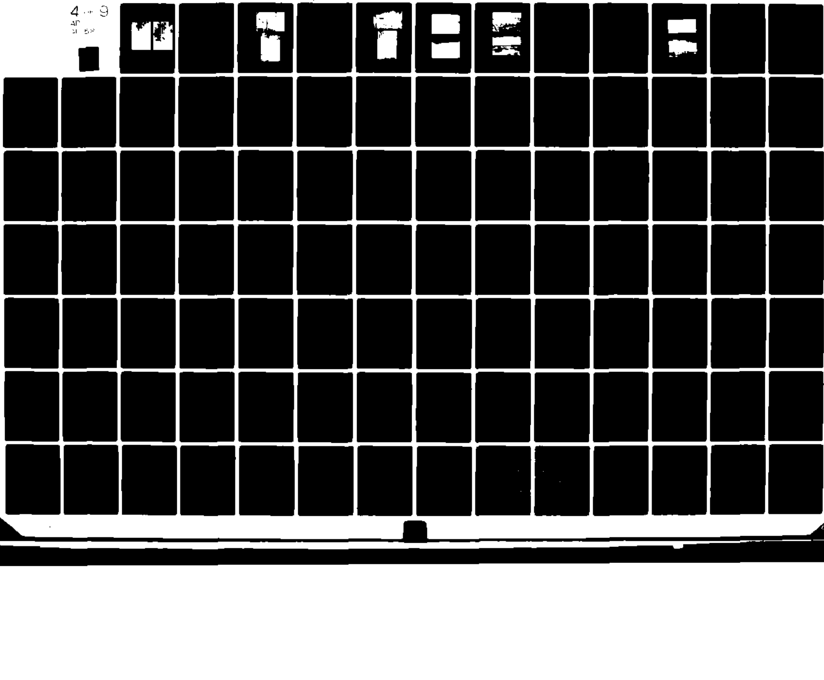
II. SOFTWOOD FOREST

This habitat type consisted of stands dominated by either white pine or pitch pine. The older white pine stands had closed canopies, little understory and poor structural diversity while the younger stands had thicker shrub layers and hence, provided better cover. Browse was present in small quantities; ground cover of huckleberries and blueberries was present in varying amounts. The pitch pine stands were generally present in disturbed and sandy areas and were in an early successional stage. As such, an understory of young pines, white oak, sweet fern and lowbush blueberry was generally abundant, providing good cover for many wildlife species. Figure 9 depicts typical areas of softwood forest habitat.

Certain species, such as red squirrels, prefer or require this habitat. The dense understory present in pitch pine stands is important as food and cover for snowshoe hare (Brocke, 1975; Marston, 1966). Others, such as white-tailed deer, snowshoe hare, ruffed grouse and many songbirds utilize these areas when they are adjacent to other habitat types (see Section VI). Generally, however, the softwood forests in the study area were not of high wildlife value.

AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED NL



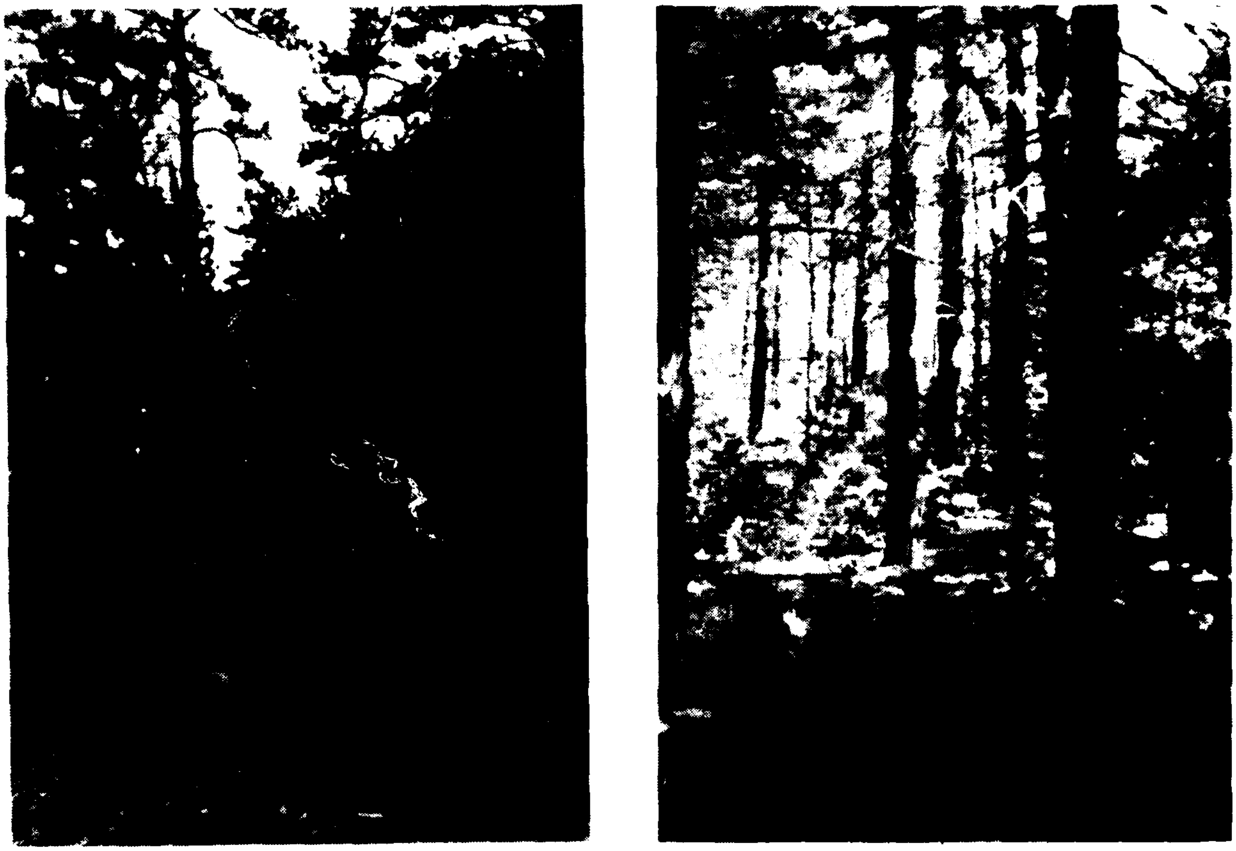


Figure 9. Softwood forest habitat. Big River Terrestrial Ecosystem Analysis, 1978.

III. MIXED FORESTS

Oaks and pines comprised the overstory of the mixed forest cover type with small oaks, pines and maples present in the shrub layer. Ground cover was dominated by huckleberry, blueberry and sheep laurel. Typical mixed forest habitat is depicted in Figure 10.

Wildlife value of the mixed forests was the highest of the three forest types due to greater amounts of structural and vegetative diversity. The hardwood trees and fruit producing understory plants provide abundant food while the softwood trees provide both food and cover. The thick undergrowth provides concealment for ground nesting birds such as ring-necked pheasants, American woodcock, black and white warbler, rufous-sided towhee, Tennessee warbler and ovenbirds. The larger oaks and pines provide branches and foliage for those species which nest high above the ground. Included in this group are the great horned owl, mourning dove, least flycatcher, blue jay, robin and myrtle warbler. Cavities present *in these* trees may be utilized by common flickers, hairy woodpeckers, downy woodpeckers, black-capped chickadees and white-breasted nuthatches. Snowshoe hare, white-tailed deer, mice and voles utilize the bark, twigs and fruits of the trees and shrubs present (Martin *et al.*, 1951).

IV. WETLANDS

A. SWAMPS AND BOGS

As discussed in Section 3.1.2.4, swamp areas were primarily red maple and shrub swamps. Vegetative and structural diversity was very high in these areas, and wildlife habitat value was excellent. The thick undergrowth provided food and cover for many wildlife species and nesting habitat for such songbird species as the brown thrasher, yellow warbler, chestnut-sided warbler, yellowthroat, catbird, white-throated sparrow and song sparrow. The larger maples present in wooded swamps

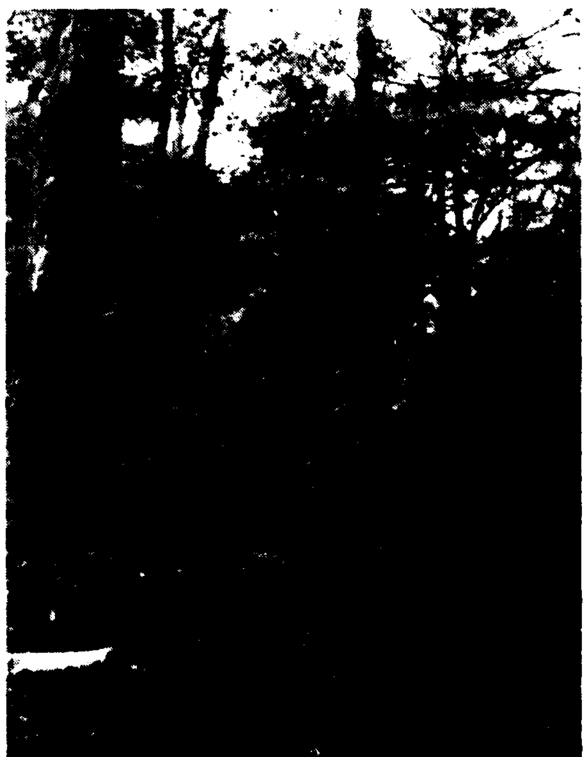


Figure 10. Mixed wood forest habitat. Big River Terrestrial Ecosystem Analysis, 1978.

provide the branches and foliage for those species which nest above the ground (see Mixed Forest, III above). This area was suitable habitat for raccoons, skunks, porcupine and snowshoe hare. Although the ground was only damp in late summer, it is undoubtedly covered with water in the spring and hence, unsuitable for ground nesting birds. The thick vegetation and lack of open water generally precludes use of these areas by waterfowl and aquatic furbearers.

Shrub swamp areas are similar to the wooded swamps, but with fewer trees, denser understory and usually the presence of standing water. As such, their value to nesting songbirds would be nearly identical to wooded swamps, while value to mammals would be less. Where open water is present, shrub swamps provide suitable habitat for waterfowl feeding and nesting as well as brood rearing.

Bogs are characterized by small amounts of open water and vegetation which is of low value to wildlife. As such, these areas are generally not inhabited by many species of wildlife although in many instances bogs support wildlife especially dependent upon the unique habitat conditions which are present. When flooded in early spring, they may be used by waterfowl during migration as resting and feeding habitat. Figures 11 and 12 depict typical swamp and bog habitat in the study area.

B. MARSHES

Shallow and deep water marsh areas are present in the study area, usually in association with the Big River or the several major ponds. These areas are characterized by shallow water and abundant vegetation consisting of pickerelweed, water lily, rush, burreed, and pondweed. Water-vegetation interspersion was very high. In areas of tall rush growth or in shrub swamp areas bordered by buttonbush, abundant wildlife cover is provided. Typical deep marsh habitat is depicted in Figure 13.

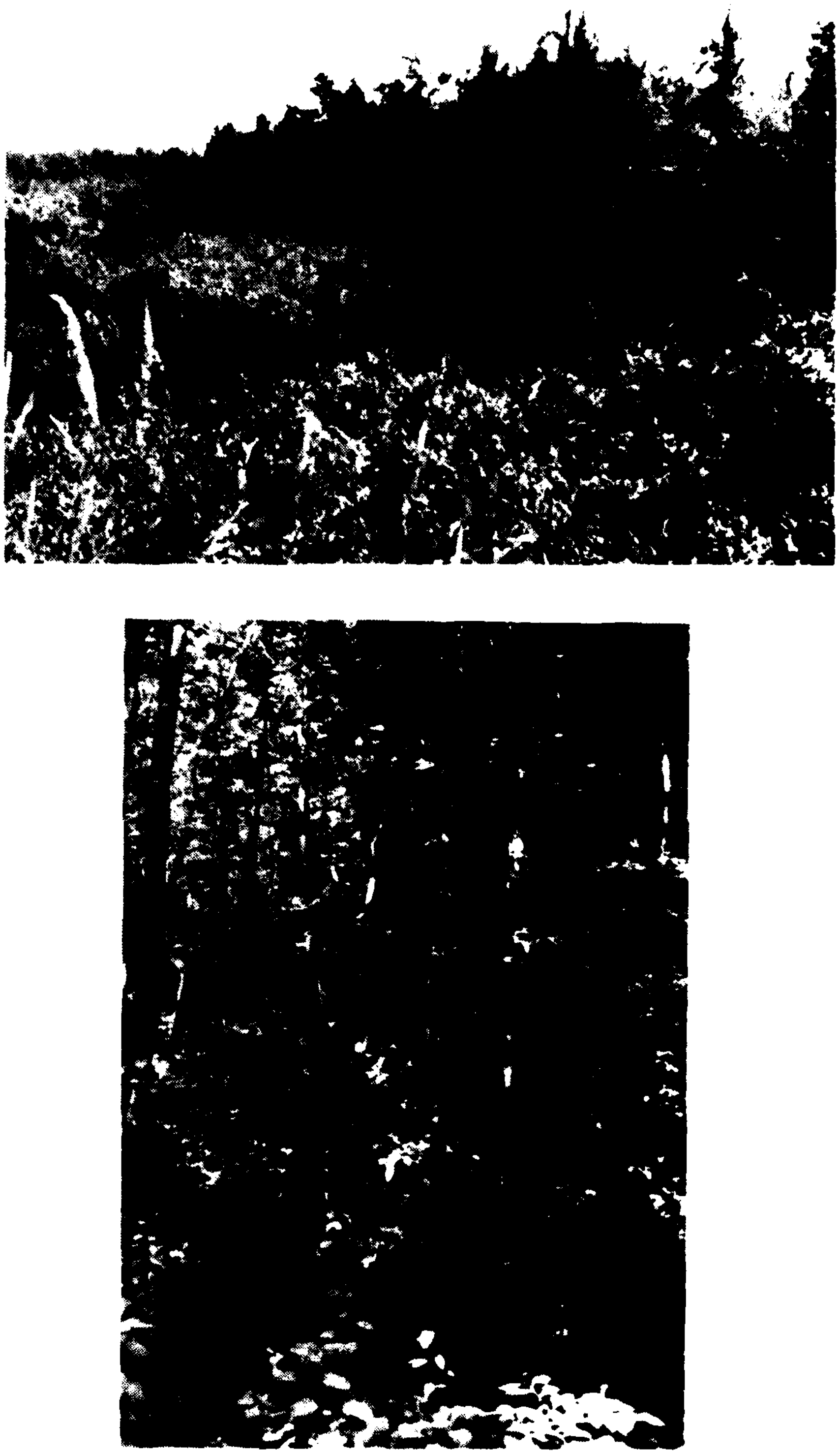


Figure 11. Swamp habitat. Big River Terrestrial Ecosystem Analysis, 1978.

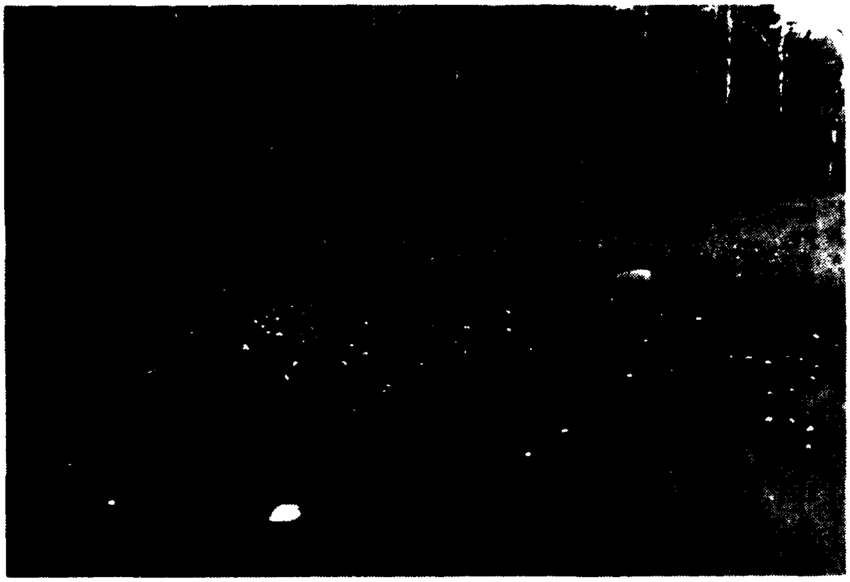


Figure 12. Bog habitat. Big River Terrestrial Ecosystem Analysis, 1978.

Figure 13. Marsh habitat. Big River Terrestrial Ecosystem Analysis, 1978.

These areas provide excellent waterfowl habitat. The vegetation present provides both food and cover. Such species as mallards, black ducks and wood ducks likely utilize these areas during migration periods for feeding and resting. Waterfowl breeding in these areas is probably restricted primarily to wood ducks. In addition to nesting boxes, the surrounding forests provide the tree cavities in which this species nests. The emergent vegetation is excellent cover for ducklings while the thick growth of floating and submerged vegetation provides habitat for aquatic insects. These insects provide a necessary source of animal protein to ducklings during their first two weeks of life.

In addition to waterfowl, these shallow and deep marsh areas are excellent habitat for wading birds and aquatic furbearers. The heavy plant growth furnishes habitat for frogs, turtles and fish which are a food source for otter, herons and kingfishers. Figure 14 depicts locations of marshes providing waterfowl breeding habitat.

V. OPEN LAND

This habitat type consisted primarily of abandoned agriculture fields and sandy areas. Dominant vegetation was grass and forbs with some small trees. Typical open field areas are pictured in Figure 15.

Open areas provide the habitat required for open country species such as cottontail rabbits, bobwhite quail, ring-necked pheasants and meadow voles. The seeds of the many grasses and forbs are utilized by songbirds, while the herbaceous material is grazed upon by cottontail rabbits and deer. Open areas provide hunting habitat for raptors and mammalian predators such as red fox and short-tail weasel. The value of these areas is increased because they are surrounded by forested areas, providing cover from which wildlife will venture to feed.

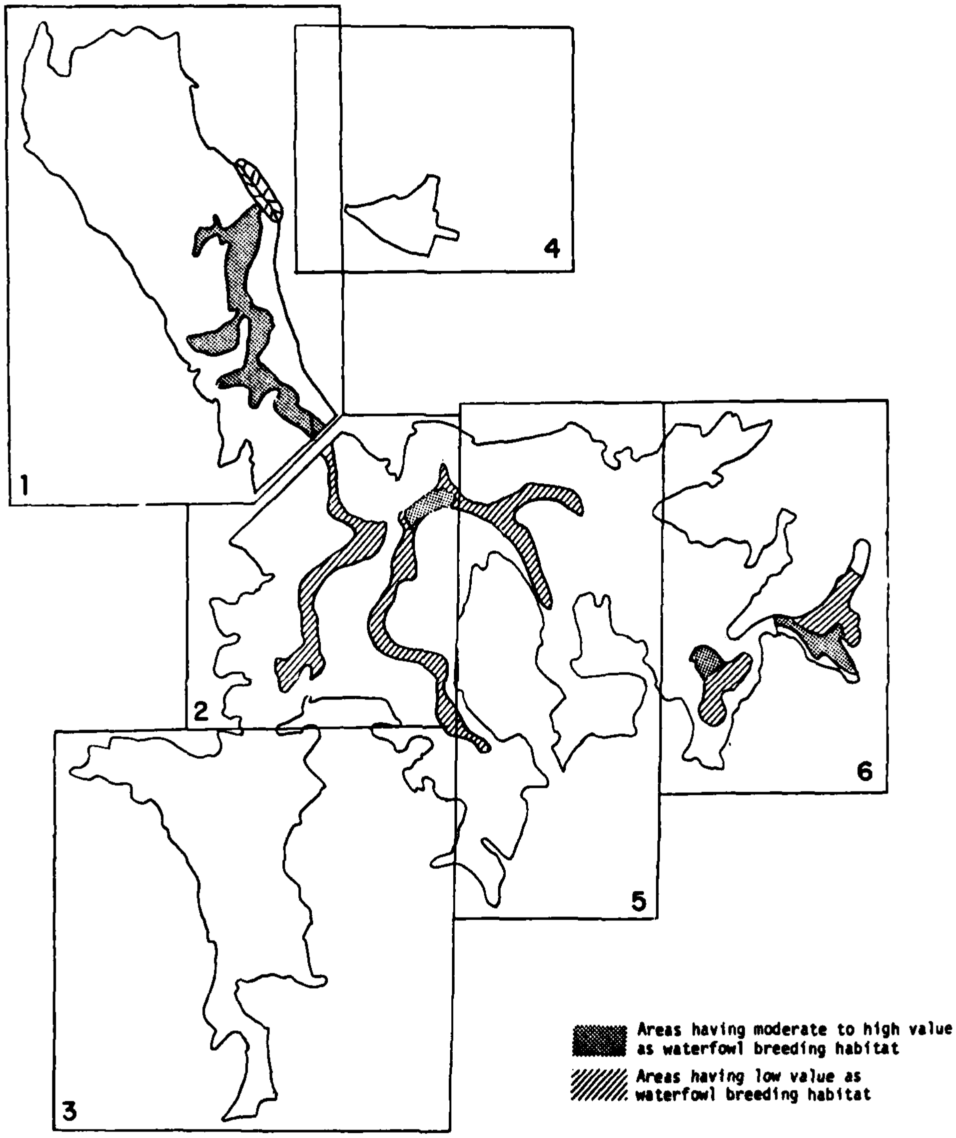


Figure 14. Location of waterfowl breeding habitat. Big River Terrestrial Ecosystem Analysis, 1978.

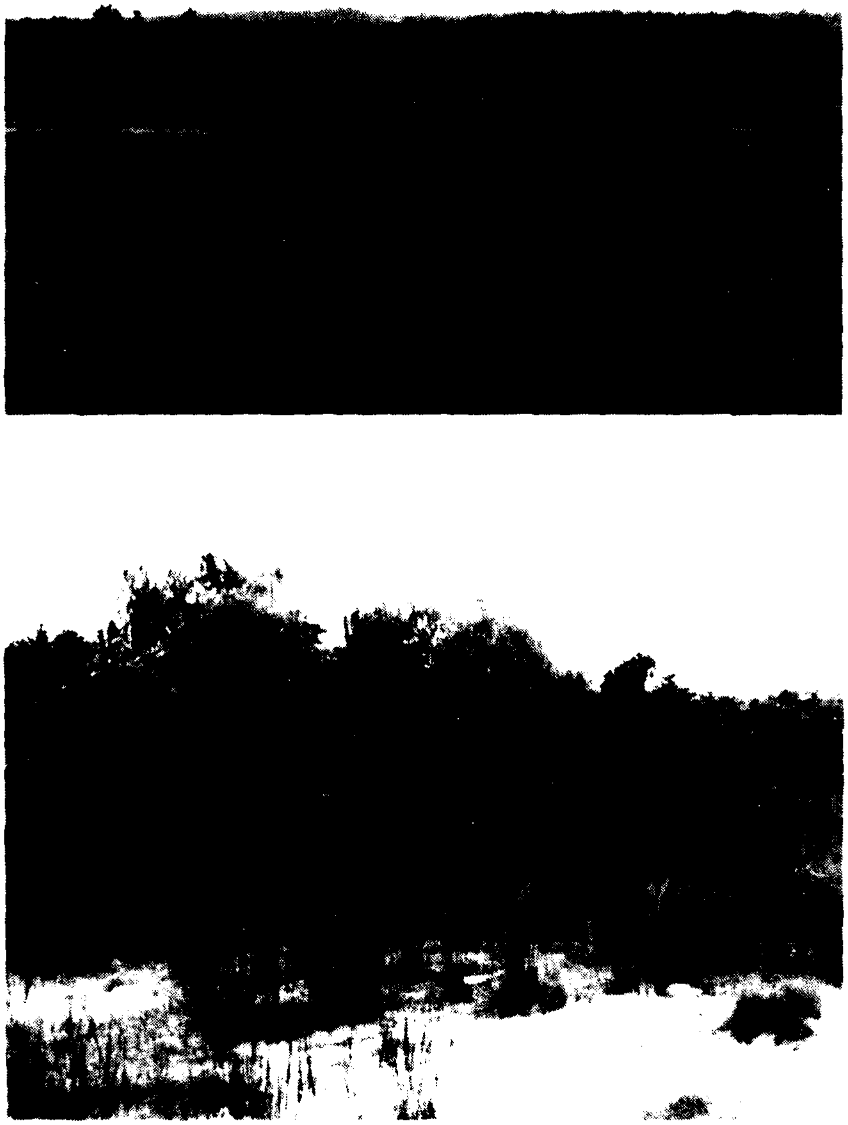


Figure 15. Open land habitat. Big River Terrestrial Ecosystem Analysis, 1978.

VI. HABITAT INTERSPERSION

A well known principle in wildlife biology is the edge effect; when two different habitat types meet and blend together, an ecotone is created. The diversity and number of organisms is often greater in an ecotone than in the surrounding areas (Leopold, 1933). Open fields are of more value to wildlife if they are bordered by forest areas which provide escape cover. This principle is illustrated in studies concerning white-tailed deer by McCaffery and Creed (1969), for ruffed grouse by Jordan and Sharp (1967), for snowshoe hare by Brocke (1975), and for songbirds by Schemnitz (1974).

In the proposed reservoir area, habitat interspersion is not exceptionally high. However, open areas and wetlands are surrounded by forested areas, and their value, therefore is increased as wildlife habitat.

3.2.1.5 Carrying Capacity Estimates

The carrying capacity of the Big River area for nine species was estimated using results of the habitat evaluations and information from published sources as discussed on Page 16. With the exception of gray squirrels and ovenbirds, which would not be found in open areas, and white-footed mice, which could not survive in wetlands, it was assumed all the species considered could utilize the entire area as habitat. The open water of Tarbox and Capwell Mill Pond (30 acres) was subtracted from the wetland total when estimating carrying capacity; the remaining wetland areas are primarily red maple swamps which are suitable habitat for the species considered and, thus, were considered in the total acreage of the area.

I. RUFFED GROUSE

This bird is a forest resident, seeming to prefer deciduous trees. The preferred habitat type is various aged stands of trees of the genera *Betula* and *Populus* (Johnsgard, 1973; Gullion, 1972). Aspen buds and leaves are important ruffed grouse food, particularly in winter (Carson, 1966; Gullion, 1972; Schemnitz, 1970). Other important habitat types include mixed forests with thick understory, the conifers providing cover while the hardwood trees provide food (Edminster, 1947; Dorney, 1959). This habitat type is found to contain more grouse than either pure hardwood or softwood stands (Dorney, 1959). Small clearings are also valuable because of the fruits and foliage from shrubs and herbaceous plants (Sharp, 1963).

The Big River study area is primarily forest with a limited number of open areas. Birch and poplar stands were not observed, nor were these species abundant at any of the upland sites evaluated. Because of the above, the study area can be considered to be of fair value as ruffed grouse habitat. Comparing values from the literature (Table 9) with the habitat types in the study area, density of breeding grouse is estimated at one bird per 15 acres and 210 ruffed grouse is projected as the maximum total carrying capacity for the proposed Big River reservoir area.

II. GREAT HORNED OWL

This species is distributed over a wide geographic range and occupies many habitat types including forests and open prairies (Burton, 1973). It feeds primarily on small rodents, with birds, insects and fish also consumed (Martin *et al.*, 1951; Palmer, 1949).

The forests and open land of Big River study area provide both the nesting and roosting habitat required by these birds, as well as small mammals, birds and insects as prey. Because these owls are

TABLE 9. DENSITIES OF BREEDING RUFFED GROUSE POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (ACRES/BIRD)	LOCATION	SOURCE
4	Minnesota	Trippensee, 1948
5	Minnesota	Gullion, 1969
8	New York	Bump *et al.*, 1947
9	New York	Trippensee, 1948
15	New York	Trippensee, 1948
20	Minnesota	Gullion, 1969
21	New York	Bump *et al.*, 1947
37	New York	Trippensee, 1948
38	New York	Bump *et al.*, 1947

typically found in low densities (Table 10), the carrying capacity of the proposed Big River reservoir is estimated to be a maximum of two breeding pairs.

III. OVENBIRD

A member of the warbler family, the ovenbird is found primarily in forested areas, seeming to prefer hardwood stands (Bent, 1953; Palmer, 1949). Food items consist primarily of insects, snails and earthworms.

The forested areas of the Big River region can be utilized by this species. Results of breeding bird surveys (indicating the density of singing males) are presented in Table 11. With these values, a density of 15 breeding males or 30 birds per 100 acres is estimated for the proposed reservoir area. Subtracting the acreage of open areas from the total land available, a carrying capacity of 860 breeding ovenbirds is estimated.

IV. SNOWSHOE HARE

This species is also an animal of the forest, generally utilizing hardwood and softwood trees for food, and softwood stands for cover. Marston (1968) found snowshoe hares preferred low level conifer stands and tended to avoid older stands. A study conducted in the Adirondacks showed the importance of coniferous trees 7-15' tall as snowshoe hare base cover (Brocke, 1975). Food items include buds, bark and twigs of woody vegetation as well as herbaceous plants (Trippensee, 1948). Preferred food items in the northeast include red maple, sugar maple, white pine, hazelnut and viburnums (Marston, 1966; Martin *et al.*, 1951).

The Big River study area contains habitat suitable for snowshoe hare as discussed in Section 3.2.1.4. Portions of the forested

TABLE 10. DENSITIES OF BREEDING GREAT HORNED OWL POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (BIRDS/SQUARE MILE)	LOCATION	SOURCE
2-4	Manitoba	Bird, 1929
2-4	Saskatchewan	Houston, 1960
2-6	Kansas	Baumgartner, 1939
0.2-0.3	Alberta	Rusch *et al.*, 1972

TABLE 11. DENSITIES OF BREEDING OVENBIRD POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (MALES/100 ACRES)	LOCATION	SOURCE
21	Massachusetts	Van Velzen, 1978
15	Massachusetts	Van Velzen, 1977
11	Vermont	Van Velzen, 1975
8	Vermont	Van Velzen, 1977

area are characterized by dense understory while other portions have sparse understory vegetation. The value of the area on the whole as snowshoe hare habitat is estimated to be fair to good. Comparing this with the values in Table 12, an estimated density of 10 acres per hare is reached. The carrying capacity for the proposed Big River reservoir area, therefore, is 312 snowshoe hare.

V. GRAY SQUIRREL

This animal is an inhabitant of hardwood forests. Nuts of oaks, hickories, walnuts, beech and butternuts are preferred food with fruits of blueberries, blackberry and other shrubs and vines also consumed (Uhlig, 1965; Martin *et al.*, 1951). Hardwood trees also provide escape cover and cavities for shelter, breeding and rearing of the young (Davis, 1968).

The Big River study area is primarily forested. Hardwood stands dominated by white oak are present throughout the area. Mixed forests, softwood forests and red maple swamps also contain red, white and black oaks. In general, the area is good gray squirrel habitat. Comparing the density values and habitat from the literature (Table 13) with the Big River study area, a density figure of 1 squirrel per 1.5 acres is estimated. After subtracting open land from the amount of available habitat, a population of 1912 animals is estimated.

VI. WHITE-FOOTED MOUSE

Primary habitats of the white-footed mouse include forest areas, brushy areas and lowland thickets; they are also found occasionally in open fields (Burt, 1957; Palmer, 1949; Cronan and Brooks, 1968). Food items include seeds, roots and tubers of plants as well as a variety of insects (Martin *et al.*, 1951).

TABLE 12. DENSITIES OF SNOWSHOE HARE POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (ACRES/HARE)	LOCATION	SOURCE
0.2	Unknown	Criddle, 1938
0.3	Alberta	Keith and Windberg, 1978
1	Wisconsin	Grange, 1932
2	New York	Brocke, 1975
5	New York	Brocke, 1975
8	New York	Brocke, 1975
10	Unknown	Criddle, 1938
20	Minnesota	Green and Evans, 1940

TABLE 13. DENSITIES OF GRAY SQUIRREL POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (ACRES/HARE)	LOCATION	SOURCE
2	Unknown	Goodrum, 1963
1	Midwestern United States	Trippensee, 1948
1	Midwestern United States	Uhlig, 1965
0.5	Midwestern United States	Uhlig, 1965

Since the proposed Big River reservoir area contains abundant forest land, it can be considered as good white-footed mouse habitat. With the values from Table 14, a density of six mice per acre is estimated. Because the wetland areas (including the forested red maple swamps) are either covered with water during all or portions of the year, this acreage was subtracted, yielding an estimated carrying capacity of approximately 15,400 white-footed mice.

VII. RED FOX

Red foxes are fairly adaptable, being found in many habitat types. Optimum habitat conditions are those where forested areas are interspersed with open country and croplands (Burt, 1969; Palmer, 1949). These areas are abundant in small mammals and birds, important red fox prey. Other foods consumed include fruits, insects, grasses and acorns (Martin *et al.*, 1951; Trippensee, 1948).

The Big River study area is primarily forested, having limited openings and cropland. Therefore, it is only fair to poor habitat for red fox and a density of 1 fox per 1500 acres is estimated (Table 15). The Big River study area probably supports one breeding pair of red foxes.

VIII. RACCOON

An adaptable species found in almost all cover types, raccoons, nevertheless, do have certain habitat requirements. Mature hardwood forests are an important habitat component, providing den trees as well as nuts, and fruits from plants in the understory (Trippensee, 1947). Grassy openings, wetlands, ponds and streams are also essential to raccoons; insects from grassy areas and crayfish, shellfish and frogs from wet areas are utilized as food. Corn and oats from agricultural areas are also taken when available (Johnson, 1970).

TABLE 14. DENSITIES OF WHITE-FOOTED MOUSE POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (MICE/ACRES)	LOCATION	SOURCE
7	West Virginia	O'Farel *et al.*, 1977
6	Maryland	Stickel, 1965
5	West Virginia	O'Farel *et al.*, 1977

TABLE 15. DENSITIES OF RED FOX POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (ACRES/FOX)	LOCATION	SOURCE
213	Massachusetts	Trippensee, 1953
213	New York	Sheldon, 1950
640	California	Grinnel *et al.*, 1937
640	Denmark	Seton, 1929
1280	Great Britain	Seton, 1929
1440	Pennsylvania	Seton, 1929
5120	Manitoba	Seton, 1924

The Big River study area contains substantial amounts of wetland areas and mast producing hardwood forests, but few stands of trees large enough for denning. Overall, the study area can be considered fair raccoon habitat. Using the figures from Table 16, a density of one raccoon per 40 acres is estimated, yielding a carrying capacity of 78 raccoons for the Big River study area.

IX. WHITE-TAILED DEER

Ideal habitat for white-tailed deer consists of open areas, farmland and early successional growth for feeding, combined with forest thickets and shrub areas for cover. Deer are entirely vegetarian, with a diet consisting of twigs and foliage of maples, hemlocks, oaks and willow (Martin *et al.*, 1951) as well as sweet fern, wild raisin, dogwood and apple (Skinner and Telfer, 1974). Acorns and beech nuts are also important foods, particularly in winter.

The proposed Big River reservoir area contains large stands of mixed and hardwood forests, but little open land and cropland. From the figures in Table 17 and conversation with personnel of the Rhode Island Department of Conservation, a deer density of one animal per 80 acres is estimated, yielding a population of approximately 39 deer.

3.2.2 Fauna, Habitat Evaluations and Carrying Capacity Estimates of the Alternate Sites

Field inspections of the alternate sites showed these areas to be similar to the Big River area in terms of wildlife habitat. As such, wildlife species composition and population densities are assumed to be similar. It is also assumed, therefore, numbers of wildlife will be proportional to the numbers of acres of habitat relative to the proposed Big River reservoir and to each of the alternate sites. The only exception to this occurs in wetland habitat. While the Big River area had

TABLE 16. DENSITIES OF RACCOON POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (ACRES/COON)	LOCATION	SOURCE
0.63	Missouri	Twichell and Dill, 1949
2	Missouri	Twichell and Dill, 1949
10	Michigan	Stuewer, 1943
14	Virginia	Soneshine and Winslow, 1972
16	Illinois	Yeager and Rennels, 1943
16	Michigan	Stuewer, 1943
20	California	Grinnel *et al.*, 1937
36	Michigan	Stuewer, 1943
46	Michigan	Stuewer, 1943
100	Ohio	Trippensee, 1948b
320	California	Grinnel *et al.*, 1937

TABLE 17. DENSITIES OF WHITE-TAILED DEER POPULATIONS. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

DENSITY (ACRES/DEER)	LOCATION	SOURCE
2	Ohio	Rice and Harden, 1977
6	Ontario	Holsworth, 1973
25	Pennsylvania	Anonymous, 1940
26	Michigan	Anonymous, 1940
58	Minnesota	Anonymous, 1940
119	Vermont	Anonymous, 1940
526	Virginia	Anonymous, 1940
617	New Hampshire	Anonymous, 1940

several areas of deep marsh providing excellent waterfowl habitat, wetland areas in the three alternate sites are composed almost entirely of shrub and red maple swamp. These areas are of little to no value to waterfowl.

Table 18 lists acres of habitat available, estimated densities of representative wildlife species and carrying capacity estimates for the proposed Big River area and the three alternate sites.

TABLE 18. COMPARATIVE CARRYING CAPACITY ESTIMATES FOR SELECTED WILDLIFE SPECIES OF THE PROPOSED BIG RIVER RESERVOIR AND THREE ALTERNATE SITES. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

SPECIES	ESTIMATED DENSITY	BIG RIVER		WOOD RIVER ALTERNATE		MOOSUP RIVER		BUCKS HORN BROOK	
		ACRES OF HABITAT AVAILABLE	TOTAL CARRYING CAPACITY	ACRES OF HABITAT AVAILABLE	TOTAL CARRYING CAPACITY	ACRES OF HABITAT AVAILABLE	TOTAL CARRYING CAPACITY	ACRES OF HABITAT AVAILABLE	TOTAL CARRYING CAPACITY
Ruffed grouse	1 bird/15 acres	3125	208	883	59	540	36	479	32
Great horned owl	1 pair/square mile	3125	2	883	2	540	2	479	2
Ovenbird	30 birds/100 acres	2867[1]	860	857[1]	258	443[1]	147	473[1]	141
Snowshoe hare	10 acres/hare	3125	312	883	88	540	54	479	48
Gray squirrel	1 squirrel/1.5 acres	2867[1]	1,912	857[1]	571	493[1]	329	473[1]	315
White-footed mouse	6 mice/acre	2565[2]	15,400	717[2]	4302	381[2]	2286	300[2]	1800
Red fox	1 fox/1500 acres	3125	2	883	1	540	1	479	1
Raccoon	1 raccoon/40 acres	3125	78	883	22	540	13	479	12
White-tailed deer	1 deer/80 acres	3125	39	883	11	540	7	479	6

1 Acreage of open land subtracted from total acreage present

2 Acreage of wetland subtracted from total acreage present

4.0 FUTURE TERRESTRIAL ECOLOGY WITHOUT THE PROJECT

4.1 FLORA

The development pattern of the regional vegetation complex is one which culminates in a climax plant community dominated by oaks and pine. Due to the close functional and structural relationship of the site vegetation to the regional complex, the sequences and rates of maturation can be assumed to be the same. The time required for open land to mature to a climax forest may be two hundred years whereas a young wetland, such as a marsh or herb-dominated bog may require several thousand years. It can be expected, therefore, that wetlands on the site will change only slowly while the ecology of an open field or pine forest may change comparatively rapidly. However, on some sites in the study area, for example sandy soils occupied by pitch pine, little change in vegetative cover is expected to occur. This is also true of sites occupied by plant communities such as hardwood and mixed stands which are already in or near the climax stage. In these stands vigorously growing individuals will be the first to attain maturity, outcompeting other plant species for dominance in the overstory.

Ultimately, therefore, the future ecology of the project site would be one characterized by: 1) large, mature hardwood and pine, 2) areas supporting stands of pine and scrub oak, and 3) wetlands dominated by woody species.

4.2 FAUNA

Wildlife populations in an area are determined by the types and amount of habitat available. Therefore, as the vegetation in the Big River study area changes through time, wildlife populations will also change.

Open land areas, currently dominated by grasses, and forbs are utilized by those wildlife species preferring open areas as discussed in Section 3.2.1.4. Included in this group are cottontail rabbits, meadow voles, pheasants, raptors and seed eating songbirds. If not maintained in an open state, these open areas will undergo plant succession. Woody growth, shrubs and small hardwood trees and pines will become established. Shrub and early forest growth will continue to be used by open country wildlife species, but in smaller number as forest wildlife move into the area. Such secondary growth is both attractive to and productive of such species as ruffed grouse, tree sparrow, slate colored junco, robin, yellow warbler, snowshoe hare, red fox and white-tailed deer.

As these areas of shrub and young forest succeed to mature forest types, wildlife populations will gradually shift to those species favoring mature forest habitat. In the study area, hardwood and mixed wood forests are most likely to be inhabited by ovenbirds, black and white warblers, woodpeckers, gray squirrel, ruffed grouse and white-tailed deer. Where softwood stands are the major vegetative community, gray squirrels will be partially replaced by red squirrels.

Wetland areas currently characterized as red maple swamps will change slowly as the trees grow larger. Wildlife utilization of these areas should not change appreciably. However, as shallow and deep marshes succeed to wetland areas dominated by woody growth, definite changes in wildlife utilization will occur. These areas will be of less value than when they were marshes and eventually become unacceptable to waterfowl, wading birds and aquatic furbearers such as muskrat, beaver and otter. These species will be replaced at first by shrub seeking wildlife and eventually forest species.

5.0 IMPACTS OF THE PROPOSED ACTION

5.1 FLORA

Removal of existing terrestrial plant communities preparatory to impounding the project area would be immediately followed by growth of young saplings, stump sprouts, and root suckers where woodlands formerly existed, and pioneer herbs and shrubs in old open areas. In the years required for the reservoir to become filled, most of the site would become vegetated by shrub and sapling growth. Increase in water level, however, would inundate this new growth and kill it. At this stage, the terrestrial ecosystem will have been all but replaced by a large area of standing water. Hilltops vegetated by species components of upland communities will have become islands. Fluctuating water levels common in reservoirs, particularly where diversions occur, would create zones of instability along the borders. These bands which would vary in width depending upon slope steepness, would be vegetated by a plant community typical of such disturbed conditions. Such a community would contain a high proportion of annual and alien herbacious species. Energy which formerly supported the growth of high plant biomass before clearing and inundation would now impinge directly on the water surface and support the growth of floating plants to the depth of effective light penetration. These large quantities of available energy would increase the rate of biomass accumulation and the complexity of this oligotrophic system would increase to the point where the system would become a eutrophic system. Undoubtedly, conditions would not progress far beyond an oligotrophic stage since, in the interest of maintaining water quality, water purveyors and managers would undertake means to arrest natural processes of aquatic community development.

The future ecology of the project site, then, would be one characterized by a large open body of water supporting few floating plants, a reservoir border vegetated by plants adapted to the unstable environment created by fluctuating water levels, and islands vegetated by upland plant communities.

5.2 FAUNA

5.2.1 Construction and Land Clearing

Dam construction and forest clearing operations would likely be accomplished through use of chain saws, brush cutters, bulldozers and other heavy equipment.

The actual construction activities will directly affect those wildlife species which are unable to escape machinery. Small numbers of the less mobile species (mice, voles, shrews, etc.) will be unavoidably killed or injured as clearing and construction occurs. Animals occupying burrows will suffer high mortality. Gray squirrels, flying squirrels, porcupines and other mammals which live all or portions of their lives in trees may be killed when the trees are felled. This impact would be most severe during the breeding season when litters of these species would be in dens or burrows.

Most birds will flee the area and direct mortality should be minimal. In spring and early summer, however, many bird species will be nesting in the trees and shrubs, in tree cavities or on the ground. If construction occurred during this period, mortality of eggs and young may be close to 100 percent. Nesting habitat will also be destroyed.

Another factor to be considered is that of noise caused by construction activities. This noise will cause some animals to flee the area, thus avoiding immediate danger. More subtle effects may occur through interference of intraspecific communication. Animals that rely on their auditory systems for courtship and mating, prey location and/or predator detection will be affected (Kerbec, 1972). The probability of individuals meeting for breeding purposes depends upon the species density, mobility and ability to communicate (Busnel, 1963). The higher the level of background noise intensity the smaller the probability of individuals meeting and breeding successfully. Birds are most vulnerable to noise disturbance. In almost all bird species, mate location and territory defense are conducted through acoustical signals. Songs of birds are individualistic; a female goldfinch will be attracted to the song of a male goldfinch only. His song will elicit a response in her and allow breeding to occur. As songs of many species are very similar, background noise could interfere with this process and thereby hinder reproduction.

Following land clearing and prior to inundation, vegetation in the area will be characterized by young saplings, stump sprouts and root suckers from felled trees as well as by grasses and forbs. The abundant vegetative growth will provide excellent wildlife food and cover. During this period, the area will be very productive of those species preferring this early successional habitat type.

5.2.2 Removal of Habitat

Wildlife populations in an area are dependent upon the presence of suitable habitat. The important components of this habitat are the species composition, spacing abundances and life form of the vegetation and presence of water and food sources. Other important factors include presence of den trees for birds and mammals, perches for raptors and songbirds and rocky ledges for bobcats and snakes. When a habitat is eliminated or modified, those species which can adapt or prefer the new habitat will survive, those that can't will attempt to relocate to suitable habitat.

Those species that move to new areas will survive only if the carrying capacity for that species has not been reached in this area. If the habitat is already at its carrying capacity for that species, the excess will die or have to continue searching for an area. Wildlife mortality is known to be high during these periods as the animals are more susceptible to predation, road kills and other sources of mortality.

Many animals (breeding songbirds in particular) defend territories from encroachment of other members of the same species. As territory size is fairly constant, the number of territories in an area is limited by the total size of that area. Certain species also have a maximum density of individuals which they will tolerate. When this saturation density is reached, the excess are controlled by starvation, predation or a breakdown in reproductive success.

In summary, as the total number of organisms in an area is determined by the carrying capacity of that area, and as carrying capacity is determined by the amount of suitable habitat (including suitable breeding grounds and defended territories), the removal and modification of habitat through reservoir construction will reduce the total carrying capacity of the area for many forest-dependent wildlife species. Total number of individuals will decline as their habitat declines. Removal of food and cover plants will cause shortages, therefore facilitating a decline in some species of small mammals and birds. This, in turn will reduce availability of prey items to animals at higher trophic levels.

Creation of the Big River reservoir will permanently remove approximately 3150 acres of wildlife habitat. Displaced wildlife will attempt to relocate to areas outside the proposed reservoir. Field inspection of surrounding areas showed them to be very similar to the reservoir area in terms of successional stage, land use and vegetative characteristics. Therefore, the wildlife carrying capacity of relocation areas is likely similar to that of the proposed reservoir area. It was beyond the scope of this study to determine if the wildlife carrying capacity of the surrounding area has been reached. However, in view of the human population density in the northeastern United States, accompanying land development and removal and deterioration of wildlife habitat, it is likely these areas are currently supporting the maximum wildlife populations possible. This situation also generally precludes relocation programs of wildlife in the northeast as no suitable unstocked habitat exists.

5.3 BENEFICIAL EFFECTS OF THE PROJECT ON THE TERRESTRIAL ECOSYSTEM

The major benefit of creating a reservoir in the study area is that resulting from replacement of the upland forested ecosystem with an open water system, which adds a landscape component that would otherwise have been lacking. The existing landscape patterns on the site are the same as those found throughout the region. Presence of a large open water body would therefore result in greater environmental diversity of the region.

The presence of a large reservoir will be of some value to certain wildlife. Although not as productive as marsh habitats, this water body will provide suitable habitat for such waterfowl species as scaup, common goldeneyes, buffleheads and other diving ducks which prefer large bodies of water (Kortright, 1942). The peripheral area of the reservoir may also be utilized by puddle ducks, wading birds and aquatic furbearers. The exact value of these areas will depend upon bank drop-off and stability of water levels; if managed properly, many miles of the littoral zone could be very beneficial to wildlife as this highly productive habitat type is currently not present in large areas. Other large water bodies currently present nearby include Flat River Reservoir, Stump Pond, Quidnick Reservoir and Scituate Reservoir.

5.4 ADVERSE EFFECTS OF THE PROJECT ON THE TERRESTRIAL ECOSYSTEM

Removal of the existing vegetation at the proposed reservoir site, and replacement of it by an open water body effectively reduces the biological productivity of a large area. The net effect of this loss on the regional system as a whole is a reduction in the capacity of that system to perform such services as biogeochemical cycling, erosion control, pollution filtration, predator control and oxygen production. The capability of the open water body to provide such services is far less than for the woodland. In addition to the loss in ecosystem functions, permanent removal of a large area of land from terrestrial production eliminates the potential for sustained-yield (forest or agricultural) management.

Creation of the reservoir would remove 3150 acres of wildlife habitat. This would result in a decrease in wildlife populations in the area (see Section 3.2.1.5).

In cutting the trees prior to inundating the area, large quantities of nutrients would be released into surface waters on the site. This effect may be felt in the adjacent regions for a period of several years until a shrub cover was established or filling of the reservoir was complete (Likens, *et al*., 1969 and Bormann *et al*., 1974). In the meantime, the influx of nutrients to surface waters could cause serious eutrophication problems in the reservoir (Likens and Bormann, 1974).

6.0 MITIGATION TECHNIQUES

The removal of approximately 3100 acres of wildlife habitat will reduce the total wildlife population in the area. One method to partially mitigate this impact is to increase the wildlife carrying capacity of the surrounding areas. This will permit some of the wildlife displaced by the reservoir to survive.

As discussed in Section 3.2.2, the surrounding areas are very similar in terms of successional stage, land use and vegetative characteristics. The area is mainly forested with few openings. The primary method of increasing wildlife carrying capacity, therefore, would be to create habitat interspersion and its accompanying edge, the value of which is discussed in Section 3.2.1.4.

Hunt (1971) stated the key to habitat improvement is the maximum diversity and interspersion of vegetative growth. In an area that is primarily forested, this is accomplished partially through the creation of open areas. Logging, burning and/or bulldozing can be used to clear portions of the forest. These openings should be of one to five acres in size as these are most utilized by wildlife (McCaffery and Creed, 1969; Shemnitz, 1974; USFS, 1974). The narrowest dimension of the openings should be two to three times the height of surrounding trees (Hunt, 1971) to insure adequate sunlight can reach the ground. Irregularly shaped openings have more edge and hence are more valuable than perfect circles. From 10% to 20% of the total forest area should be cleared, leaving forested areas between the clearings to provide cover and habitat for all wildlife and for those species which require unbroken forest stands such as gray squirrels.

Once these forest openings are created, they can be allowed to undergo natural plant succession. In this case, they will benefit the various wildlife species groups which prefer the various successional stages as discussed in Section 4.2. After a period of 10-15 years, however, the value as openings will decline and it would be necessary to conduct another clearing operation. To avoid this situation, the openings may be limed, fertilized as required and seeded to perennial seed producing plants which will both provide wildlife food and slow the successional process. Species recommended for planting include ladino clover, flatpea, birds foot trefoil, perennial ryegrass, millet, sorghum and buckwheat (Hunt, 1971; Connecticut Board of Fish and Game, 1968).

In addition to seed producing plants, those shrubs which bear fruits useful to wildlife can be used to increase wildlife carrying capacity. Wild apple trees or those in abandoned orchards should be released from competition by cutting away trees and shrubs growing nearby. Pruning, fertilizing and liming will stimulate fruit production. Where no fruit producing shrubs are present, plantings of autumn olive, gray dogwood, multiflora rose and highbush cranberry will provide valuable wildlife food.

In most cases, the forest surrounding these openings will provide the protective cover from which wildlife will venture to feed. In areas where this cover may be lacking (mature hardwood stands with limited understory) the planting of softwoods may be used to provide this cover (Hunt, 1971). Jordan and Sharp (1967) recommend planting hemlocks at 10 foot intervals in patches 100 feet wide and 300 feet long to provide ruffed grouse cover. To create a hedge and low growth for small mammals, the center stem of planted softwoods may be cut when the tree is 10 to 12 feet high.

When conducting clearing and planting operations, consideration should be given to other aspects of habitat management. Snags (dead or dying trees) should be left standing at the rate of two per acre (Gillam, 1973)as these provide nesting habitat for many birds and mammals, hunting perches for raptors and singing perches for songbirds. Some of the brush and logs should be piled and left around the edges of the clearings. These will provide shelter for small mammals, reptiles and amphibians. As this material (as well as the snags) decay, they will become infested with insects, providing food for many wildlife species. Finally, no cutting operations should be conducted within 100 feet of streams or other waterways; this is necessary both to provide protective cover for wildlife and to avoid erosion and sedimentation which would cause a decrease in water quality.

7.0 FOREST HARVEST ALTERNATIVES

7.1 TIMBER REMOVAL

The following discussion of forest harvest alternatives is predicated on several assumptions:

1) That impoundment of water on the proposed site precludes consideration of options that are designed for sustained yield management of forest resource products. Examples of such options include shelterwood cutting, selection cutting, and seed tree cutting.

2) That a desirable forest harvest objective is to obtain as much monetary return as possible from the sale of forest products in order to offset the costs of removal.

3) That water quality of the proposed reservoir must be safeguarded in the early planning stages by removing as much living plant material as possible before impoundment thereby eliminating potential sources of high COD and BOD, color, odor, and other undesirable characteristics.

Neither the economic importance nor efficient methods of removal of shrubs and herbs that occur in the forest understory, in openings and in wetlands, are as well established as for tree species; therefore, such plants will not be considered in this discussion. Also, since trees comprise the bulk of the plant biomass on the site, they afford the greatest resource harvest opportunity, and represent the largest potential source of water quality contamination following inundation.

The harvest options which are most practical fall under the category of presalvage cuttings; that is removal of trees that are in danger of being killed in order to recover timber values that might otherwise be lost. There are two types of presalvage operations which can be considered, clearcutting and partial cutting.

Before harvesting can begin, however, timber to be cut must be marked. In clearcutting operations, only the boundaries of the area to be cut are marked. Where partial cutting is used, however, the individual trees selected for sawtimber must also be marked within the area. Marks are generally either blazes cut into the bark at eye level or paint.

In the clearcutting method, the area is cut clear; all trees in the stand are removed. In commercial operations, however, all merchantable timber is removed and all trees that cannot be utilized profitably are left. The major advantage of this method is that the harvest operation can proceed with a high degree of efficiency because equipment and methods of logging can be chosen without regard for protecting residual trees within the cutting area. This method is less expensive than the partial cutting method but has one major disadvantage; risks of erosion are high due to disruption of the soil over large, continuous areas. Aesthetically, clear cutting is highly undesirable due to the devastated appearance of recently cut over areas.

In the partial cutting method, certain trees are removed before others. In a mixed stand on the study area, for example, sawtimber-size pine and hardwoods would be removed first and the smaller wood that would be used for cordwood removed last. The major disadvantage is that this method can be somewhat more costly than the clearcut method. However, losses of soil due to erosion are considerably less because the timber is removed in stages and the disturbed areas have an opportunity to revegetate before erosion progresses very far. Aesthetically, this method is more desirable because the disturbance is localized in small areas which become revegetated as other small areas become disturbed thereby minimizing the total visual effect of the operation.

Results of the resource inventory together with the vegetation type map and descriptions can be used to select the best harvest alternative or combination of alternatives for the study site. In stands having uniform characteristics on sites where erosion may not be a severe problem, clearcutting in patches may prove to be the most practical and desirable alternative. The best example of such a condition is a mature white pine stand on a flat site. Where sawtimber is mixed with trees affording different utilization potential, as in mixed wood stands, and particularly where the site is highly erodable, partial cutting may be the best operation. In locations where the cutting operation is highly visible, such as on hillsides viewed from a road, partial cutting would have a lower impact to the aesthetics of the area than clear cutting. In hidden valleys, on the other hand, which are not easily visible to the public, impacts to aesthetics are of much less concern.

7.2 DEBRIS CONTROL

A consideration common to all harvest alternatives is disposal of tops, branches and other logging debris. In many logging operations, slash is allowed to remain either scattered or in small piles but where water quality of the proposed reservoir is a prime concern, all major sources of potential contamination must be eliminated. The most effective means of removing slash is piling and controlled burning, but chipping small hardwood branches and tops in a wood chipper may yield a saleable product if the markets are available. Any debris which floats to the surface following inundation of the area should be removed using boats or barges and disposed of by burning, burying or chipping.

8.0 SUMMARY AND CONCLUSIONS

The U.S. Army Corps of Engineers proposes to construct a dam across the Big River, Rhode Island, creating a water supply reservoir. Three alternate sites are also being considered.

A study was conducted in late summer, 1978 to determine impacts of such an action on the flora and fauna of the area. Bird populations were censused along six transects encompassing the major habitat types (hardwood forest, softwood forest, mixed forest, wetland and open land). Vegetation surveys and wildlife habitat evaluations were conducted at seventeen sites in the proposed Big River reservoir area and at six to eight sites at each of the three alternates.

The Big River site consisted of approximately 832 acres of hardwood forest, 872 acres of softwood forest, 601 acres of mixed forests, 561 acres of wetland and 288 acres of open land.

Hardwood forests were dominated by an overstory of red and white oaks with understory of highbush blueberry, huckleberry, lowbush blueberry and Prince's pine. Softwood forests were dominated by an overstory of either white pine or pitch pine and understory of pine and oak saplings, huckleberry and lowbush blueberry. Overstory of the mixed woods consisted of oaks and pines, with understory consisting of oak and pine saplings, sheep berry, huckleberry, lowbush blueberry and sheep laurel.

Wetlands on the study area were dominated by red maple swamps with smaller acreages of shrub swamps, bogs and marshes. Vegetation found was typical for New England wetlands and included red maple, white pine, highbush blueberry, pepperbush, buttonbush, pickerelweed, sedge, rush, pond lily, burreed and pondweed.

Open land areas were characterized by grasses and forbs such as hawkweed, quack grass, timothy and yarrow. No rare or endangered species of plants were found nor are any known to occur on the study area.

Timber resources on the Big River Site consist of an estimated 6.5 million board feet and 800 cords, approximately two-thirds of which is contributed by white pine. White oak and red oak together contribute over one million board feet and other upland hardwood and softwood species make up the remainder of the total volume. Total commercial value of the timber resources on the site is estimated at around $404,629.00.

Forty-nine species of birds and seven species of mammals were observed in the study area. Blue jays, black-capped chickadees and catbirds were the most abundant and widespread bird species noted during late summer. No rare or endangered wildlife are known to occur in the area.

Carrying capacity of the area for nine representative species was estimated. Mixed forests were judged to be the most valuable as forest wildlife habitat followed by hardwood and softwood forest cover types. Red maple swamps also provided excellent wildlife habitat, particularly for nesting songbirds, while marshes and shrub swamps were excellent waterfowl habitat. Open land areas provided the necessary habitat for open country species. Habitat interspersion in the area was fair.

Field inspections of the three alternate sites showed them to be of similar value as wildlife habitat, the only exception being the lack of waterfowl breeding areas at any of the alternate sites.

Should the project not be undertaken, future plant communities at the proposed site would be primarily 1) large, mature hardwood and pine forests, 2) stands of pine and scrub oak and 3) wetlands dominated by woody species. Wildlife populations would shift slightly to favor those species preferring late successional stages.

Construction of the proposed reservoir would remove approximately 3150 acres of forest areas, open fields and wetlands which provide wildlife habitat. Surrounding areas would probably not be able to support the displaced wildlife. Construction of one or more of the alternate reservoirs would remove smaller amounts of wildlife habitat.

9.0 LITERATURE CITED

Anonymous. 1940. Estimate of big game animals on national forests as of December 31, 1940. U.S. Dept. Agric. For. Serv.

Baumgartner, F.M. 1939. Territory and population in the great horned owl. Auk. 56(3):274-282.

Bent, A.C. 1953. Life histories of North American wood warblers. Dover Pub., Inc., N.Y. 734 pp.

Bird, R.D. 1929. The great horned owl in Manitoba. Can. Field. Nat. 43(4):79-83.

Borman, F.H., G.E. Likens, T.G. Siccama, R.S. Pierce and J.S. Eaton. 1974. The export of nutrients and recovery of stable conditions following deforestation and Hubbard Brook. Ecol. Mon. 44:255-277.

Braun, E.L. 1972. Deciduous forest of eastern North America. Hafner Publ. Co., N.Y.

Brooke, R.H. 1975. Preliminary guidelines for managing snowshoe hare habitat in the Adirondacks. Trans. 32nd N.E. Fish and Wildl. Conf. 20 pp.

Bump, G., R. Darrow, F. Edminston and W. Crissey. 1947. The ruffed grouse: life history, propagation, management. N.Y. State Cons. Dept., Albany.

Burt, W.H. 1969. Mammals of the Great Lakes region. Univ. of Mich. Press. 246 pp.

Burton, J.A. 1973. Owls of the world. E.P. Dutton, N.Y. 216 pp.

Busnel, R.G. 1963. On certain aspects of animal acoustic signals. Acoustic behavior of animals. Elsevier Publ. Co., N.Y. 933 pp.

Carson, H.S. 1966. The ruffed grouse, forest drummer. Maine Fish and Game. Spring 1966.

Connecticut State Board of Fisheries and Game. 1968. A program of land improvement to benefit wildlife. 28 pp.

Criddle, S. 1938. A study of the snowshoe rabbit. Can. Field Natur. 52(3):31-40.

Cronan, J.M. and A. Brooks. 1968. The mammals of Rhode Island. R.I. Dept. Natur. Resour. Wildl. Pamph. No. 6. 133 pp.

Davis, P.R. 1968. Tree top travelers. Maine Fish and Game Rept. 13-160.

Dorney, R.S. 1959. Relationship of ruffed grouse to forest cover types in Wisconsin. *Wisc. Cons. Dept. Tech. Bull. No. 18.*

Edminster, F.C. 1947. The ruffed grouse: its life story, ecology and management. MacMillan, N.Y.

Evans, G.C. 1976. A sack of diamonds: the study of ecosystems and the future resources of mankind. J. of Ecol. 64(1):1-40.

Federal Register. 1976. Wednesday, October 27. Part IV: Endangered and threatened wildlife and plants. 47180-47198.

Forbes, R.D. 1961. Forestry handbook. The Ronald Press Co., N.Y.

Frankel, O.H. and E. Bennet (eds.). 1970. Genetic resources in plants: their exploration and conservation. IBP Handbook #11. F.A. Davis Co., Phila., Pa.

Gillam, H.L. 1973. More wildlife on your property. Va. Comm. Game and Inland Fish. 28 pp.

Goodrum, P.D. 1961. The gray squirrel in Texas. Texas Parks and Wildl. Dept. Bull. No. 42. 43 pp.

Grange, W.B. 1932. Observations on the snowshoe hare. J. Mammal. 13(1):1-19.

Green, R.G. and G.A. Evans. 1940. Studies on population cycles of snowshoe hares on the Lake Alexander area. III: Effect of reproduction and mortality of young hares on the cycle. J. Wildl. Manage. 4(4):347-358.

Grinnel, J., J.S. Dixon and J.M. Linsdale. 1937. Furbearing mammals of California. Univ. Calif. Press, Berkeley.

Gullion, G.W. 1969. Aspen ruffed grouse relationships. Proc. 31st Midwest Wildl. Conf.

__________ and F.J. Svoboda. 1972. The basic habitat resource for ruffed grouse. IN: Aspen Symposium Proceedings. U.S. Dept. Agric. For. Serv. Gen. Tech. Rpt. NC-1. 154 pp.

Heilbrun, L.H. 1977. 'Seventy-seventh Christmas bird count. Am. Birds. 31(4):493-494.

__________. 1976. Seventy-sixth Christmas bird count. Am Birds. 30(2):242.

Holsworth, W. 1973. Hunting efficiency and white-tailed deer density. J. Wildl. Manage. 37(3):336-342.

Houston, S. 1960. 1960: The year of the owls. Blue Jay. 18(3):105-110.

Hunt, J.H. 1971. Improve your land for forest game. Maine Fish and Game -- Spring 1971. 4 pp.

Johnsgard, P.A. 1973. Grouse and quails of North America. Univ. Nebraska Press, Lincoln. 553 pp.

Jordan, J.S. and W.M. Sharp. 1967. Seeding and planting hemlock for ruffed grouse cover. U.S. Dept. Agric. For. Serv. Res. Pap. NE-83. 17 pp.

Keith, L.B. and L.A. Windberg. 1978. A demographic analysis of the snowshoe hare cycle. Wildl. Mono. No. 58. 70 pp.

Kerbec, M.G. 1972. Noise and hearing. Output Systems Corporation, Arlington, Va. 111 pp.

Keyes Assoc. and Metcalf & Eddy, Inc. (KAME). 1976. Preliminary inventory of vegetation, wildlife and aquatic biota in Big River study area.

Kortright, F.H. 1942. The ducks, geese and swans of North America. Stackpole Pub. Co., Harrisburg, Pa. 476 pp.

Leopold, A. 1933. Game management. Charles Scribner Sons, N.Y. 481 pp.

Likens, G.E. and F.H. Borman. 1974. Linkages between terrestrial and aquatic ecosystems. Bioscience. 24:447 pp.

__________ and N.M. Johnson. 1969. Nitrification: importance to nutrient losses of a cut over forested ecosystem. Science. 163-1205-1206.

Lull, H.W. 1968. A forest atlas of the northeast. Northeast For. Exp. Sta. Upper Darby, Pa.

Marston, D.L. 1966. Maine's rabbits. Maine Fish and Game. Summer 1966.

McCaffery, K.R. and W.A. creed. 1969. Significance of forest openings to deer in northern Wisconsin. Wis. Dept. Nat. Resour. Technol. Bull. No. 44. 104 pp.

National Research Council. 1978. Conservation of germplasm resources: an imperative. Natl. Academy of Sciences, Washington, D.C.

Odum, E.P. 1969. The strategy of ecosystems development. Science. 164(3877):262-270.

O'Farel, M.J., D.W. Kaufman and D.W. Lundahl. 1977. Use of live trapping with the assessment line method for density estimation. J. Mammal. 58(4):575-582.

Palmer, E.L. 1949. Fieldbook of natural history. McGraw Hill Co., N.Y. 664 pp.

Peters, J.R. and T.M. Bowers. 1977. Forest statistics for Rhode Island USDA. For. Serv. Resour. Bull NE-49. 38 pp.

Rhode Island Dept. Natur. Resour. 1976. State Comprehensive Outdoor Recreation Plan.

Rice, W.R. and J.D. Harder. 1977. Application of multiple aerial sampling to a mark-recapture census of white-tailed deer. J. Wildl. Manage. 41(2):197-206.

Robbins. C.S., B. Brown and H.S. Zim. 1966. A guide to field identification, birds of North America. Golden Field Guide, N.Y. 340 pp.

Rusch, D.H., E.C. Meslow, P.D. Doerr and L.B. Keith. 1972. Response of great horned owl populations to changing prey densities. J. Wildl. Manage. 36(2):282-296.

Schemnitz, S.D. 1970. Fall and winter feeding activities and behavior of ruffed grouse in Maine. Trans. NE Sect. Wildl. Soc. 27:127-139.

__________. 1974. Wildlife habitats and management in the boreal forests of northeastern United States and maritime Canada. Univ. Maine Life Sci. Agric. Expt. Sta. Misc. Rept. 154. 28 pp.

Sharp, W.M. 1963. The effects of habitat manipulation and forest succession on ruffed grouse. J. Wildl. Manage. 27:664-671.

Skinner, W.R. and E.S. Telfer. 1974. Spring, summer and fall foods of deer in New Brunswick. J. Wildl. Manage. 38(2):210-214.

Smith, D.M. 1962. The practice of silviculture. John Wiley & Sons, Inc., N.Y.

Soneshine, D.E. and E.L. Winslow. 1972. Contrasts in distribution of raccoons in two Virginia localities. J. Wildl. Manage. 36(3): 838-847.

Stickel, Lucille F. 1965. A method for approximating range size of small mammals. J. Mammal. 46(4):677-679.

Stuewer, F.W. 1943. Raccoons: their habits and management in Michigan. Ecol. Monogr. 13(2):203-257.

Trippensee, R.E. 1948. Wildlife management: upland game and general principles, Vol. I. McGraw-Hill Book Co., N.Y. 479 pp.

__________. 1953. Wildlife management: furbearers, waterfowl and fish, Vol. II. McGraw-Hill Book Co., N.Y. 572 pp.

Twichell, A.R. and H.H. Dill. 1949. One hundred raccoons from one hundred acres. J. Mammal. 30(2):130-133.

Uhlig, H.G. 1965. Land management for tree squirrels. U.S. Dept. Agric. Soil Conserv. Serv. 131-S. 1 pp.

U.S. Forest Service 1974. Wildlife and patchcuts. Coordination guidelines for wildlife habitats number four. USFS, California Region. 15 pp.

Valiela, I., J.M. Teal and W.J. Sass. 1975. Production and dynamics of salt marsh vegetation and the effects of experimental treatment with sewage sludge. Biomass, production and species composition. The J. of Applied Ecol. 12(3):973-982.

Van Velzen, W.T. 1975. Thirty-ninth breeding bird census. Amer. Birds. 29(6):1080-1145.

__________. 1977. The fortieth breeding bird census. Amer. Birds. 31(1):24-94.

__________. 1978. The forty-first breeding bird census. Amer. Birds. 32(1):49-125.

Yeager, L.E. and R.A. Rennels. 1943. Fur yield and autumn foods of the raccoon in Illinois river bottom lands. J. Wildl. Manage. 7(1):45-60.

APPENDICES

APPENDIX TABLE 1. SPECIES OF PLANTS FOUND IN THE BIG RIVER STUDY AREA. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
HARDWOOD FOREST			
Lycopodiaceae	*Lycopodium complanatum*	Trailing Clubmoss	C
Pinaceae	*Pinus strobus*	White Pine	C
Orchidaceae	*Cypripedium acaule*	Pink Lady's Slipper	O
Fagaceae	*Fagus grandifolia*	Beech	O
	Castanea dentata	Chestnut	O
	Quercus alba	White Oak	C
	Quercus borealis	Red Oak	C
	Quercus velutina	Black Oak	C
Aceraceae	*Acer rubrum*	Red Maple	O
Ericaceae	*Kalmia angustifolia*	Sheep Laurel	O
	Gaylussacia baccata	Black Huckleberry	D
	Vaccinium vaccillans	Lowbush Blueberry	C
	Vaccinium angustifolium	Lowbush Blueberry	C
	Vaccinium corymbosum	Highbush Blueberry	O
Caprifoliaceae	*Viburnum lentago*	Nannyberry	O
SOFTWOOD FOREST			
Lycopodiaceae	*Lycopodium complanatum*	Trailing Clubmoss	C
Polypodiaceae	*Pteridium aquilinum*	Bracken Fern	O
Pinaceae	*Pinus strobus*	White Pine	O-D
	Pinus rigida	Pitch Pine	D

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Orchidaceae	*Cypripedium acaule*	Pink Lady's Slipper	O
Salicaceae	*Populus tremuloides*	Quaking Aspen	O
Myricaceae	*Myrica gale*	Sweet Gale	O
	Comptonia peregrina	Sweet Fern	C
Fagaceae	*Castanea dentata*	Chestnut	O
	Quercus alba	White Oak	O-C
	Quercus borealis	Red Oak	O-C
	Quercus ilicifolia	Scrub Oak	C
Rosaceae	*Prunus serotina*	Black Cherry	O
Pyrolaceae	*Monotropa hypopithys*	Pine-sap	O
Ericaceae	*Gaultheria procumbens*	Teaberry	O
	Gaylussacia baccata	Black Huckleberry	D
	Vaccinium vaccillans	Lowbush Blueberry	C
	Vaccinium angustifolium	Lowbush Blueberry	C
	Vaccinium corymbosum	Highbush Blueberry	O
MIXED FOREST			
Polypodiceae	*Dennstaedtia punctilobula*	Hay-scented Fern	O
Pinaceae	*Pinus strobus*	White Pine	C-O
	Pinus rigida	Pitch Pine	D-O
Gramineae	*Andropogon scoparius*	Little Bluestem	C
Liliaceae	*Smilax rotundifolia*	Common Greenbriar	O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Orchidaceae	*Cypripedium acaule*	Pink Lady's Slipper	O
Myricaceae	*Comptonia peregrina*	Sweet Fern	O
Corylaceae	*Betula populifolia*	Gray Birch	O
Fagaceae	*Castanea dentata*	Chestnut	O
	Quercus alba	White Oak	C-O
	Quercus borealis	Red Oak	O-C
	Quercus palustris	Pin Oak	O
	Quercus velutina	Black Oak	C
	Quercus ilicifolia	Scrub Oak	O
Rosaceae	*Prunus serotina*	Black Cherry	O
Aceraceae	*Acer rubrum*	Red Maple	O
Arailiaceae	*Aralia nudicaulis*	Wild Sarsaparilla	O
Ericaceae	*Kalmia angustifolia*	Sheep Laurel	O
	Gaultheria procumberns	Teaberry	O
	Gaylussacia baccata	Black Huckleberry	D
	Vaccinium vaccillans	Lowbush Blueberry	C
	Vaccinium angustifolium	Lowbush Blueberry	O-C
Caprifoliaceae	*Viburnum lentago*	Nannyberry	O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
WETLANDS			
Open Water/Deep Marsh			
Pinaceae	*Chamaecyparis thyoides*	White Cedar	O
Typhaceae	*Typha latifolia*	Cat-tail	C
Sparganiaceae	*Sparganium* sp.	Bur-reed	O
	Sparganium americanum	Bur-reed	C
Zosteraceae	*Potamogeton* sp.	Pondweed	D
	Potamogeton zosteriformis	Pondweed	O
	Potamogeton epihydrus	Pondweed	C
	Potamogeton natans	Pondweed	C
Gramineae	*Vallisneria americana*	Wild-celery	O
Cyperaceae	*Eleocharis* sp.	Spike-Rush	O
	Scirpus sp.	Bulrush	O
Pontederiaceae	*Pontedaria cordata*	Pickerelweed	D
Juncaceae	*Juncus* sp.	Rush	C
Myricaceae	*Myrica gale*	Sweet Gale	C
Nymphaeaceae	*Nymphaea odorata*	Water-Lily	D
	Brasenia schreberi	Water-shield	O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Aceraceae	*Acer rubrum*	Red Maple	O
Haloragaceae	*Myriophylum heterophylum*	Water-Milfoil	C
	Myriophylum farwellii	Water-Milfoil	C
	Myriophylum humile	Water-Milfoil	C
Clethraceae	*Clethra alnifolia*	Sweet Pepperbush	C
Ericaceae	*Vaccinium corymbosum*	Highbush Blueberry	C
Apocynaceae	*Nymphoides cordata*	Floating-heart	C
Lentibulariaceae	*Utricularia purpurea*	Bladderwort	D
	Utricularia vulgaris	Bladderwort	D
Compositae	*Eupatorium maculatum*	*Joe-Pye-Weed*	O
WETLAND			
Shallow Marsh			
Sparganiaceae	*Sparganium americanum*	Bur-reed	C
Gramineae	*Calamagrostis canadensis*	Blue-joint	C
Cyperaceae	*Dulichium arundinaceum*	Three-way Sedge	D
Pontederiaceae	*Pontederia cordata*	Pickerelweed	C
Juncaceae	*Juncus* sp.	Rush	C

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Nymphaeceae	*Nymphaea odorata*	Water-Lily	O
Haloragaceae	*Proserpinaca palustris*	Mermaid-weed	C
Clethraceae	*Clethra alnifolia*	Sweet Pepperbush	C
Ericaceae	*Vaccinium corymbosum*	Highbush Blueberry	C
Rubiaceae	*Cephalanthus occidentalis*	Buttonbush	C
WETLAND			
Shrub Swamp			
Sphagnaceae	*Sphagnum* sp.	Sphagnum	C
Osmundaceae	*Osmunda regalis*	Royal Fern	O
Polypodiaceae	*Dryopteris thelypteris*	Marsh Fern	C
Pinaceae	*Chamaecyparis thyoides*	White Cedar	C
Typhaceae	*Typha latifolia*	Cat-tail	C
Sparganiaceae	*Sparganium americanum*	Bur-reed	O
Alismataceae	*Saggitaria latifolia*	Duck-potato	O
Gramineae	*Glyceria obtusa*	Manna-grass	O
	Calamagrostis canadensis	Blue-joint	C-O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
WETLAND			
Wooded Swamp			
Sphagnaceae	*Sphagnum* sp.	Sphagnum	C
Lycopodiaceae	*Lycopodium lucidulum*	Shining Club-moss	O
Osmundaceae	*Osmunda cinnamomea*	Cinnamon-Fern	O
Polypodiaceae	*Onoclea sensibilis*	Sensitive Fern	C
	Dryopteris simulata	Massachusetts Fern	C-O
	Dryopteris noveboracensis	New York Fern	C
	Dryopteris cristata	Crested Wood-Fern	O
	Athyrium filix-femina	Lady Fern	O
Pinaceae	*Pinus strobus*	White Pine	O
Cyperaceae	*Carex stricta*	Sedge	O
Araceae	*Symplocarpus foetidus*	Skunk-cabbage	C
Liliaceae	*Lilium philadelphieum*	Wood Lily	O
	Siimlax rotundifolia	Greenbriar	O
Corylaceae	*Betula lutea*	Gray Birch	C
Fagaceae	*Quercus alba*	White Oak	O
	Quercus borealis	Red Oak	C

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Cyperaceae	*Eleocharis* sp.	Spike-Rush	O
	Carex stricta	Sedge	D-O
Araceae	*Peltranda virginica*	Tuckahoe	O
Pontederiaceae	*Pontedaria cordata*	Pickerelweed	O-C
Juncaceae	*Juncus* spp.	Rush	C
Myricaceae	*Myrica gale*	Sweet Gale	C
Nymphaeaceae	*Nymphaea odorata*	Water-Lily	C
Aceraceae	*Acer rubrum*	Red Maple	C
Cornaceae	*Cornus amomum*	Red Willow	C
Clethraceae	*Clethra alnifolia*	Sweet Pepperbush	C
Ericaceae	*Kalmia angustifolia*	Sheep Laurel	O
	Chamaedaphne calyculata	Leather-leaf	C
	Vaccinium corymbosum	Highbush Blueberry	O
Rubiaceae	*Cephalanthus occidentalis*	Buttonbush	D
Caprifoliaceae	*Viburnum recognitum*	Arrow-wood	O
	Sambucus canadensis	Common Elder	O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Lauraceae	*Lindera benzoin*	Spicebush	D
Hamamelidaceae	*Hamamelis virginiana*	Common Witch-Hazel	O
Aceraceae	*Acer rubrum*	Red Maple	D
Nyssaceae	*Nyssa sylvatica*	Black Gum	O
Clethraceae	*Clethra alnifolia*	Sweet Pepperbush	C-D
Ericaceae	*Rhododendron viscosum*	Swamp Honeysuckle	C
	Vaccinium corymbosum	Highbush Blueberry	C
Oleaceae	*Fraxinus americana*	White Ash	O
Convolvulacea	*Cuscuta* sp.	Strangle-weed	O
Caprifoliaceae	*Viburnum recognitum*	Arrow-wood	C
Compositae	*Aster umbellatus*	Aster	O
WETLAND			
Bog			
Sphagnaceae	*Sphagnum* sp.	Sphagnum	C
Gramineae	*Glyceria canadensis*	Rattlesnake-grass	O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Cyperaceae	*Eleocharis obtusa*	Spike Rush	C
	Eriophorum virginica	Tawny Cotton Grass	C
	Rhynchospora capitellata	Beak rush	O
	Rhynchospora alba	White Beak rush	C
Eriocaulaceae	*Eriocaulon septangulare*	Duckgrass	O
Juncaceae	*Juncus effusis*	Soft Rush	C
	Juncus canadensis	Gay Rush	O
Nymphaeaceae	*Nymphaea odorata*	Water-Lily	O
Droseraceae	*Drosera rotundifolia*	Round-leaved sundew	C
Rosaceae	*Spiraea tomentosa*	Steeple-bush	C
Guttiferae	*Hypericum mutilum*	St. John's wort	O
Melastomataceae	*Rhexia virginica*	Deergrass	C
Ericaceae	*Chamaedaphne calyculata*	Leather-leaf	C
	Vaccinium corymbosum	Highbush Blueberry	O
Apocynaceae	*Nymphoides cordata*	Floating-heart	O
Compositae	*Solidago graminifolia*	Goldenrod	O

(Continued)

APPENDIX TABLE I. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
OPEN LAND			
Gramineae	*Festuca capillata*	Fescue Grass	C
	Festuca rubra	Fescue Grass	C
	Dactylus glomerata	Orchard Grass	C
	Triodia flava	Tull Red-top	O
	Agropyron repens	Quack Grass	C
	Danthonia compressa	Wild Oat-grass	O
	Agrostis perennans	Upland Bent Grass	C
	Phleum pratense	Timothy	C
	Panicum lanuginosum	Panic Grass	O
	Andropogon Scoparius	Bunchgrass	O-D
Cyperaceae	*Cyperus filiculmis*	Sedge	O
Juncaceae	*Juncus tenuis*	Rush	O
Salicaceae	*Populus tremuloides*	Quaking Aspen	O
Polygonaceae	*Rumex crispus*	Yellow Dock	O
	Rumex acetocella	Common sorrel	O
Caryophyllaceae	*Saponaria officinalis*	Soapwort	O

(Continued)

APPENDIX TABLE 1. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
Rosaceae	*Spirea latifolia*	Meadow sweet	O
	Potentilla sp.	Cinquefoil	C
	Rubus occidentalis	Black Raspberry	O
	Rubus hispidus	Dewberry	O-C
	Prunus pensylvanica	Pin Cherry	O
	Prunus serotina	Black Cherry	O
Leguminosae	*Lespedeza hirta*	Bush Clover	C
	Lespedeza capitata	Bush Clover	C
	Vicia cracca	Tufted Vetch	O
Guttiferae	*Hypericum perforatum*	St. John's wort	O
	Hypericum gentianoides	Pineweed	O
Onagraceae	*Oenthera biennis*	Evening Primrose	O
Labiatae	*Trichostema dichotomum*	Bastard Pennyroyal	O
Scrophulariaceae	*Verbascum thapsus*	Common Mullein	O
Compositae	*Solidago* sp.	Goldenrod	C
	Solidago rugosa	Goldenrod	O
	Aster sp.	Aster	O
	Erigeron annus	Daisy fleabane	O
	Ambrosia artemisiifolia	Ragweed	O
	Rudbeckia hirta	Coneflower	O
	Achillea millefolium	Milfoil	C
	Cirsium vulgare	Thistle	C
	Hieraceum pratense	King Devil	C

KEY:

O = Occasional
C = Common
D = Dominant

APPENDIX TABLE 2. LIST OF AQUATIC MACROPHYTES OBSERVED IN CAPWELL MILL POND AND TARBOX POND. BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

	PLANT		CAPWILL MILL POND		TARBOX POND	
FAMILY	SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	TYPE	ABUNDANCE	TYPE
Typhaceae	*Typha latifolia*	Cat-tail	C	E	C	E
Sparganiaceae	*Sparganium* sp.	Bur-reed			O	E
	Sparganium americanum	Bur-reed	C	E	O	E
Zosteraceae	*Potamogeton* sp.	Pondweed	D	F		
	Potamogeton zosteriformis	Pondweed	O	F		
	Potamogeton epihydrus	Pondweed	C	F		
	Potamogeton natans	Pondweed	C	F	C	F
Gramineae	*Vallisneria americana*	Wild celery	O	F		
Cyperaceae	*Eleocharis* sp.	Spike rush	O	E		
	Scirpus sp.	Bulrush	O	E		
Pontederiaceae	*Pontederia cordata*	Pickerelweed	D	E	D	E
	Juncus sp.	Rush	C	E		
Juncaceae	*Nymphaea odorata*	Water-lily	D	F	D	F
Nymphaceae	*Brasenia Schreberi*	Water-shield	C	F	O	F
	Myriophylum heterophylum	Water milfoil	C	F	C	S
Haloragaceae	*Myriophylum farwellii*	Water milfoil	C	F		
	Myriophylum humile	Water milfoil	C	F		
	Nymphoides cordata	Floating heart	C	F		
Apocynaceae	*Utricularia purpurea*	Bladderwort	D	F	D	F
Lentibulariaceae	*Utricularia vulgaris*	Bladderwort	D	F		

a) Abundance: C = Common
O = Occasional
D = Dominant

b) type: E = Emergent
F = Floating
S = Submerged

APPENDIX TABLE 3. SPECIES OF PLANTS FOUND ON ALTERNATE SITES. BIG RIVER TERRESTRIAL ECOSYSTEMS ANALYSIS. 1978.

FAMILY	SCIENTIFIC NAME	COMMON NAME	OCCURRENCE
HARDWOOD DOMINATED FOREST			
Pinaceae	*Pinus strobus*	White Pine	C
Liliaceae	*Smilax rotundifolia*	Common Greenbrier	O
Orchidaceae	*Cypripedium acaule*	Pink Lady Slipper	O
Corylaceae	*Corylus americana*	Hazelnut	O
Fagaceae	*Quercus alba*	White Oak	D
	Quercus borealis	Red Oak	C
	Quercus ilicifolia	Scrub Oak	C
Rosaceae	*Rubus hispidus*	Bramble	O
	Prunus serotina	Black Cherry	O
Pyrolaceae	*Chimaphila maculata*	Spotted Wintergreen	O
Ericaceae	*Kalmia angustifolia*	Sheep Laurel	O
	Gaultheri procumberis	Teaberry	C
	Gaylussacia baccata	Black Huckleberry	C
	Vaccinium vacillans	Lowbush Blueberry	C
	Vaccinium angustifolium	Lowbush Blueberry	C
	Vaccinium corymbosum	Highbush Blueberry	O
	Vaccinium atrococcum	Black Highbush Blueberry	O
Caprifoliaceae	*Viburnum lentago*	Nannyberry	O
SOFTWOOD DOMINATED FOREST			
Lycopodiaceae	*Lycopodium complanatum*	Trailing Evergreen	O
Pinaceae	*Pinus strobus*	White Pine	C-O
	Pinus rigida	Pitch Pine	D
Liliaceae	*Smilax rotundifolia*	Common Greenbrier	C

(Continued)

APPENDIX TABLE 3. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	OCCURRENCE
Orchidaceae	*Cypripedium acaule*	Pink Lady Slipper	O
Myricaceae	*Myrica gale*	Sweet Gale	O
	Comptonia peregrina	Sweet Fern	C-O
Corylaceae	*Betula populifolia*	Gray Birch	O
Fagaceae	*Quercus alba*	White Oak	C
	Quercus borealis	Red Oak	C
	Quercus ilicifolia	Scrub Oak	C
Rosaceae	*Prunus serotina*	Black Cherry	C
	Rubus hispidus	Bramble	C
Ericaceae	*Kalmia angustifolia*	Sheep Laurel	C
	Arctostaphylos Uva-ursi	Common Bearberry	C
	Gaylussacia baccata	Black Huckleberry	O
	Vaccinium angustifolium	Lowbush Blueberry	C
	Vaccinium corymbosum	Highbush Blueberry	O
WETLAND			
Open Water			
Gramineae	*Sagittaria latifolia*	Duck Potato	C
Cyperaceae	*Scripus validus*	Great Bullrush	C
Pontederiaceae	*Pontederia cordata*	Pickerelweed	C
Apocynaceae	*Nymphoides cordata*	Floating Heart	O
Shrub Swamp			
Sphagnaceae	*Sphagnum* sp.	Sphagnum	C
Osmundaceae	*Osmunda cinnamonea*	Cinnamon Fern	C
Polypodiaceae	*Dryopteris thelypterus*	Meadow Fern	O
Pinaceae	*Pinus strobus*	White Pine	O
Araceae	*Symplocarpus foetidus*	Skunk Cabbage	O

(Continued)

APPENDIX TABLE 3. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	OCCURRENCE
Rosaceae	*Pyrus arbutifolia*	Red Chokeberry	C
Aquifoliaceae	*Ilex verticillata*	Winterberry	C
Aceraeae	*Acer rubrum*	Red Maple	C
Clethraceae	*Clethra alnifolia*	Sweet Pepperbush	O
Ericaceae	*Rhododendron viscosum*	Swamp Honeysuckle	O
	Lyonia ligustrina	Maleberry	O
Caprifoliaceae	*Vaccinium corymbosum*	Highbush Blueberry	C
	Viburnum cassinoides	Witherod	C
WETLAND			
Wooded Swamp			
Sphagnaceae	*Sphagnum* sp.	Sphagnum	C
Osmundaceae	*Osmunda regalis*	Royal Fern	O
	Osmunda cinnamonea	Cinnamon Fern	C
Polypodiaceae	*Onoclea sensibilis*	Sensitive Fern	C-O
	Dryopteris thelypteris	Marsh Fern	O
	Dryopteris noveboracensis	New York Fern	O
Pinaceae	*Pinus strobus*	White Pine	O
	Chamaecyparis thyoides	White Cedar	O
Spargoniaceae	*Sparganium americana*	Bur-reed	C
Gramineae	*Cinna arundinacea*	Wood Reedgrass	O
Cyperaceae	*Carex stricta*	Sedge	C
	Carex folliculata	Sedge	O
Araceae	*Symplocarpus foetidus*	Skunk Cabbage	C
Pontederiaceae	*Pontederia cordata*	Pickerel Weed	O
	Polygonatum biflorum	Solomon's Seal	O
Liliaceae	*Smilax rotundifolia*	Greenbrier	O

(Continued)

APPENDIX TABLE 3. (Continued)

FAMILY	SCIENTIFIC NAME	COMMON NAME	OCCURRENCE
Corylaceae	*Alnus rugosa*	Alder	C
Polygonaceae	*Polygonium robustrus*	Smart Weed	C
Ranunculaceae	*Thalictrium polygamum*	Tall Meadow Rue	C
Rosaceae	*Pyrus melanocarpa*	Black Chokeberry	O
	Prunus serotina	Black Cherry	O
Aquifoliaceae	*Ilex verticillata*	Black Alder	C
Aceraceae	*Acer rubrum*	Red Maple	D
Balsamaceae	*Impatiens capensis*	Spotted Touch-Me-Not	C
Nyssaceae	*Nyssa sylvatica*	Black Gum	O
Cornaceae	*Cornus amomum*	Red Willow	C
Clethraceae	*Clethra alnifolia*	Sweet Pepperbush	C
Ericaceae	*Rhododendron viscosum*	Swamp Honeysuckle	C
	Chamaedaphne calyculata	Leather-leaf	O
	Vaccinium corymbosum	Highbush Blueberry	C
Rubiaceae	*Cephalanthus occidentalis*	Buttonbush	O
Caprifoliaceae	*Viburnum cassinoides*	Witherod	C-O
	Viburnum recognitum	Arrow-wood	C
	Sambucus canadensis	Common Elder	O
Compositae	*Eupatorium maculatum*	Joe-Pye-Weed	O
	Solidago remoralis	Goldenrod	O
OPEN LAND			
Pinaceae	*Pinus rigida*	Pitch Pine	C
	Juniperus virginiana	Red Cedar	O
Gramineae	*Arostis perennans*	Upland Bent Grass	C
	Andropogon virgnicus	Beardgrass	D
Juncaceae	*Juncus tenuis*	Rush	C
Myricaceae	*Comptonia peregrina*	Sweet-fern	C
Corylaceae	*Betula populifolia*	White Birch	O
Fagaceae	*Quercus alba*	White Oak	O
Rosaceae	*Spirea latifolia*	Meadow sweet	C
	Rubus hispidus	Bramble	C
	Prunus serotina	Black Cherry	C

APPENDIX TABLE 4. SPECIES AND SEASONAL STATUS OF BIRDS POSSIBLY OCCURRING IN THE BIG RIVER STUDY AREA (FROM ROBBINS *ET AL.*, 1966). BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

COMMON NAME	SCIENTIFIC NAME	STATUS	HABITAT
Red-necked grebe	*Podiceps grisegena*	M	W
Horned grebe	*Podiceps auritus*	M	W
Pied-billed grebe	*Podilymbus podiceps*	B	W
Canada goose	*Branta canadensis*	M	W
Brant	*Branta bernicla*	M	W
Snow goose	*Chen hyperborea*	M	W
Mallard	*Anas platyrhynchos*	W	W
Black duck	*Anas rubripes*	A	W
Pintail	*Anas acuta*	M	W
Gadwall	*Anas strepera*	M	W
American wigeon	*Mareca americana*	M	W
Shoveler	*Spatula clypeata*	M	W
Blue-winged teal	*Anas discors*	M	W
Green-winged teal	*Anas carolinensis*	M	W
Wood duck	*Aix sponsa*	B	W
Redhead	*Aythya americana*	M	W
Canvasback	*Aythya valisineria*	M	W
Ring-necked duck	*Aythya collaris*	M	W
Greater scaup	*Aythya marila*	M	W
Lesser scaup	*Aythya affinis*	M	W
Common goldeneye	*Bucephala clangula*	W	W
Bufflehead	*Bucephala albeola*	W	W
White-winged scoter	*Melanitta deglandi*	M	W
Ruddy duck	*Oxyura jamaicensis*	M	W
Red-breasted merganser	*Mergus serrator*	M	W
Hooded merganser	*Lophodytes cucullatus*	B	W
Goshawk	*Accipiter gentilus*	A	FO
Cooper's hawk	*Accipiter cooperii*	A	FO
Sharp-shinned hawk	*Accipiter striatus*	A	FO
Marsh hawk	*Circus cyaneus*	B	O
Rough-legged hawk	*Buteo lagopus*	W	O
Red-tailed hawk	*Buteo jamaicensis*	W	FO
Red-shouldered hawk	*Buteo lineatus*	BW	FO
Broad-winged hawk	*Buteo platypterus*	B	F
Golden eagle	*Aquila chrysaetos*	W	O
Bald eagle	*Haliaeetus luecocephalus*	WM	W
Osprey	*Pandion haliaetus*	BM	WF
Peregrine falcon	*Falco peregrinus*	M	FOW
Merlin	*Falco columbarius*	M	O
Kestrel	*Falco sparverius*	A	FO
Ruffed grouse	*Bonasa umbellus*	A	FO

(Continued)

APPENDIX TABLE 4. (Continued)

COMMON NAME	SCIENTIFIC NAME	STATUS	HABITAT
Bobwhite	*Colinus virginianus*	A	O
Ring-necked pheasant	*Phasianus colchicus*	A	FO
Great blue heron	*Ardea herodias*	BW	W
Great heron	*Butorides virescens*	B	W
Black-crowned night heron	*Nycticorax nycticorax*	A	W
American bittern	*Botaurus lentiginosus*	B	W
Least bittern	*Ixobrychus exilis*	B	W
Virginia rail	*Rallus limicola*	B	W
Sora	*Porzana carolina*	B	W
Yellow rail	*Coturnicops noveboracensis*	M	W
Black rail	*Laterallus jamaicensis*	B	W
King rail	*Rallus elegans*	B	W
Common gallinule	*Gallinula chloropus*	B	W
American coot	*Fulica americana*	B	W
American golden plover	*Pluvialis dominica*	M	W
Black-bellied plover	*Squatarola squatarola*	M	W
Killdeer	*Charadrius vociferus*	B	OW
Upland plover	*Bartramia longicauda*	B	OW
Solitary sandpiper	*Tringa solitaria*	M	W
Spotted sandpiper	*Actitis macularia*	B	W
Greater yellowlegs	*Totanus melanoleucus*	M	W
Lesser yellowlegs	*Totanus flavipes*	M	W
Stilt sandpiper	*Micropalama himantopus*	M	W
Short-billed dowitcher	*Limnodromus griseus*	M	W
Long-billed dowitcher	*Limnodromus scolopaceus*	M	W
Pectoral sandpiper	*Erolia melanotos*	M	W
Knot	*Calidris canutus*	M	W
Dunlin	*Erolia alpina*	M	W
White-rumped sandpiper	*Erolia fuscicollis*	M	W
Bairds sandpiper	*Erolia bairdii*	M	W
Least sandpiper	*Erolia minutilla*	M	W
Semipalmated sandpiper	*Ereunetes pusillus*	M	W
American woodcock	*Philohela minor*	B	WF
Common snipe	*Capella gallinago*	B	W
Herring gull	*Larus argentatus*	M	W
Ring-billed gull	*Larus delewarensis*	M	W
Bonaparte's gull	*Larus philadelphia*	M	W
Common tern	*Sterna hirundo*	M	W
Caspian tern	*Hydroprogne caspia*	M	W
Black tern	*Chilidonias niger*	M	W
Rock dove	*Columba livia*	A	O
Mourning dove	*Zenaidura macroura*	A	O

(Continued)

APPENDIX TABLE 4. (Continued)

COMMON NAME	SCIENTIFIC NAME	STATUS	HABITAT
Yellow-billed cuckoo	*Coccyzus americanus*	B	F
Black-billed cuckoo	*Coccyzus erythropthalmus*	B	F
Screech owl	*Otus asio*	A	FO
Great horned owl	*Bubo virginianus*	A	FO
Long-eared owl	*Asio otus*	A	FO
Short-eared owl	*Asio flammeus*	A	FO
Barn owl	*Tyto alba*	A	FOW
Barred owl	*Strix varia*	A	FOW
Saw-whet owl	*Aegolius acadicus*	A	F
Whip-poor-will	*Caprimulgus vociferus*	B	FO
Common nighthawk	*Chordeiles minor*	B	FO
Chimney swift	*Chaetura pelagica*	B	O
Ruby-throated hummingbird	*Archilochus colubris*	B	FO
Belted kingfisher	*Megaceryle alcyon*	B	FOW
Common flicker	*Colaptes auratus*	A	FO
Pileated woodpecker	*Dryocopus pileatus*	A	F
Red-headed woodpecker	*Melanerpes erythrocephalus*	B	F
Yellow-bellied sapsucker	*Sphyrapicus varius*	B	F
Hairy woodpecker	*Dendrocopus villosus*	A	F
Downy woodpecker	*Dendrocapos pubescens*	A	F
Eastern kingbird	*Tyrannus tyrannus*	B	FO
Great-crested flycatcher	*Myiarchus crinitus*	B	FO
Eastern phoebe	*Sayornis phoebe*	B	FO
Yellow-bellied flycatcher	*Empidonax flaviventris*	B	F
Alder's flycatcher	*Empidonax alorum*	B	FW
Least flycatcher	*Empidonax minimus*	B	FO
Eastern wood phoebe	*Contopus virens*	B	F
Olive-sided flycatcher	*Nuttallornis borealis*	B	F
Horned lark	*Eremophila alpestris*	A	O
Barn swallow	*Hirundo rustica*	B	O
Cliff swallow	*Petrochelidon fulva*	B	FO
Tree swallow	*Iridoprocne bicolor*	B	FOW
Bank swallow	*Riparia riparia*	B	OW
Rough-winged swallow	*Stelgidopteryx ruficollis*	B	FOW
Purple martin	*Progne subis*	B	FO
Blue jay	*Cyanocitta cristata*	A	F
Common crow	*Corvus brachyrhynchus*	A	FOW
Black-capped chickadee	*Parus atricapillus*	A	F
Tufted titmouse	*Parus bicolor*	A	FW
White-breasted nuthatch	*Sitta carolinensis*	A	F
Red-breasted nuthatch	*Sitta canadensis*	A	F
Brown creeper	*Certhia familiaris*	A	F

(Continued)

APPENDIX TABLE 4. (Continued)

COMMON NAME	SCIENTIFIC NAME	STATUS	HABITAT
House wren	*Troglodytes aedon*	B	FO
Winter wren	*Troglodytes troglodytes*	A	FO
Carolina wren	*Thryothorus ludovicianus*	A	FO
Long-billed marsh wren	*Telmatodytes palustris*	B	WO
Short-billed marsh wren wren	*Cistothrus platensis*	B	WO
Mockingbird	*Mimus polyglottos*	W	FO
Catbird	*Dumetella carolinensis*	B	FO
Brown thrasher	*Toxostoma rufum*	B	FO
Robin	*Turdus migratorius*	A	FO
Wood thrush	*Hylocichla mustelina*	B	F
Hermit thrush	*Hylocichla guttata*	A	F
Swainson's thrush	*Hylocichla ustulata*	M	F
Gray-cheeked thrush	*Hylocichla minima*	M	F
Veery	*Hylocichla fuscescens*	B	FW
Eastern bluebird	*Sialia sialis*	B	FO
Golden-crowned kinglet	*Regulus satrapa*	A	F
Ruby-crowned kinglet	*Regulus calendula*	M	F
Water pipit	*Anthus spinoletta*	M	OW
Cedar waxwing	*Bombycilla cedrorum*	A	FO
Northern shrike	*Lanius excubitor*	W	FO
Loggerhead shrike	*Lanius ludovicianus*	A	FO
Starling	*Sturnus vulgaris*	A	FO
Solitary vireo	*Vireo solitarius*	B	F
White-eyed vireo	*Vireo griseus*	B	FO
Yellow-throated vireo	*Vireo flavifrons*	B	FW
Red-eyed vireo	*Vireo olivaceus*	B	F
Philadelphia vireo	*Vireo philadelphicus*	M	FO
Warbling vireo	*Vireo gilvus*	B	F
Black-and-white warbler	*Mniotilta varia*	B	F
Worm-eating warbler	*Helmitheros vermivorus*	B	F
Golden-winged warbler	*Vermivora chrysoptera*	B	FO
Blue-winged warbler	*Vermivora pinus*	B	FO
Tennessee warbler	*Vermivora peregrina*	B	F
Nashville warbler	*Vermivora ruficapilla*	B	FO
Parula warbler	*Parula americana*	B	FW
Yellow warbler	*Dendroica petechia*	B	FO
Magnolia warbler	*Dendroica magnolia*	B	F
Cape May warbler	*Dendroica tigrina*	B	F
Myrtle warbler	*Dendroica coronata*	B	F
Black-throated green warbler	*Dendroica virens*	B	F
Black-throated blue warbler	*Dendroica caerulescens*	B	FO
Blackburnian warbler	*Dendroica fusca*	B	F
Chestnut-sided warbler	*Dendroica pensylvanica*	B	FO
Bay-breasted warbler	*Dendroica castanea*	M	F
Blackpoll warbler	*Dendroica striata*	M	F

(Continued)

APPENDIX TABLE 4. (Continued)

COMMON NAME	SCIENTIFIC NAME	STATUS	HABITAT
Pine warbler	*Dendroica pinus*	B	F
Prairie warbler	*Dendroica discolor*	B	FO
Palm warbler	*Dendroica palmarum*	M	OW
Ovenbird	*Seiurus aurocapillus*	B	F
Northern waterthrush	*Seiurus noveboracensis*	B	W
Louisiana waterthrush	*Seiurus motacilla*	B	W
Yellowthroat	*Geothlypis trichas*	B	FO
Yellow-breasted chat	*Icteria virens*	B	FO
Mourning warbler	*Oporornis philadelphia*	M	FO
Hooded warbler	*Wilsonia citrina*	B	FO
Wilson's warbler	*Wilsonia pusilla*	M	FO
Canada warbler	*Wilsonia canadensis*	B	FO
American redstart	*Setophaga ruticilla*	B	F
House sparrow	*Passer domesticus*	A	FO
Bobolink	*Dolichonyx oryzivorus*	B	OW
Eastern meadowlark	*Sturnella magna*	A	O
Red-winged blackbird	*Agelaius phoeniceus*	B	OW
Rusty blackbird	*Euphagus carolinus*	B	FW
Common grackle	*Quiscalus quiscula*	A	FO
Brown-headed cowbird	*Molothrus ater*	A	O
Orchard oriole	*Icterus spurius*	B	FO
Norther oriole	*Icterus galbula*	B	F
Scarlet tanager	*Piranga olivacea*	B	F
Cardinal	*Richmondena cardinalis*	A	FO
Rose-breasted grosbeak	*Pheucticus ludovicianus*	B	FO
Evening grosbeak	*Hesperiphona vespertina*	W	F
Indigo bunting	*Passerina cyanea*	B	FO
Purple finch	*Carpoducus purpureus*	A	FO
Pine grosbeak	*Pinicola enucleator*	W	F
Common redpoll	*Acanthis flammea*	W	O
Pine siskin	*Spinus pinus*	W	F
American goldfinch	*Spinus tristis*	A	FO
Dickcissel	*Spiza americana*	W	O
Rufous-sided towhee	*Pipilo erythrophthalmus*	A	FO
Savannah sparrow	*Passerculus sandwichensis*	B	O
Grasshopper sparrow	*Ammodramus savannarum*	B	O
Henslow's sparrow	*Passerherbulus henslowii*	B	O
Sharp-tailed sparrow	*Ammospiza caudacuta*	M	OW
Vesper sparrow	*Pooecetes gramineus*	B	O
Slate-colored junco	*Junco hyemalis*	A	FO
Tree sparrow	*Spizella arborea*	W	FO
Chipping sparrow	*Spizella passerina*	B	O
Field sparrow	*Spizella pusilla*	A	O

(Continued)

APPENDIX TABLE 4. (Continued)

COMMON NAME	SCIENTIFIC NAME	STATUS	HABITAT
White-crowned sparrow	*Zonotrichia leucophrys*	M	FO
White-throated sparrow	*Zonotrichia albicollis*	A	FO
Fox sparrow	*Passerella iliaca*	M	FO
Lincoln's sparrow	*Melospiza lincolnii*	M	FOW
Swamp sparrow	*Melospiza georgiana*	W	OW
Song sparrow	*Melospiza melodia*	A	FOW
Lapland longspur	*Calcarius lapponicus*	W	O
Snow bunting	*Plectrophenax nivalis*		O

STATUS KEY

B = Breeding or summer resident
M = Migrant
W = Winter resident
A = Present all year

HABITAT KEY

W = Wetland
F = Forest
O = Open

APPENDIX TABLE 5. SPECIES OF BIRDS OBSERVED DURING WINTER IN RHODE ISLAND AND POSSIBLY OCCURRING ON THE BIG RIVER STUDY AREA. (HEILBRUN, 1976, 1977). BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

FAMILY	COMMON NAME	SCIENTIFIC NAME
Gaviidae	Common loon	*Gavia immer*
	Red-throated loon	*Gavia stellata*
Podicipedidae	Red-necked grebe	*Podiceps grisegena*
	Horned grebe	*Podiceps auritus*
	Pied-billed grebe	*Podilymbus podiceps*
Phalacrocoracidae	Great cormorant	*Phalacrocorax carbo*
	Double-crested cormorant	*Phalacrocorax auritus*
Anatidae	Mute swan	*Cygnus olor*
	Canada goose	*Branta canadensis*
	Snow goose	*Chen hyperborea*
	Mallard	*Anas platyrhynchos*
	Black duck	*Anas rubripes*
	Pintail	*Anas acuta*
	Gadwall	*Anas strepera*
	American wigeon	*Mareca americana*
	Shoveler	*Spatula clypeata*
	Green-winged teal	*Anas carolinensis*
	Redhead	*Aythya americana*
	Canvasback	*Aythya valisineria*
	Ring-necked duck	*Aythya collaris*
	Greater scaup	*Aythya marila*
	Common goldeneye	*Bucephala clangula*
	Bufflehead	*Bucephala albeola*
	Harlequin duck	*Histrionicus histrionicus*
	Old squaw	*Clangula hyemalis*
	Ruddy duck	*Oxyura jamaicensis*
	Common merganser	*Mergus merganser*
	Red-breasted merganser	*Mergus serrator*
	Hooded merganser	*Lophodytes cucullatus*
Accipitridae	Cooper's hawk	*Accipiter cooperi*
	Sharp-shinned hawk	*Accipiter cyaneus*
	Marsh hawk	*Circus cyaneus*
	Rough-legged hawk	*Buteo lagopus*
	Red-shouldered hawk	*Buteo lineatus*
Falconidae	Merlin	*Falco columbarius*
	American kestrel	*Falco sparverious*

(Continued)

APPENDIX TABLE 5. (Continued)

FAMILY	COMMON NAME	SCIENTIFIC NAME
Tetraonidae	Ruffed grouse	*Bonasa umbellus*
	Bobwhite	*Colinus virginianus*
Phasianidae	Ring-necked pheasant	*Phasianus colchicus*
Ardeidae	Great blue heron	*Ardea herodias*
	Black-crowned night heron	*Nycticorax nycticorax*
	American bittern	*Botaurus lentiginosus*
Rallidae	American coot	*Fulica americana*
Charadriidae	Black-bellied plover	*Pluvialis squatorola*
	Killdeer	*Charadrius vociferus*
Scolopacidae	Greater yellowlegs	*Totanus melanoleucus*
	Purple sandpiper	*Erolia maritima*
	Dunlin	*Calidris alpina*
	Sanderling	*Calidris alba*
	Semi-palmated sandpiper	*Calidris pusillus*
	American woodcock	*Philohela minor*
	Common snipe	*Capella gallinago*
Laridae	Iceland gull	*Larus glaucoides*
	Great black-backed gull	*Larus marinus*
	Herring gull	*Larus argentatus*
	Ring-billed gull	*Larus delawarensis*
	Bonaparte's gull	*Larus philadelphia*
	Black-headed gull	*Larus ridibundus*
Columbidae	Rock dove	*Columba livia*
	Mourning dove	*Zenaida macroura*
Strigidae	Screech owl	*Otus asio*
	Great-horned owl	*Bubo virginianus*
Tytonidae	Barn owl	*Tyto alba*
Alcedinidae	Belted kingfisher	*Megaceryle alcyon*
Picidae	Common flicker	*Colaptes auratus*
	Red-headed woodpecker	*Melanerpes erythrocephalus*
	Hairy woodpecker	*Dendrocopos villosus*
	Downy woodpecker	*Dendrocopos pubescens*

(Continued)

APPENDIX TABLE 5. (Continued)

FAMILY	COMMON NAME	SCIENTIFIC NAME
Tyrannidae	Eastern phoebe	*Sayornis phoebe*
Alaudidae	Horned lark	*Eremophila alpestris*
Hirundinidae	Tree swallow	*Iridoprocne bicolor*
Corvidae	Blue jay	*Cyanocitta cristata*
	Common crow	*Corvus brachyrhynchos*
Paridae	Black-capped chickadee	*Parus atricapillus*
	Tufted titmouse	*Parus bicolor*
Sittidae	White-breasted nuthatch	*Sitta carolinensis*
	Red-breasted nuthatch	*Sitta canadensis*
Certhiidae	Brown creeper	*Certhia familiaris*
Troglodytidae	Winter wren	*Troglodytes troglodytes*
	Carolina wren	*Thryothorus ludovicianus*
Mimidae	Mockingbird	*Mimus polyglottus*
	Catbird	*Dumetella carolinensis*
	Brown thrasher	*Toxostoma rufum*
Turdidae	Robin	*Turdus migratorius*
	Hermit thrush	*Catharus guttata*
	Eastern bluebird	*Sialia sialis*
Sylviidae	Golden-crowned kinglet	*Regulus satrapa*
	Ruby-crowned kinglet	*Regulus calendula*
Motacillidae	Water pipit	*Anthus spinoletta*
Bombycillidae	Cedar waxwing	*Bombycilla cedrorum*
Laniidae	Loggerhead shrike	*Lanius ludovicianus*
Sturnidae	Starling	*Sturnus vulgaris*
Parulidae	Myrtle warbler	*Dendroica coronata*
	Palm warbler	*Dendroica palmarus*
	Yellow-breasted chat	*Icteria virens*
Ploceidae	House sparrow	*Passer domesticus*

(Continued)

APPENDIX TABLE 5. (Continued)

FAMILY	COMMON NAME	SCIENTIFIC NAME
Icteridae	Eastern meadowlark	*Sturnella magna*
	Red-winged blackbird	*Agelaius phoeniceus*
	Rusty blackbird	*Euphagus carolinus*
	Common grackle	*Quiscalus quiscula*
	Brown-headed cowbird	*Molothrus ater*
	Northern oriole	*Icterus galbula*
Fringillidae	Cardinal	*Richmondena cardinalis*
	Evening grosbeak	*Hesperiphona vespertina*
	Purple finch	*Carpodacus purpureus*
	House finch	*Carpodacus mexicanus*
	Pine siskin	*Spinus pinus*
	American goldfinch	*Spinus tristis*
	Red crossbill	*Loxia curvirostra*
	Rufous-sided towhee	*Pipilo erythrophthalmus*
	Savannah sparrow	*Passerculus sandwichensis*
	Ipswich sparrow	*Passerculus princeps*
	Sharp-tailed sparrow	*Ammospiza caudacuta*
	Vesper sparrow	*Pooecetes gramineus*
	Slate-colored junco	*Junco hyemalis*
	Tree sparrow	*Spizella arborea*
	Chipping sparrow	*Spizella passerina*
	Field sparrow	*Spizella pusilla*
	White-crowned sparrow	*Zonotrichia leucophrys*
	White-throated sparrow	*Zonotrichia albicollis*
	Fox sparrow	*Passetella iliaca*
	Swamp sparrow	*Melospiza georgiana*
	Song sparrow	*Melospiza melodia*
	Lapland longspur	*Calcarius lapponicus*
	Snow bunting	*Plectrophenax nivalis*

APPENDIX TABLE 6. MAMMALS POSSIBLY OCCURRING IN THE BIG RIVER STUDY AREA. (CRONAN AND BROOKS, 1968). BIG RIVER TERRESTRIAL ECOSYSTEM ANALYSIS, 1978.

COMMON NAME	SCIENTIFIC NAME	HABITAT
Opposum	*Didelphis marsupialis virginiana*	FO
Masked shrew	*Sorex cinereus cinereus*	FO
Water shrew	*Sorex palustris albibarbis*	FOW
Smoky shrew	*Sorex fumeus fumeus*	F
Long-tailed shrew	*Sorex dispar dispar*	F
Short-tailed shrew	*Blarina brevicauda talpoides*	FOW
Hairy-tailed shrew	*Parascalops breweri*	FOW
Eastern mole	*Scalopus aquaticus aquaticus*	FO
Star-nosed mole	*Condylura cristata cristata*	FOW
Little brown myotis	*Myotis lucifugus lucifugus*	FOW
Keen's myotis	*Myotis keeni septentrionalis*	F
Indiana myotis	*Myotis sodalis*	FO
Small-footed myotis	*Myotis subulatus leibii*	F
Silver-haired bat	*Lasionycterus noctivagans*	F
Eastern pipistrel	*Pipistrellus subflavus subflavus*	FO
Big brown bat	*Eptesicus fuscus fuscus*	F
Red bat	*Lasiurus borealis borealis*	F
Hoary bat	*Lasiurus cinereus cinereus*	F
Black bear	*Ursus americanus americanus*	FW
Raccoon	*Procyon lotor lotor*	FW
Fisher	*Martes pennanti pennanti*	FO
Ermine	*Mustela erminea cicognanii*	F
Long-tailed weasel	*Mustela frenata noveboracensis*	FOW
Mink	*Mustela vison mink*	W
Striped skunk	*Mephitis mephitus nigra*	FO
River otter	*Lutra canadensis canadensis*	W
Coyote	*Canis latrans thannos*	FO
Red fox	*Vulpes vulpes fulva*	FO
Gray fox	*Urocyon cinereoargenteus cinereoargenteus*	FO
Lynx	*Lynx canadensis canadensis*	FOW
Bobcat	*Lynx rufus rufus*	FOW
Eastern chipmunk	*Tamias striatus fisheri*	FO
Woodchuck	*Marmota monax preblorum*	FO
Gray squirrel	*Sciurus carolinensis pennsylvanicus*	FW
Red squirrel	*Tamiasciurus hudsonicus loquax*	FW
Southern flying squirrel	*Glaucomys volans volans*	F
Northern flying squirrel	*Glaucomys sabrinus macrotis*	F
Beaver	*Castor canadensis*	W
Deer mouse	*Peromyscus maniculatus gracilis*	FO

(Continued)

APPENDIX TABLE 6. (Continued)

COMMON NAME	SCIENTIFIC NAME	HABITAT
White-footed mouse	*Peromyscus maniculatus noveboracensis*	FO
Boreal red-backed vole	*Clethrionomys gapperi gapperi*	FOW
Meadow vole	*Microtus pennsylvanicus pennsylvanicus*	OW
	Microtus pennsylvanicus provectus	OW
Pine vole	*Microtus pinetorum scalopsoides*	F
Muskrat	*Ondatra zibethicus zibethicus*	W
Southern bog lemming	*Synaptomys cooperi stonei*	OW
Black rat	*Rattus rattus rattus*	O
Norway rat	*Rattus norvegicus*	O
House mouse	*Mus musculus domesticus*	O
Meadow jumping mouse	*Zapus hudsonius americanus*	O
Woodland jumping mouse	*Napoeozapus insignis insignis*	FOW
Porcupine	*Erethizon dorsatum dorsatum*	F
Eastern cottontail	*Sylvilagus floridanus mallurus*	FOW
New Enland cottontail	*Sylvilagus transitionalis*	FO
Snowshoe hare	*Lepus americanus virginianus*	FOW
White-tailed deer	*Odocoileus virginiana borealis*	FOW

KEY:

F = Forestland
O = Open Land
W = Wetland

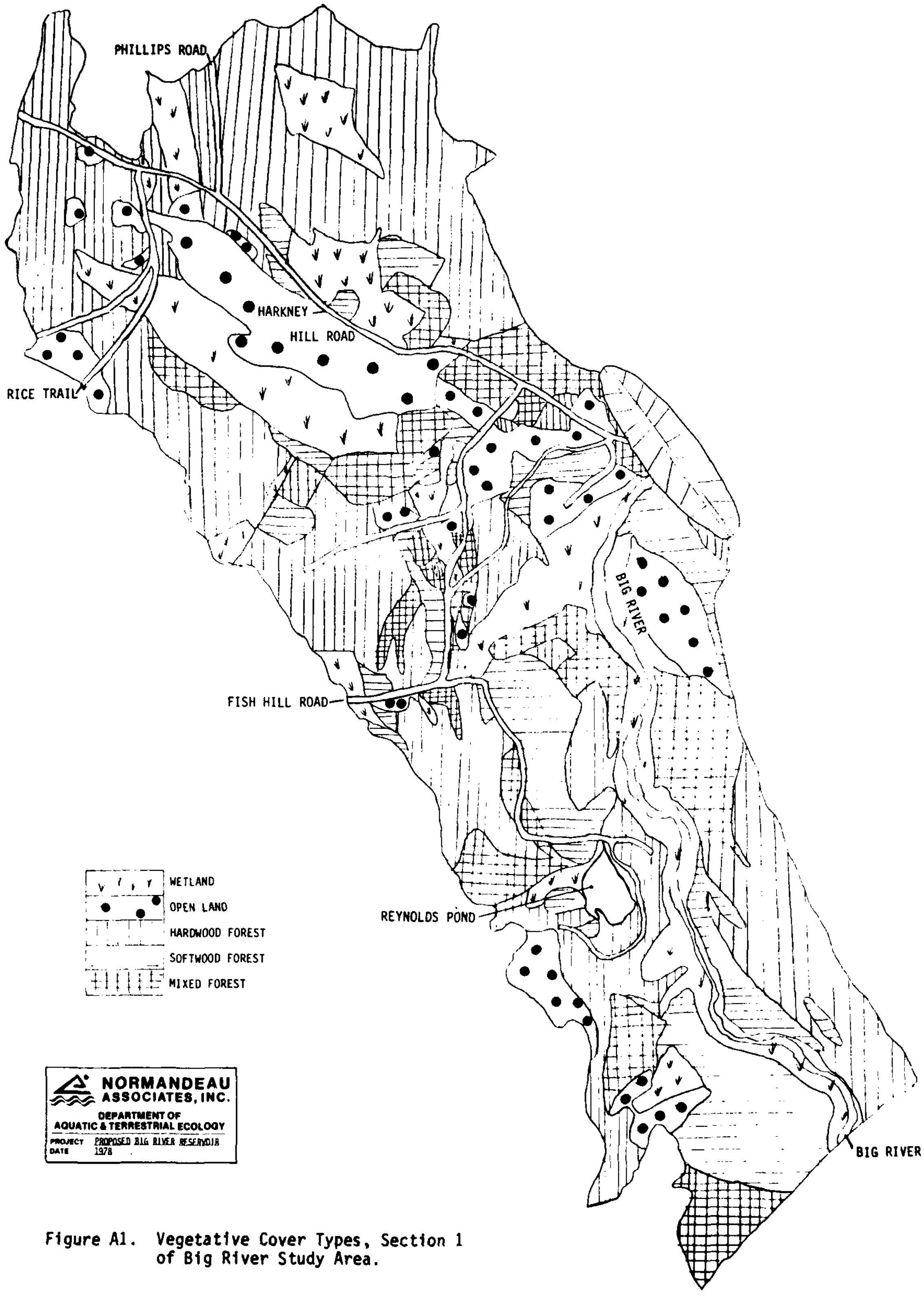


Figure A1. Vegetative Cover Types, Section 1 of Big River Study Area.

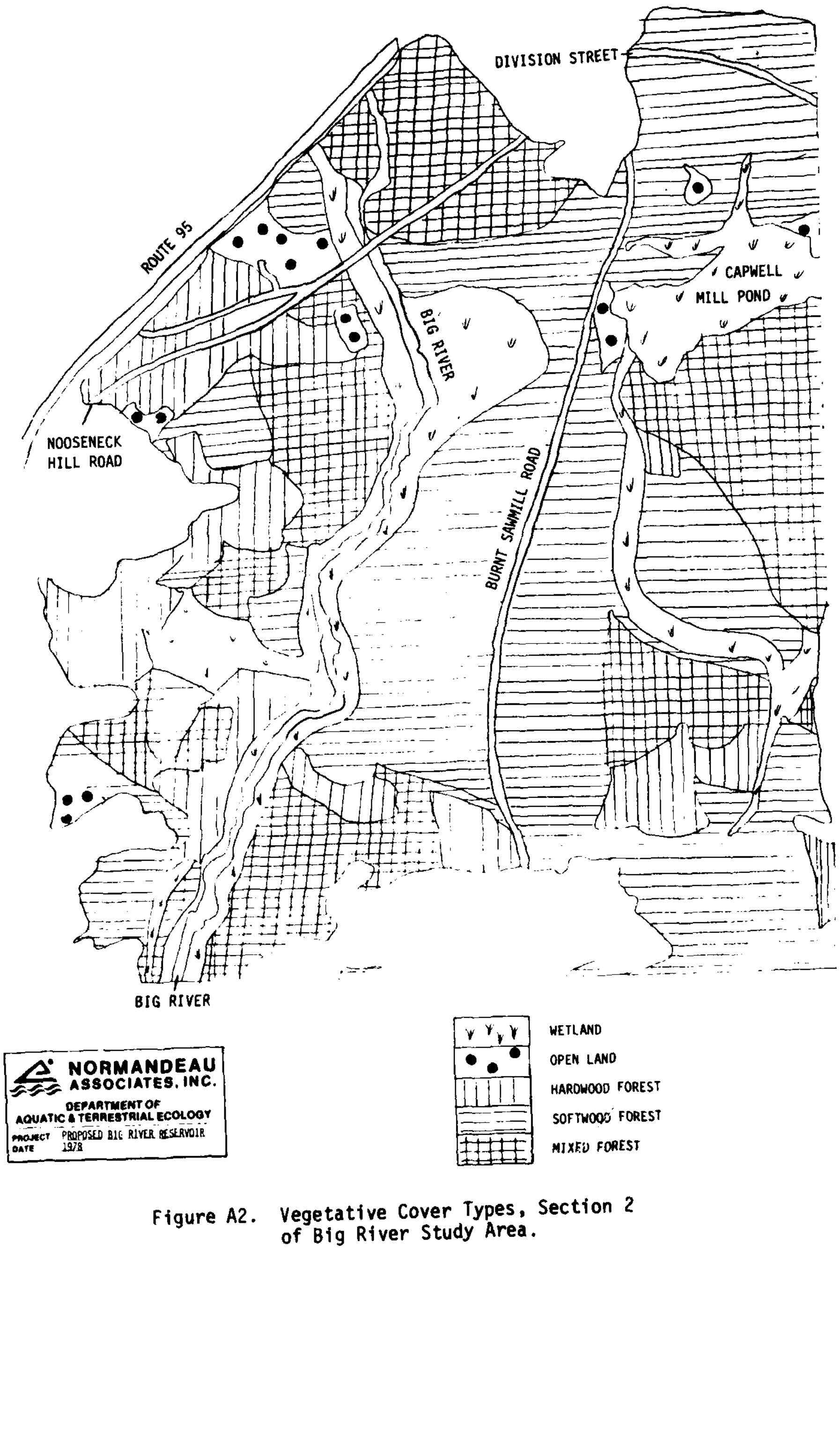


Figure A2. Vegetative Cover Types, Section 2 of Big River Study Area.

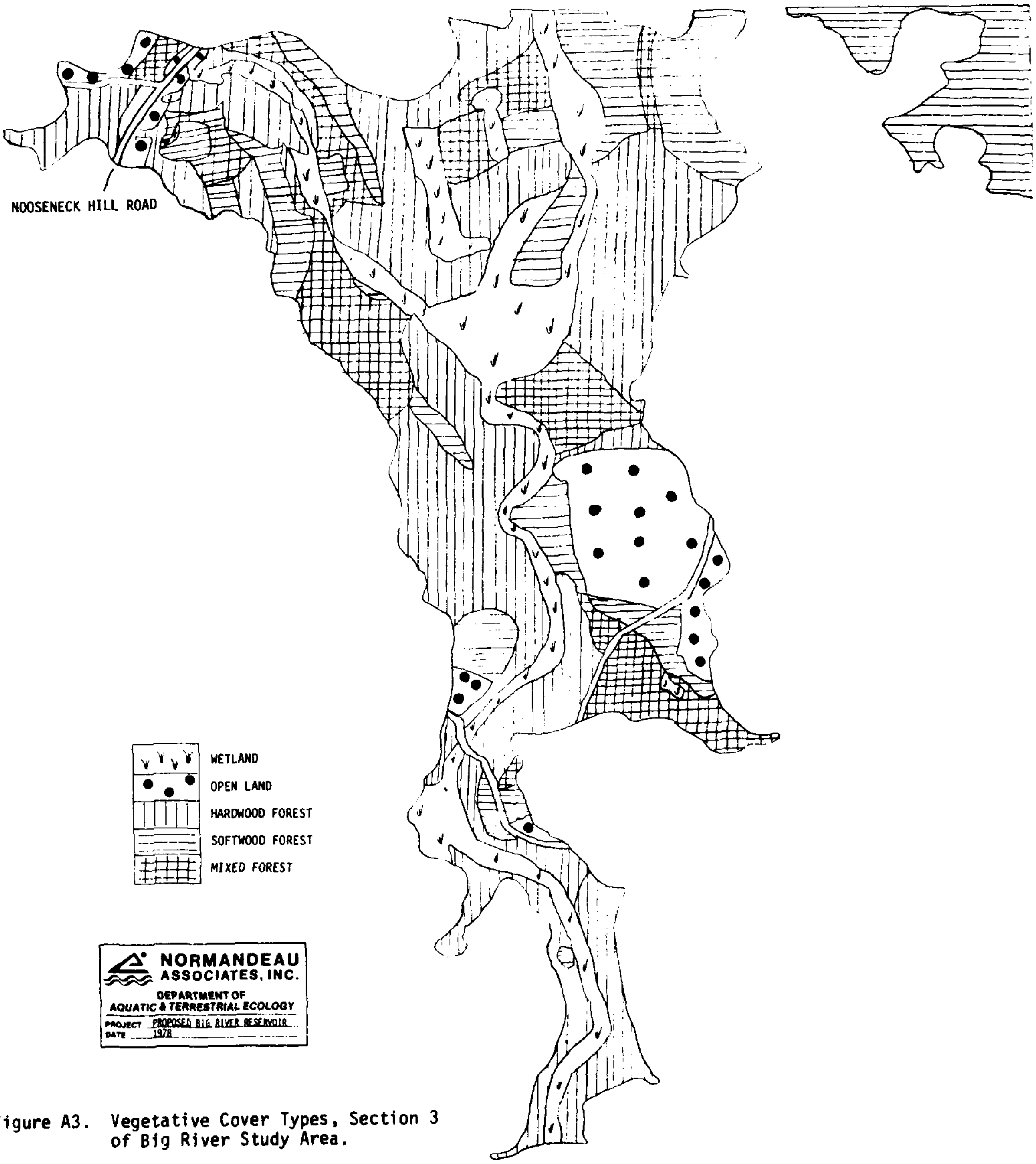


Figure A3. Vegetative Cover Types, Section 3 of Big River Study Area.

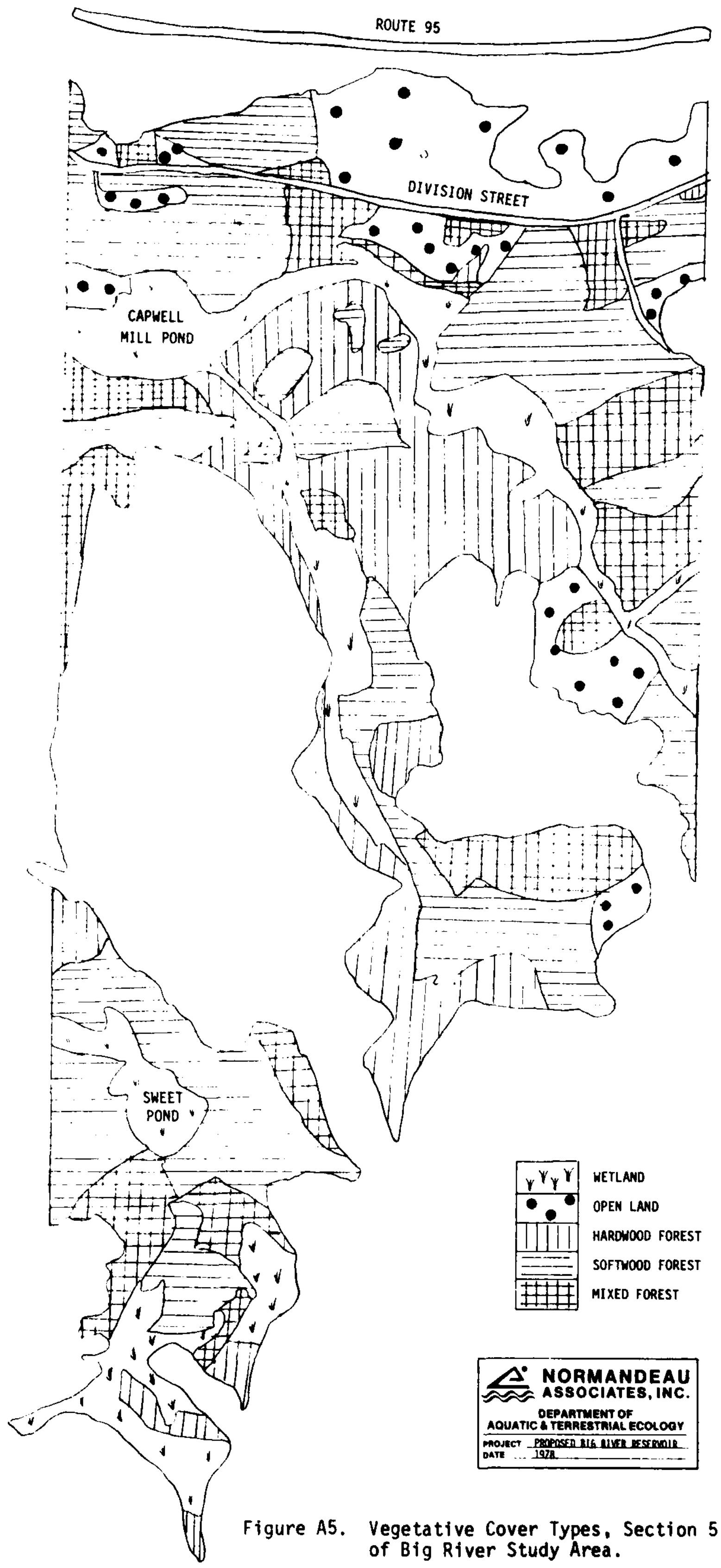


Figure A5. Vegetative Cover Types, Section 5 of Big River Study Area.

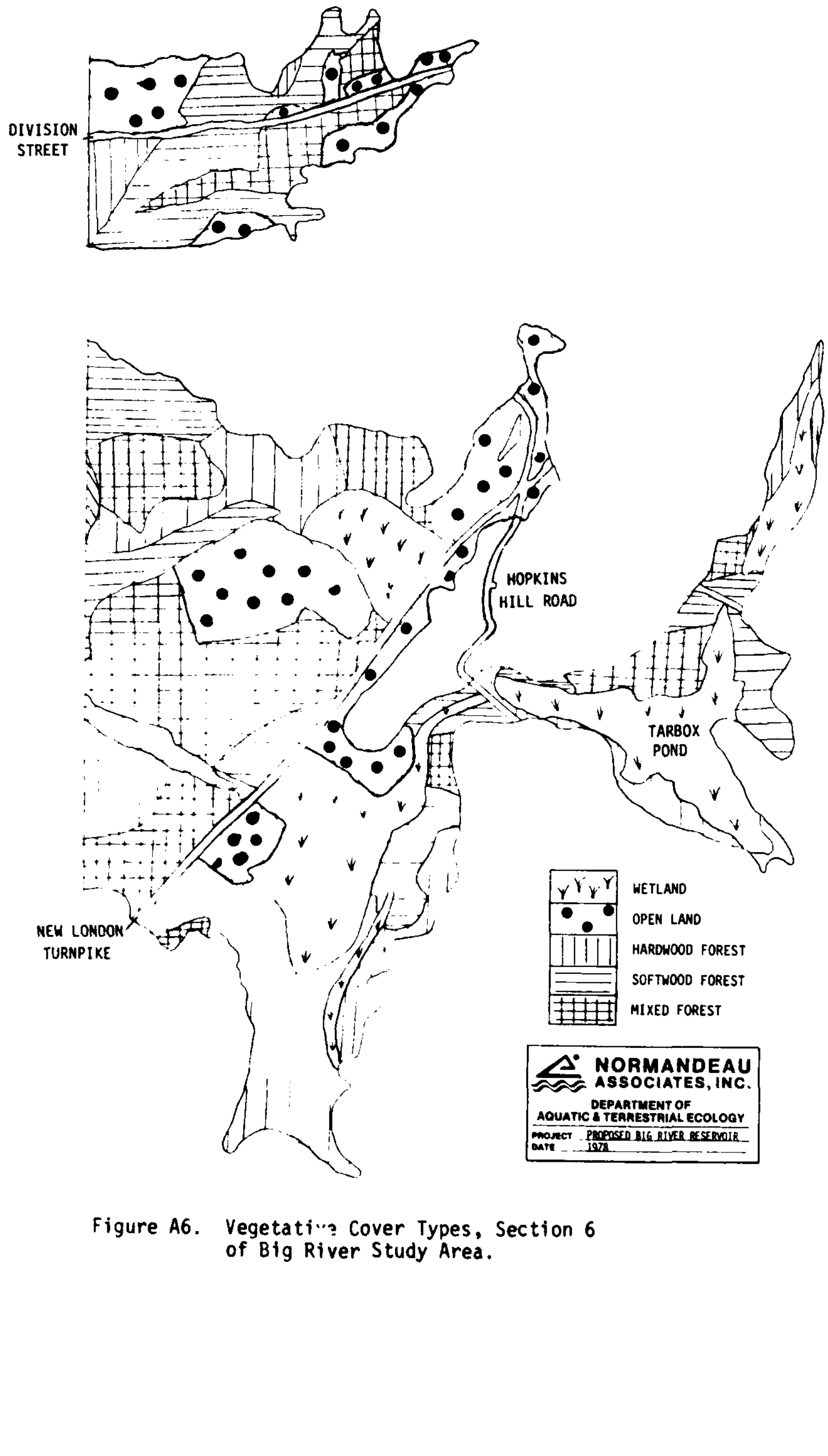


Figure A6. Vegetati~e Cover Types, Section 6 of Big River Study Area.

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX H

RECREATION AND NATURAL RESOURCES

Section 4 - Fish and Wildlife Management Plan

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1980

BIG RIVER RESERVOIR

NATURAL RESOURCES
Mitigation and Management Recommendations

Preface

Development of Big River Reservoir would displace various Natural Resource values. These have been discussed in detail in Sections 1, 2 and 3 of this Appendix, and in less detail in the EIS. Consistent with relevent environmental policies, primarily NEPA and the F&W Coordination Act (EIS, Section 1.3), Structural and nonstructural measures are planned to offset or ameliorate (mitigate) project impacts to natural resources. The following parts of this Appendix are concerning these measures.

The first part explains the Corps' basic mitigation recommendations. These recommendations are still subject to modification per significant public interest, but presently reflect the Corps' intentions pursuant to the guidance of NEPA and other environmental authorities.

The second part is a discussion, provided by the investigators of natural resources at the Big River Site (Normandeau Associates), of detailed wildlife mitigation techniques applicable to the Big River area.

The third part is the U.S. Fish and Wildlife Service's Coordination Report. This report provides the results of an evaluation of the wildlife habitat at the Big River area and recommendations for mitigation from the U.S. Fish & Wildlife Service perspective.

The primary differences between the Corps recommended plan and USFWS recommendations is that the Corps favors less land acquisition, but greater enhancement of those resources acquired in the original land takings. The Fish & Wildlife Service recommends purchasing approximately 12,000 acres of land in addition to that necessary for the reservoir with more subtle improvements thereon to offset wildlife losses due to inundation. The Corps recommendation differs from FWS's for the following general reasons.

(1) The 8600 acres already purchased represent a major loss of privately owned open land in the State of Rhode Island - particularly significant to the towns affected. The public has expressed significant concern for the need for "extra" land takings. The Corps recommends multiple use of all lands purchased with more intensive enhancement to mitigate losses, rather than extensive land purchase, with subtle enhancement.

(2) The Corps recommends the creation of several subimpoundments in shallow coves that would be formed by inundation of the Big River Site. Such subimpoundments could be constructed and operated in a manner to

create ideal habitats for many of the wildlife species impacted by inundation of wetlands by the project. The FWS report does not adequately consider this aspect of the plan, nor its significance in habitat enhancement.

(3) The Corps recommends reservoir fisheries habitat enhancement and utilization. The benefits of such measures are not considered by FWS toward mitigation of Fish and Wildlife losses. The Corps feels such benefits, though costly, are significant and offset many of the Fish and Wildlife values lost due to inundation by reservoir construction.

In summary, the Corps plan is intended to balance Economic, Social, and Environmental values, needs and opportunities presented by the proposed Big River Reservoir development to achieve a final product that is in the best interest of the people of Rhode Island. Fish and Wildlfe do receive priority in mitigation planning, but not at the expense of unnecessary social and economic impacts of extensive land acquisition.

PRELIMINARY GENERAL RESOURCE MANAGEMENT PLAN

FOR

BIG RIVER RESERVOIR

Introduction.

This plan contains specific and general recommendations for establishing and maintaining resource management and enhancement measures at the proposed Big River Reservoir area. Emphasis is on fish and wildlife habitat management for mitigating impacts that would occur to the existing resources. Most of the recommendations are structural and administrative measures to be incorporated into construction and post construction activities. Principle background information for much of this plan comes from "Mitigation of Wildlife at Big River Reservoir Project, Rhode Island" (Contract #DACW33-78-0362, Normandeau Associates, Inc., infra), consultation with R.I. Department of Fish and Game, and other sources.

The scope of this plan is limited to briefly describing proposed measures and identifying locations within the project area for execution of these measures. Detailed plans for application of the recommended activities would be studied and addressed in Advanced Engineering and Design Studies if the project is authorized. These efforts would be closely coordinated with the R.I. Department of Fish and Game to ensure their interests, needs, and plans are sufficiently considered. It is recommended that they become the managing agency of the resources described of hereafter once the project is completed.

Fisheries.

The reservoir would incorporate multi-level intakes to provide discharge temperatures similar to existing temperatures downstream in Flat River Reservoir and to create a reasonably stable hypolimnion in Big River Reservoir. Removal of vegetation and organic material from the pool would be selective. There are sites where standing trees, brush and stumps would provide cover for fish and wildlife. Detailed plans for such should consider trade-offs among water quality, trash accumulation and visitor safety. Slash from vegetation removal operations along with boulders and stones from construction sites would be used to create cover and possibly spawning sites for both cold and warm water fish in selected locations throughout the reservoir.

Stripping the organic material from low pool elevations would decrease the dissolved oxygen losses in the hypolimnion due to decomposition reactions; however, the costs of stripping the entire reservoir pool might exceed benefits of establishing a cold water fishery maintained by stocking. Proposed plans for removal of organic material included analysis of the following options: strip the entire pool, strip only the pool north of I-95, strip the north pool plus selected sites in the south pool, strip only selected sites throughout the entire pool, and no stripping. Organic soil would also be useful to reclaim the strip mine area, create wetlands in the subimpoundments, and other areas (Figure 1).

Stripping the north pool plus selected sites in the south pool appears to be a good compromise for high water quality and sport fisheries. The steepsided north pool would then contain a deep, clear, well oxygenated reservoir connected to the south pool hypolimnion by a narrow culvert beneath I-95. This creates, in effect, two reservoirs, each with different management potentials. If the north pool is stripped of organic material, a habitat suitable in cold water fisheries would exist in this portion of the reservoir year-round. One preferred stripping site in the south pool is the deep bay adjacent to the Nooseneck River. This site would provide excellent habitat for salmonides and smallmouth bass if properly prepared. The rest of the reservoir is shallow, open to wind action, contains more organic material and is probably not cost effective to attempt to provide a year-round cold water fishery habitat as is more readily attainable in the coves just described.

Recommended species to be stocked include: rainbow trout, brown trout, smallmouth bass, and crappie. Largemouth bass, pickerel and forage species are present in the watershed, and are capable of establishing themselves in the reservoir pool. Smallmouth bass will require rock and gravel areas to maintain natural reproduction. The choice of rainbow trout in addition to brown trout is based on the "catchability" of the two species. Brown trout are probably better suited for Big River Reservoir, but angler success for this species is usually low. Rainbow trout will tolerate relatively warm water and provide satisfactory recreation benefits. All populations should be monitored to determine post construction management requirements. Establishment of a variety of habitats should be considered before addressing stocking requirements.

Wildlife

There are three major components for wildlife management in the reservoir area: prepare and implement a detailed forest management plan; reclaim and manage the surface mining sites; build and manage subimpoundments for wetland habitats. These components incorporate many of the techniques and recommendations found elsewhere in Volume IV, Appendix H and in the literature.

Forest Management:

Direction for terrestrial habitat management activities would be best provided in a comprehensive forest management plan. Most of the terrestrial habitat around the reservoir site is forestland with other types interspersed. Construction of the project would include service roads, gates, fire breaks and clearings specified in the plan. These items are necessary for access by service personnel and visitors as well as for creating and maintaining diversified habitats and protecting the reservoir area from wildfire and misuse. The plan would be prepared cooperatively by Rhode Island resource management agencies and the Corps of Engineers prior to construction.

Promotion of natural regeneration through manipulation of existing cover types is preferrable to large scale plantings due to high costs of the latter. The plan would identify sites for improving existing stands for wildlife and timber by thinning, pruning and prescribed burns. Standard procedures for protection and creation of den trees, mast trees, snags, low cover and brush piles would be incorporated in stand evaluations and implemented under field supervision by a forester or his representative. Priorities for planting would be specified in the plan. Service roads, skidder trails, log landings and other existing openings would be limed and fertilized if necessary, and seeded to grasses and legumes. Additional clearings would be constructed away from roads to discourage poaching and "road hunting." In particular, one or two large clearings or isolated pennisulas would create Canada Geese habitat which does not presently exist at the Big River area. Such a measure is recommended by the R.I. Department of Fish & Game.

Sites for planting shrubs and trees would also be identified in the plan and priorities set for implementation based on site characteristics, habitat requirements and area management guidelines. For examples, fruit bearing shrub plantings on fertile soil near the public recreation area would have higher priority than plantings on poor soil in an area with sufficient existing mast crops. In areas prescribed for hunting, enhancement of "game" species habitat would receive priority, while near nature trails, enhancement of songbirds and other non-game species of aesthetic interest would prevail.

There are portions of the reservoir which have potential for a program of prescribed burns to increase the carrying capacity of existing habitats. For example, a peninsula would benefit from a grid of fire breaks and a burning schedule to promote vigorous browse and production on alternating blocks, with minimal danger of wildlife spreading to other areas.

Reclamation of Surface Mining Areas

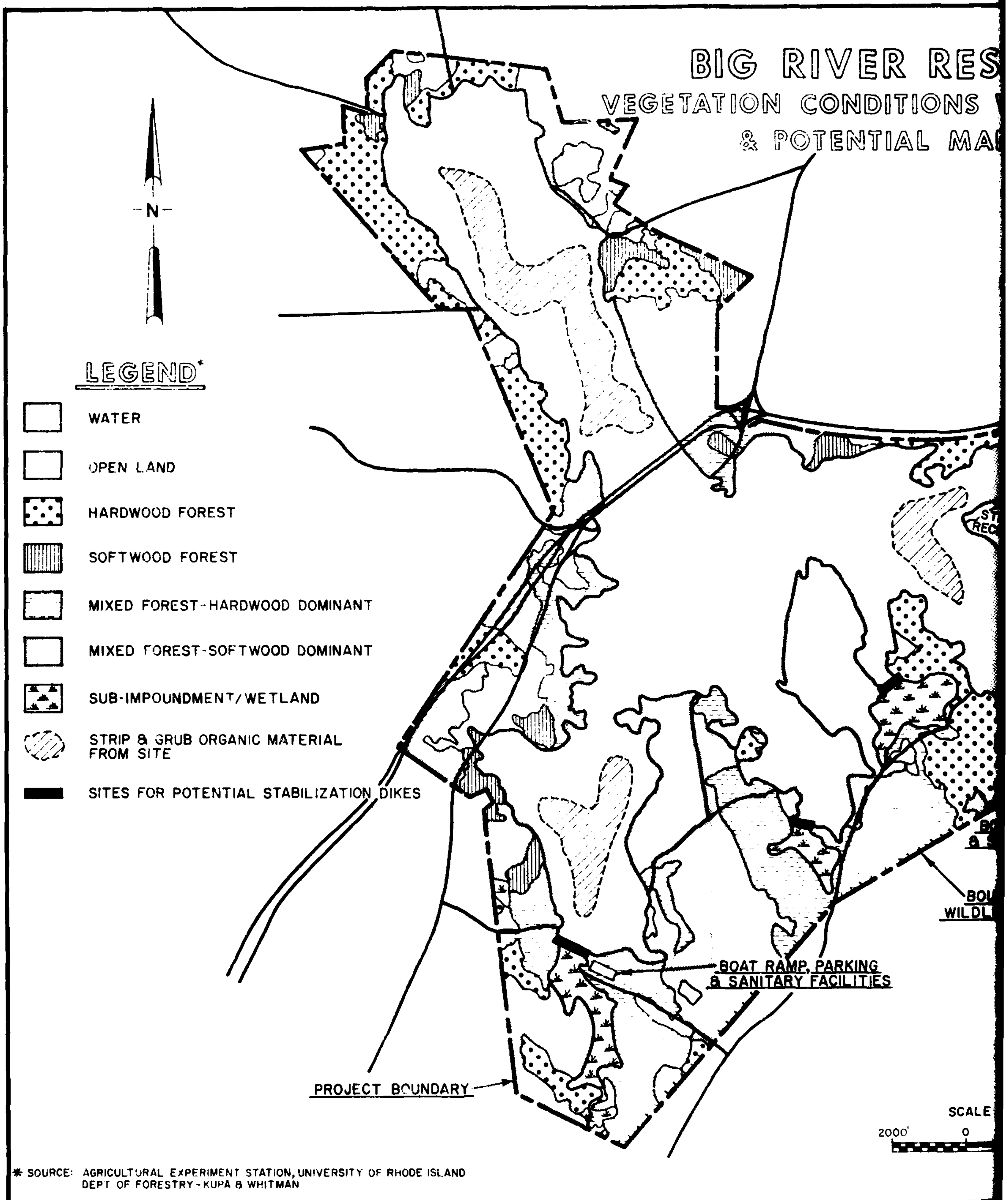
Reclamation of an active gravel mining operation (Figure 1) would significantly enhance major habitat requirements. Basic elements of the reclamation process are: sculpture the topography, distribute organic surface soils, stabilize the area with vegetation and structures as needed, monitor establishment of cover and manage according to plan guidelines.

This area has high potential for creating a diverse habitat of herbaceous and shrub vegetation. Proper control of topography and vegetation patterns would provide habitat for many animal species. Trails and observation areas would provide maximum non-consumptive recreational use of the wildlife resource. Hedgerows of deciduous and coniferous species would provide cover and food within the area. The terrain would lend itself to the operation of machinery and the use of prescribed burning to maintain the vegetation patterns.

Subimpoundments

The significant loss of wetland would be mitigated by creation of subimpoundments in portions of the south pool. Evaluation characteristics by NED personnel resulted in preliminary selection of four areas for subimpoundments and establishing emergent wetland vegetation. The four recommended sites (Figure 2) show a high to moderate potential for establishing and maintaining wetland vegetation by means of dikes, water control structures, and limited plantings of desirable plant species. A detailed analysis of each site with specific modifications would be included in advanced studies if the project is authorized. Details to be addressed in these studies include, but are not limited to: soils, effects on hydrology and water quality, schedules and techniques for manipulating water levels, accessibility, desirable vegetation characteristics and wildlife propagation and control.

Associated shoreline management for the entire reservoir should be addressed in further studies. There are opportunities to improve wildlife habitat at reservoirs with seasonal water fluctuations. Creating islands, leaving some standing timber in shallow areas and planting food crops such as millet on exposed mud flats would be integrated into reservoir construction and operation plans.


BIG RIVER RES
VEGETATION CONDITIONS
& POTENTIAL MA
N
LEGEND*
WATER
OPEN LAND
HARDWOOD FOREST
SOFTWOOD FOREST
MIXED FOREST-HARDWOOD DOMINANT
MIXED FOREST-SOFTWOOD DOMINANT
SUB-IMPOUNDMENT/WETLAND
STRIP & GRUB ORGANIC MATERIAL FROM SITE
SITES FOR POTENTIAL STABILIZATION DIKES
BOAT RAMP, PARKING & SANITARY FACILITIES
PROJECT BOUNDARY
SCALE
2000'
0
* SOURCE: AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF RHODE ISLAND
DEPT. OF FORESTRY - KUPA & WHITMAN

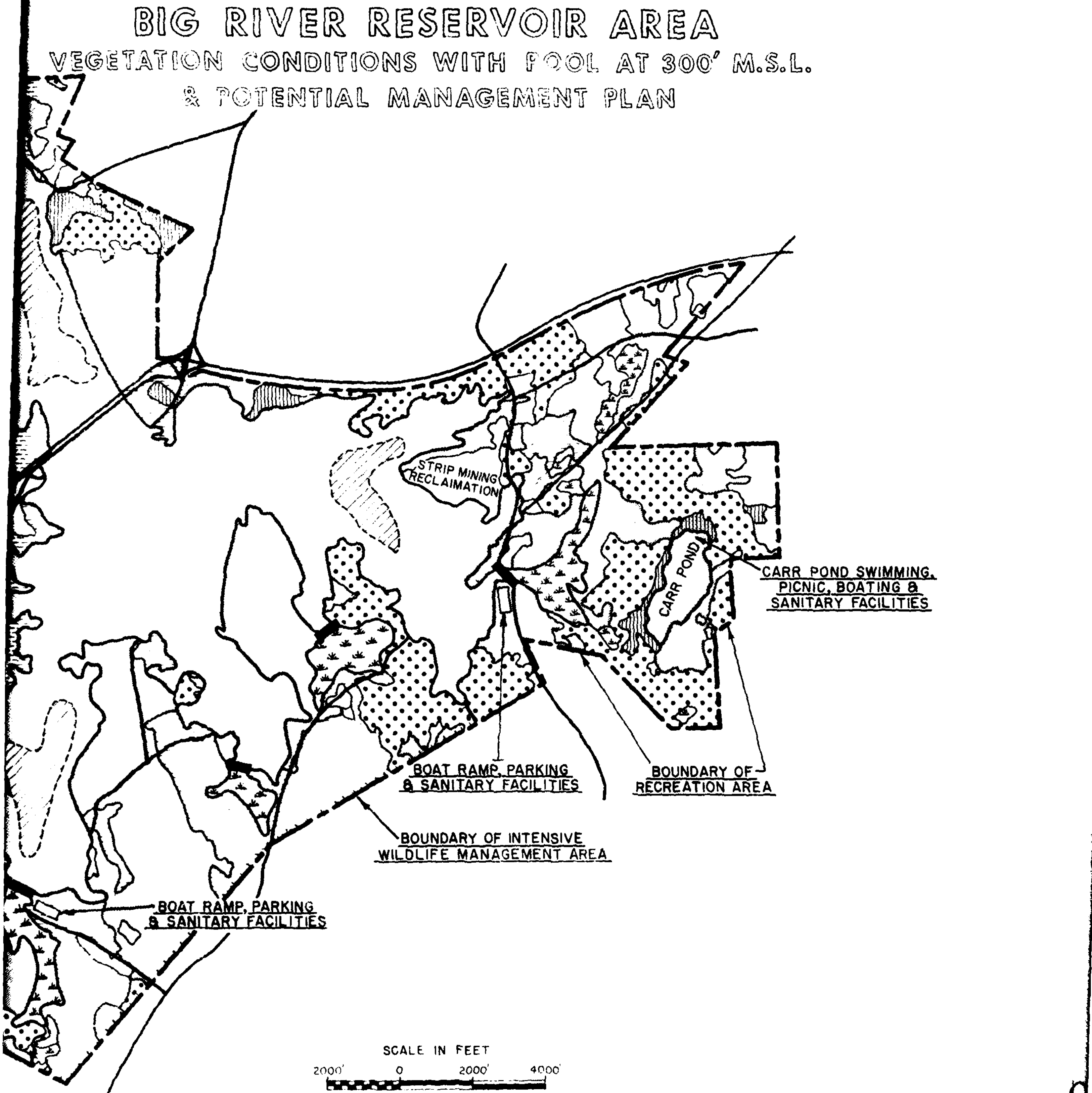

BIG RIVER RESERVOIR AREA
VEGETATION CONDITIONS WITH POOL AT 300' M.S.L.
& POTENTIAL MANAGEMENT PLAN
STRIP MINING RECLAIMATION
CARR POND
CARR POND SWIMMING, PICNIC, BOATING & SANITARY FACILITIES
BOAT RAMP, PARKING & SANITARY FACILITIES
BOUNDARY OF RECREATION AREA
BOUNDARY OF INTENSIVE WILDLIFE MANAGEMENT AREA
BOAT RAMP, PARKING & SANITARY FACILITIES
SCALE IN FEET
2000' 0 2000' 4000'

FIGURE 2

MITIGATION OF WILDLIFE AT THE BIG RIVER RESERVOIR PROJECT, RHODE ISLAND

Prepared for

NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS
CONTRACT #DACW 3-78-C-0362

by

NORMANDEAU ASSOCIATES, INC.
Bedford, New Hampshire

PRINCIPAL CONTRIBUTORS:

Michael M. Grubb
Dennis W. Magee

JUNE 1979

TABLE OF CONTENTS

LIST OF TABLES

AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2

BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)

JUL 81

UNCLASSIFIED NL

5 of 9

AD
A105822

BIG RIVER WILDLIFE MITIGATION PLAN

1.0 INTRODUCTION

Construction of the Big River Reservoir and flooding of approximately 3100 acres of wildlife habitat will reduce the total wildlife population in Rhode Island. This impact may be partially mitigated by increasing the carrying capacity of the surrounding areas, thereby permitting survival of some of the wildlife displaced by the reservoir. This increase in wildlife carrying capacity is accomplished primarily through habitat management of the surrounding upland areas.

In addition, the Big River Reservoir will flood 560 acres of wetlands, yet will also allow for creation of other wetland areas. This can be accomplished through construction of dikes in the upper reaches of the reservoir, thereby stabilizing water levels behind the dikes and permitting aquatic plants to become established.

2.0 METHODS

A literature search was conducted to document techniques, rationale and success of habitat management practices. Wildlife biologists then conducted a field reconnaissance of 26 representative sites within the project boundaries of which six were hardwood forest, five softwood forest, nine mixed forest and six open areas. In addition, six sites within the proposed reservoir were inspected to determine the feasibility of wetland creation through water level stabilization techniques. At each area, presence or absence of important habitat components were noted and recommendations made as to appropriate techniques to improve the area as wildlife habitat.

The Corps of Engineers has designated three general areas within the project boundaries for three different purposes: hunting, other recreational use (picnicking, camping, hiking, etc.) and establishing a wildlife sanctuary. To be compatible with this, management techniques have been directed towards 1) game species in the area designated for hunting, 2) songbirds, cottontail rabbits[1], white-tailed deer and other species enjoyed for aesthetic reasons in the recreational area, and 3) overall wildlife species diversity in the sanctuary.

Cost estimates for various mitigation operations (Table 1) were obtained through the Rhode Island Division of Fish and Wildlife and the Massachusetts Agricultural Extension Service. Cost of nursery stock and seed was obtained through nurseries in Massachusetts and consulting seed and plant catalogues. Due to the great variability in factors such as planting conditions, seed and stock order sizes, etc., the listed costs are approximations.

3.0 RESULTS AND DISCUSSION

3.1 GENERAL TECHNIQUES

All wildlife require food, cover and water for survival. As water is not a limiting factor to wildlife populations in the northeast, management techniques are geared toward increasing the amount of food and cover available for wildlife use.

A second principle that must be considered is the edge effect; when two different habitat types meet and blend together, an ecotone is created. The diversity and number of organisms is often greater in an ecotone than in the surrounding areas (Leopold, 1933). Hunt (1971) expanded on this principle and stated the key to habitat improvement is the maximum diversity and interspersion of vegetative growth. This

---

[1] For scientific names of species mentioned in text, refer to Appendix I.

TABLE 1. ESTIMATED COSTS TO IMPLEMENT BIG RIVER WILDLIFE MITIGATION PLAN.

PRACTICE	AVERAGE COST PER ACRE
Clearcut and pile brush	$ 75.00
Clearcut and burn brush	100.00
Controlled burning	40.00
Hydroax (for shrubs and saplings)	34.00
Create grass fields and food plots, prepare and seed old roads	450.00
Create softwood cover from seed (white pine)	300.00
Create softwood cover from nursery stock (white pine)	4,000.00
Create a stand of fruit bearing trees and shrubs from seed	550.00
Create a stand of fruit bearing trees and shrubs from nursery stock	4,000.00
Create a stand of aspen from seed	400.00
Plant sago pondweed	150.00
Plant duck potato	150.00
Plant wild millet	300.00
Plant three-square bulrush	150.00
Plant burreed	150.00

principle is illustrated in studies concerning white-tailed deer by McCaffery and Creed (1969), for ruffed grouse by Jordan and Sharp (1967), for snowshoe hare by Brocke (1975) and for songbirds by Schemnitz (1974).

Finally, the structural diversity of existing vegetation is an important consideration. Areas containing low growing shrubs, saplings and mature trees are generally more valuable than monotypic habitat types. Gill *et al.* (1974) considered life form of vegetation more important in songbird management than the plant species present.

3.1.1 Clear Cutting

To create habitat diversity and interspersion in forested areas, clear cutting is used to create forest openings. These openings are an essential component of forest wildlife habitat (Larson, 1967). Logging, burning and/or bulldozing can be used to create openings of one to five acres; such small openings are reported in the literature to be most utilized by wildlife (McCaffery and Creed, 1969; Shemnitz, 1974; USFS, 1974). However, Jim Myers, Rhode Island Division of Fish and Wildlife, believes clearings of 20 to 50 acres or larger to have even more beneficial impact on wildlife populations (personal communication, 1979). The narrowest dimension of the openings should be two to three times the height of surrounding trees (Hunt, 1971) to insure adequate sunlight can reach the ground. Irregularly shaped openings provide more edge and hence are more valuable than regularly shaped (circles, etc.) openings. From 10% to 20% of the total forest area should be cleared, leaving forested areas between the clearings to provide cover and habitat for all wildlife and for those species, such as grey squirrels, which require unbroken forest stands.

Once these forest openings are created, they can be allowed to undergo natural plant succession. Such openings will benefit these wildlife species which prefer the various successional stages (Odum, 1950). After a period of 10-15 years, the value of the openings will diminish and another clearing will be required. Shaw and Ripley (1965) recommend clear cutting 25% of an area every 20 years to provide adequate browse for deer while still maintaining areas of mature forest. This would yield a forest of staggered age classes interspersed throughout the area.

3.1.2 Thinning of Forest Overstory

Another method for improving habitat diversity, vegetative interspersion and production of wildlife food plants is to reduce the density of the forest overstory in the vicinity of fruit-bearing shrub species such as blackberries, huckleberries, lowbush blueberries and wild apple trees. This will afford more light penetration to the understory and stimulate fruit production in these species. Moreover, the patches of shrub growth scattered throughout the forest will greatly enhance diversity and interspersion which will benefit numerous wildlife species, including songbirds (MacArthur and MacArthur, 1961). The number of trees which should be removed in a given area is governed by the density of the overstory and characteristics of the shrub growth. Generally, thinning should be conducted in the fall so as not to interfere with nesting and rearing of the young; the thinning should result in a 50%-75% canopy closure (Gill *et al.*, 1974). In areas where more vigorous shrub growth is desired, canopy closure should be further reduced. Thinnings can be conducted using a chain saw to remove the trees or by girdling.

3.1.3 Release Thinnings of Mast-Bearing Trees

Production of acorns and nuts from oaks and hickory can be improved through release of potentially productive trees from competition. This practice will benefit many wildlife species which utilize mast as a food source, including white-tailed deer, gray squirrels, eastern chipmunks, raccoons and bluejays (Martin *et al.*, 1951).

The trees selected for release should be larger and more vigorous than surrounding trees and generally be at least 12" dbh. An opening should be made around each seed tree by measuring its diameter at breast height, multiplying by three, and then substituting feet for inches. This figure is the length of each side of a square from which all trees are to be removed except the mast tree to be favored. Such an opening will give the tree an opportunity to produce more mast and also allow increased production of fruit-bearing shrubs and browse. The opening can be created by removing competing trees with a chain saw.

3.1.4 Snag Management

When conducting clearing operations, consideration must be given to snag management. Snags are dead or dying trees of sufficient size to produce cavities. These nesting cavities are used by many species of birds and mammals including woodpeckers, black-capped chickadees, wood ducks, grey squirrels and raccoons. In addition, snags are infested by insects which are utilized as an avian food source. Snags also provide perching areas for songbirds and raptors. McClelland and Frissel (1975) found dead paper birches to be an important nesting area for songbirds and also found eastern bluebirds nesting in snags in forest clearcuts. Cavity nesting bird populations declined 52% when conifer snags were removed from mixed forest habitat during timber harvest while populations of these birds increased 23% when the snags were left (Scott, 1979). Rows of snags left in forest clearings have been utilized by roosting doves in Rhode Island (Jim Myers, personal communication, 1979).

Snags should be left at the rate of one to two per acre (Gillam, 1973; Gale *et al.*, 1973). When snags are absent, they can be created by girdling trees and cutting off the tops.

3.1.5 Creation of Abandoned Fields

Habitat diversity, edge and overall wildlife carrying capacity may be increased in a forested area by creating openings vegetated by grasses and forbs. These areas are a different habitat component from forest openings as they are seeded to grasses and maintained in an early successional stage. Such areas provide important habitat for open country wildlife such as kestrels, bobolinks, and cottontail rabbits.

After cutting the trees on a strip or in a patch, all stumps should be removed with a bulldozer and the plot plowed. It is best to test the soil in order to determine the optimal application rates for lime and fertilizer. However, as a general guideline, lime and commercial fertilizer can be added at rates of 1500 and 300 pounds per acre, respectively, followed by harrowing. A mixture of the seeds of grass and forb species typically occurring in abandoned fields, such as fescue, timothy, clover, and orchard grass should be broadcast at a rate of 30-40 pounds per acre, lightly covered and packed in with a bulldozer. These areas should be mowed periodically with a rotary mower to prevent invasion by woody species. Lime and fertilizer should be added periodically, at lower application rates than used initially, to maintain the planting.

3.1.6 Seeding Abandoned Roads

Abandoned dirt roads contribute substantially to the habitat diversity of an area, particularly where forests are the dominant surrounding cover. The edge effect created by the road both improves the surrounding habitat and introduces another habitat component. Habitat diversity and wildlife carrying capacity can be further improved by planting grass and clover mixtures along these roads. These areas will be grazed by deer, rabbits and small mammals and will attract ruffed grouse and songbirds to feed on the insects living in the grasses.

Since most woodland roads are narrow and likely to be quite shaded, the planting should consist of shade-tolerant species such as red fescue, perennial ryegrass and crownvetch. The seedbed should be prepared, limed and fertilized as for abandoned fields. The seeds should then be broadcast at a rate of 30-40 pounds per acre, lightly covered and packed. This seeding should be maintained by periodic mowing with a rotary motor to prevent invasion of woody species.

3.1.7 Plantings

3.1.7.1 Terrestrial Food Plots

The wildlife carrying capacity of an area can also be improved by planting crops in openings created in forest stands. These crops provide food for and benefit species such as bobwhite quail, mourning doves, ring necked pheasants, raccoons and white-tailed deer as well as a variety of small mammals and songbirds.

The food plots should contain a crop mixture which will attract a variety of game and non-game wildlife species and provide food throughout the year. The strips or patches should be cleared and the site prepared, limed and fertilized in the same manner as for creating abandoned fields. Crops should then be sown as in normal agricultural practices, in narrow, parallel strips; the strips are widened each year for several seasons, allowing strips planted in former years to lie fallow. The total area planted should be approximately one-half acre to one acre in size. A good mixture would include field corn, buckwheat, millet, soybeans and perennial ryegrass. The amounts that should be planted on each half acre area are:

Field corn	5.0 lbs
Buckwheat	1.0 lb
Millet	1.5 lbs
Soybeans	1.5 lbs
Perennial Ryegrass	1.0 lb
	10.0 lbs

3.1.7.2 Fruit Bearing Trees and Shrubs

Another method by which habitat diversity and wildlife carrying capacity can be increased is by establishing fruit bearing woody plants in woodland openings or artificially-created meadows. Some of the most beneficial species from the standpoint of providing both food and cover are autumn olive, highbush cranberry, gray dogwood, crab apple and grape. These fruits benefit a wide variety of wildlife, including ruffed grouse, white-tailed deer and many song-birds and small mammals (Martin *et al.*, 1951).

To establish plantings of such species the site should be cleared and then plowed. Lime and fertilizer should then be added at rates of 1500 and 300 pounds per acre, respectively, and then harrowed. Seed should be broadcast along strips four feet wide at a rate of about one pound per 100 square feet, lightly covered and packed. Alternatively, seed can be drilled along a row with a garden seeder, or one to two year old seedlings can be planted along a shallow furrow or in separate holes. If the latter method is used, the lime and fertilizer can be mixed with the soil in the vicinity of each seeding. Each species should be established in a separate row or strip near the center or along the perimeter of an opening.

3.1.7.3 Aspen Plantings

Big tooth and trembling aspens are two of the most valuable tree species for wildlife, particularly deer and ruffed grouse (Martin *et al.*, 1951). Both wildlife species utilize aspen stands as cover and in feeding, making use of the buds, leaves and young twigs. Stands which contain several different developmental stages (suckers, saplings and mature trees) satisfy a broad range of requirements of deer and grouse (Gullion, 1972).

To establish patches of aspen in forest stands, strips at least 60 feet wide and occupying up to five acres must be cleared and the stumps removed. Although the aspens tend to be early successional species that often colonize woodland openings naturally, seed should be broadcast uniformly over the plot for best success along with 1500 pounds of lime and 300 pounds of commercial fertilizer per acre, lightly covered, and packed or raked in. To provide a distribution of age classes, 10% of the stands should be cut every 10 years (Berner and Gysel, 1969; Moulton, 1968).

3.1.8 Creation of Cover

3.1.8.1 Softwood Cover

In addition to thickets and hedgerows, cover provided by softwoods is an important habitat component (Hunt, 1971). The evergreen nature of softwood provides dense winter cover and shelter from cold winds, rain and snow. Brocke (1975) showed the importance of low growing conifers (less than 11.5 feet) as base cover for snowshoe hare.

To create this cover, hemlocks may by planted at 10 foot intervals in patches 100 feet wide and 300 feet long (Jordan and Sharp, 1967). An alternate and less expensive method is to clear the area and plant seeds. To create a hedge and low growth for songbirds and small mammals, the center stem of planted softwoods may be cut when the tree is 10 to 12 feet high. Species recommended for establishing softwood cover include eastern hemlock, red pine, Scotch pine, white pine, red cedar, Norway spruce and white spruce (Ferber, 1969). In stands of mature white pine, patches may be cut and allowed to revegetate naturally. The mature pines on the edges will seed in such areas.

3.1.8.2 Brush Piles

A technique to supplement existing cover is the creation of brush piles which greatly benefits wildlife requiring dense cover near the ground. Brush piles properly positioned in an open area or artificially-created abandoned field can greatly increase carrying capacity for these wildlife. Brush piles should be placed in a corner, along the edge, and/or in the center of an opening. Limbs, branches, small trees and other slash created in clearing an opening can be loosely piled in heaps or in rows up to 25 feet long, five feet wide and four feet high.

3.1.9 Nesting Structures

Species such as hairy woodpecker, downy woodpecker, eastern bluebirds and other songbirds are often limited by the availability of suitable nesting cavities. As a means of providing for or supplementing existing cavities, a variety of bird houses can be constructed and placed in the forest, meadow or forest clearing. The exact size, shape, habitat and location of these boxes will vary with the species for which it is intended. Boxes suitable for grey squirrels can also be installed.

Specifications and information on construction techniques and box placement are available from state agencies, conservation organizations and the literature. Representative examples appear in Appendix II.

3.1.10 Wetlands

3.1.10.1 Installation of Dikes

Reservoir construction often makes possible the creation of wetlands through placement of dikes in the upper reaches of the reservoir. These dikes stabilize water level, thereby encouraging the growth of aquatic plants. Wetlands thus created are utilized by a wide variety of wildlife, including waterfowl, wading birds, aquatic furbearers and amphibians.

Dikes or embankments should be designed so that destruction from erosion and overtopping do not occur during peak flows and at maximum high water. Foundation soils should be stable enough to support the dike. Unsuitable foundation soils should either be replaced or treated in a manner to improve stability. The core of the dike should be constructed of highly impervious and compacted soils to resist the passage of water. The slope should be sufficient both to bury the seep line and permit operation of maintenance equipment; in this connection a four to one slope is considered the minimum for maintenance because equipment cannot safely operate on steeper slopes.

On sites where suitable foundation and fill materials are limited, such fill may have to be transported from another area. If this is not economically feasible, it will be necessary to compensate for poor on-site materials in the design and construction techniques. However, under such conditions the initial construction cost and future maintenance costs will increase proportionally with the decrease in soil stability.

Spillways should be designed for maximum flexibility in controlling water levels, thereby providing for control under all flow, precipitation and reservoir level conditions.

3.1.10.2 Wetland Food Plots

Wetlands created by diking operations can be greatly enhanced as wildlife habitat by providing food and cover. Extensive areas of red maple swamp, for example, can be improved by cutting and removing patches of trees, thereby increasing light availability at the soil or water surface. Extensive patches of shrubs can be thinned in the same manner. Plantings of seed and fruit producing species can then be established at various depths and in configurations that will result in maximum vegetative interspersion. For most wildlife species and for waterfowl in particular, it is best to maintain a 50:50 ratio between open water and emergent vegetation, thus providing both food and cover. When managing for wood ducks, optimum habitat for nesting and rearing young should be 25% open water, 41% emergent vegetation, 30% shrub growth and 4% trees (McGilvrey, 1966).

Plantings of waterfowl food can also be used to improve habitat conditions. Valuable waterfowl food plants in the northeast include wild rice, bulrush, duck potato, pond weed and burreed (Kortright, 1942; Mendall, 1949, Martin *et al.*, 1951).

Wild millet seed can be planted along the banks of impounded areas at a seeding rate of 40 pounds per acre. The soil should be exposed by discing or plowing, the seed sown, and the area raked to lightly cover the seed. If the soil has poor fertility, it should be fertilized with up to 300 pounds per acre.

Three-square rush can be planted along the waters' edge in less than six inches of water by pushing new rootstocks into the soil at a rate of 500 per quarter acre. In addition to providing abundant food this plant also provides good cover. Duck potato can be planted in a strip below the rush in depths from 1 to 2-1/2 feet. Rootstocks can be planted by pushing them 2 inches into the mud at a rate of 500 per quarter acre. Sago pondweed, one of the best waterfowl foods available, can be planted in strips below the duck potato in depths of 2 to 3-1/2 feet at a rate of 500 tubers per one quarter acre. Each tuber should be weighted with an eight penny nail attached with a rubber band and dropped into the water.

With the exception of duck potato, the best times for planting are fall, before the water freezes or in spring. Duck potato is best planted in spring so that the plants can mature over summer and produce tubers by fall.

3.1.10.3 Nest Boxes

As in upland areas, artificial nesting boxes placed in wetlands can increase wildlife utilization of the area. In the northeast, this technique is directed primarily toward wood ducks, particularly in areas where natural nesting cavities are lacking.

Boxes should be placed over water or as close to water as possible and constructed to be predator proof. It is imperative that boxes be maintained every year as unmaintained boxes result in high hen and duckling mortality. Construction specifications are available in Bellrose *et al.* (1964), Webster and Uhler (1964) and Giles (1971). An example appears in Appendix III.

3.2 SPECIFIC RECOMMENDATIONS FOR THE BIG RIVER STUDY AREA

The recommendations discussed below were designed to correlate directly with the Corps of Engineers plans to divide the reservoir property area for three different uses, hunting in the wildlife management area, other outdoor recreation in the remaining portions of the reservoir area south of I-95 and a wildlife sanctuary north of I-95. Thus, habitat management is directed towards game species in the hunting areas, wildlife species pleasing to people (songbirds, etc.) in the recreational area and towards overall wildlife productivity and diversity in the sanctuary.

The numbers appearing in parentheses following the recommended techniques refer to the previous section of this report in which the mechanics of the techniques are discussed.

3.2.1 Hardwood Forests

The two main factors to be considered when designing management plans for hardwood forest areas are the abundance of mast producing trees and the presence or lack of low cover (less than five feet from ground level).

In areas where mast trees are abundant but low cover is absent (such as Areas H3 and H6 on Figure 1), it is recommended to clearcut strips and blocks (3.1.1). Snags should be left or created in random distribution throughout the area (3.1.4). These actions will allow sunlight to penetrate to the ground, creating a forest opening of low shrub growth as well as the edge between the two habitats, benefiting most wildlife species.

Habitats of this nature encountered in the wildlife management area can be further enhanced for such game species as ruffed grouse and white-tailed deer by planting softwoods around the edges of the clearings as well as in scattered clumps (3.1.8.1) and by plantings of fruit bearing shrubs and trees in the openings (3.1.7.2). When managing for songbirds in the recreation area, these plantings should be in close proximity to each other to create a thicket effect.

The above practices should be modified as necessary for different forest conditions. When mast trees are abundant but understory cover is present (as in Area H1 on Figure 1), clearcutting (3.1.1) should be conducted as described above but softwood cover need not be planted. When mast trees are present but not abundant (such as Areas H5 or H4 on Figure 1), clearcutting (3.1.1) and plantings (3.1.7.2) should be supplemented by release thinnings (3.1.3) of mast producing trees in the unclearcut areas. This will benefit white-tailed deer, grey squirrels and other wildlife which utilize this important food source.

3.2.2 Softwood Forest

The softwood forest stands in the Big River Study Area were generally lacking in both wildlife food and cover. The basic recommended technique to improve this situation is to clearcut in strips and blocks (3.1.1). The perimeter of these areas should then be neglected and will grow in to low, dense softwood cover. When managing for game species, fruit bearing shrubs and trees should be planted (3.1.7.2) in 50% of the areas, providing food for ruffed grouse; terrestrial food plots (3.1.7.1) should be planted in the remaining 50% as this will supply food for raccoons, white-tailed deer and gallinaceous birds. In the recreation area, clearcutting should be accompanied by plantings of fruit bearing shrubs and trees (3.1.7.2), this will benefit songbirds and cottontail rabbits. All of the above techniques are recommended for the sanctuary area, thereby creating a diversity of habitat types.

3.2.3 Mixed Forests

Mixed forests in the study area generally have naturally existing food and cover. Management plans, therefore, are geared towards increasing these components.

In areas where mast producing trees are present and cover (usually in the form of huckleberry, lowbush blueberry and greenbriar) are present (Areas M5 and M6), it is recommended to clearcut in blocks and strips (3.1.1) to create forest openings. To further improve these areas for game species, release thinnings (3.1.3) should be conducted in the forest area; the resulting increase in mast will benefit grey squirrels and white-tailed deer. Fruit bearing shrubs and trees (3.1.7.2) may also be planted in the openings, benefiting ruffed grouse.

In areas where mast trees are present but understory cover is lacking, (M2 and M3), the clearcut strips and patches should be planted in softwood cover (3.1.8.1), to benefit ruffed grouse, white-tailed deer and songbirds. Selective thinning of the forest will open up the canopy and allow softwood regeneration and increased growth of huckleberry, also increasing cover. Release thinning of mast bearing trees (3.1.3) supplemented with snag management (3.1.4) will also benefit grey squirrel and raccoon populations.

In areas where mast bearing trees are lacking (M7, M8 on Figure 1), the emphasis should be on providing wildlife food. This can be accomplished through clearcutting (3.1.1) and planting fruit bearing shrubs and trees (3.1.7.2).

3.2.4 Open Land

There are three basic open land habitat types in the study area: commercial sand pits, abandoned fields and pastures. These lands provide the opportunity to manage for wildlife species typical of open country, including those commonly referred to as "farm game".

Sand pit areas are almost entirely devoid of vegetation (Area 05 on map). The recommended management technique is to create an abandoned field situation (3.1.5) with emphasis on those plant species which will grow on sandy soils such as certain grasses and forbs. Cover should be created through the use of pitch pine and other conifers. Songbird nesting boxes placed on the edge of these areas will also increase wildlife utilization (3.1.9). The above techniques will attract cottontail rabbits, bobwhite quail and ring-necked pheasants.

In wildlife management areas, plantings of aspen cover (3.1.7.3) will attract ruffed grouse; terrestrial food plots (3.1.7.1) will further increase the value of the area for ring-necked pheasant and bobwhite quail.

Areas such as 02, 06, 03 and 01 on the map are currently in the abandoned field stage of succession. As such, cover is present in adequate amounts and management, therefore, is directed toward increasing food supplies. Plantings of terrestrial food plots (3.1.7.1) and of fruit bearing trees and shrubs (3.1.7.2) will attract a variety of wildlife, including bobwhite quail, ring-necked pheasants, white-tailed deer, ruffed grouse and songbirds. Utilization of the area by breeding songbirds may be increased by placement of nest boxes (3.1.9). Mowing of these areas every three to four years is recommended to prevent invasion of woody vegetation.

Other open areas (01 in Figure 1) are currently pasture or meadow. These areas are intermediate between sand pits and abandoned fields in that cover and food are present but not abundant. To increase these elements, a variety of management practices is recommended. Cover can be increased through establishment of softwood cover on the borders (3.1.8.1) and placement of brush piles (3.1.8.2) throughout the area. Food supplies may be increased through terrestrial food plots (3.1.7.1) and planting fruit bearing trees and shrubs (3.1.7.2). These practices will attract cottontail rabbits, bobwhite quail, and ring-necked pheasants. In the recreation areas, installation of nest boxes (3.1.9) may make the area more attractive to songbirds.

3.2.5 Roads to be Abandoned

Portions of Sweet Sawmill and Burnt Sawmill roads outside of the flooded area will be abandoned. Seedings of these roads (3.1.6) will attract insects beneficial to songbirds as well as provide grass for white-tailed deer and other herbivores. It is also recommended that approximately 10% of the abandoned road be left unplanted. These areas should be distributed along the length of the road and preferably occur in areas of little or no shade. This will result in an area where mourning doves, ruffed grouse and many songbirds can obtain grit and take dust baths.

3.2.6 Wetlands

Six areas have been identified where dike construction could create a wetland area (Figure 2). Recommended management techniques for Areas W3, W4, W5 and W6 are identical. At these locations, all woody vegetation should be cleared and removed except for snags which will provide wood duck nesting habitat. Dikes should be constructed at the locations depicted in Figure 2 and following the guidelines in Section 3.1.10.1. The spillway elevation should be at 300 feet above MSL. It may be necessary to also install a variable gate, to allow the area behind the dike to fill as the reservoir fills. Following the flooding of the areas behind the dike, wetland food plantings (3.1.10.2) should be established and wood duck nesting structures placed in appropriate locations (3.1.10.3).

Wetland W1 on Figure 2 is presently a shrub growth area. Because of this it may be practical to burn the existing vegetation rather than clearcutting. Dike construction, placement of nest boxes and food planting should proceed as outlined above.

Wetland W2 is Tarbox Pond. This area is currently an excellent waterfowl area and as such should be maintained in its present state. The existing road bed and dike which form the pond should be raised to an elevation sufficient to maintain the current status of the pond. The existing wood duck boxes which were in very poor shape when inspected in August 1978, should be repaired and maintained.

LITERATURE CITED

Bellrose, F. C., K. L. Johnson and T. U. Meyers. 1964. Relative values of natural cavities and nesting houses for wood ducks. J. Wildl. Manage. 78(42):661-676.

Berner, A. and L. W. Gysel. 1969. Habitat analysis and management considerations for ruffed grouse for a multiple use area in Michigan. J. Wildl. Manage. 33:769-778.

Brocke, R. H. 1975. Preliminary guidelines for managing snowshoe hare habitat in the Adirondacks. Trans. 32nd N.E. Fish and Wildl. Conf. 20 pp.

Ferber, A. E. 1969. Windbreaks for conservation. U.S. Dept. Agric. Soil Conserv. Ser. Agric. Infor. Bull. 339. 29 pp.

Gale, R. M., W. F. Kelly and J. A. Lorenzana. 1973. Snag management. U.S. Dept. Agric. For. Serv. Coordination Guidelines for Wildlife Habitats, Number One. 11 pp.

Giles, R. H., Jr. (ed.). 1971. Wildlife management techniques. The Wildlife Society, Washington, D.C. 633 pp.

Gill, J. D., R. W. DeGraff and J. W. Thomas. 1974. Forest habitat management for non-game birds in central Appalachia. U.S. Dept. Agric. For. Serv. Res. Note NE-192. 6 pp.

Gillam, H. L. 1973. More wildlife on your property. Va. Comm. Game and Inland Fisheries. 28 pp.

Gullion, G. W. 1972. Improving your forested lands for ruffed grouse. Univ. Minn. Agric. Expt. Sta. Publ. No. 143. 34 pp.

Jordan, J. S. and W. M. Sharp. 1967. Seeding and planting hemlock for ruffed grouse cover. U.S. Dept. Agric. For. Serv. Res. Paper. NE-83. 17 pp.

Hunt, J. H. 1971. Improve your land for forest game. Maine Fish and Game - Spring 1971. 4 pp.

Kortright, F. H. 1942. The ducks, geese and swans of North America. Stackpole Books, Harrisburg, Pa. 476 pp.

Larson, J. S. 1967. Forests, wildlife and habitat management: a critical examination of practice and need. U.S. Dept. Agric. For. Serv. Res. Paper SE-30. 28 pp.

Leopold, A. 1933. Game management. Charles Scribner Sons, N. Y. 481 pp.

MacArthur, R. H. and J. W. MacArthur. 1961. On bird species and diversity. Ecol. 42:594-598.

Martin, A. C., H. S. Zim and A. L. Nelson. 1951. American wildlife and plants: a guide to wildlife food habits. Dover Publications, N. 500 pp.

McCaffery, K. R. and W. A. Creed. 1969. Significance of forest openings to deer in northern Wisconsin. Wis. Dept. Natur. Resour. Tech. Bull. No. 44. 104 pp.

McClelland, B. R. and S. S. Frissell. 1975. Identifying forest snags useful for hole nesting birds. J. For. 73:414-417.

McGilvrey, F. B. 1966. A guide to wood duck production habitat requirements. U.S. Dept. Interior Bur. Sport Fish. and Wildl. Resour. Pub. 60. 32 pp.

Mendall, H. L. 1949. Food habits in relation to black duck management in Maine. J. Wildl. Manage. 13(1):64-101.

Moulton, J. C. 1968. Ruffed grouse habitat requirements and management opportunities. Wisc. Dept. Natur. Resour. Res. Rept. No. 36. 32 pp.

Odum, E. P. 1950. Bird populations of the highlands plateau in relation to plant succession and avian invasion. Ecol. 31:587-605.

Schemnitz, S. D. 1974. Wildlife habitats and management in the boreal forests of northeastern United States and maritime Canada. Univ. Maine Life Sci. Agric. Expt. Sta. Misc. Rep. 154. 28 pp.

Scott, V. E. 1979. Bird response to snag removal in ponderosa pine. J. For. 77(1):26-28.

Shaw, S. P. and T. H. Ripley. 1965. Managing the forest for sustained yield of wood browse for deer. Proc. Soc. Amer. For. pp. 229-233.

Shomon, J. J. 1961. Birdlife of Virginia. Va. Comm. Game and Inland Fish. 88 pp.

U.S. Forest Service. 1974. Wildlife and patch cuts. Coordination Guidelines for Wildlife Habitats Number Four. U.S. For. Serv. Calif. Reg. 15 pp.

Webster, C. G. and F. M. Uhler. 1964. Improved nest structures for wood ducks. U.S. Dept. Inter. Bur. Sport Fish. and Wildl. Leaflet No. 458. 20 pp.

APPENDIX I.

SCIENTIFIC NAMES OF SPECIES MENTIONED IN THE TEXT

APPENDIX I. SCIENTIFIC NAMES OF SPECIES MENTIONED IN THE TEXT.

MAMMALS

COMMON NAME	SCIENTIFIC NAME
Raccoon	*Procyon lotor*
Eastern chipmunk	*Tamias striatus*
Grey squirrel	*Sciurus carolinensis*
Cottontail rabbit	*Sylvilagus floridanus*
	Sylvilagus transitionalis
Snowshoe hare	*Lepus americanus*
White-tailed deer	*Odocoileus virginiana*

BIRDS

COMMON NAME	SCIENTIFIC NAME
Wood duck	*Aix sponsa*
Kestrel	*Falco sparverius*
Ruffed grouse	*Bonasa umbellus*
Bobwhite quail	*Colinus virginianus*
Ring-necked pheasant	*Phasianus colchicus*
Mourning dove	*Zenaida macroura*
Hairy woodpecker	*Dendrocopos villosus*
Downy woodpecker	*Dendrocopos pubescens*
Blue jay	*Cyanocitta cristata*
Black-capped chickadee	*Parus antricapillus*
Eastern bluebird	*Sialia sialis*
Bobolink	*Dolichonyx oryzivorus*

(Continued)

APPENDIX I. (Continued)

PLANTS

COMMON NAME	SCIENTIFIC NAME
Norway spruce	*Picea abies*
White spruce	*P. glauca*
Canadian hemlock	*Tsuga canadensis*
White pine	*Pinus strobus*
Red pine	*P. resinosa*
Scotch pine	*P. sylvestris*
Red cedar	*Juniperus virginiana*
Bur-reed	*Sparganium americanum*
Pondweed	*Potamogeton pectinatus*
Duck-potato	*Sagittaria latifolia*
Red fescue	*Festuca rubra*
Orchard-grass	*Dactylus glomerata*
Wild rice	*Zizania aquatica*
Field corn	
Bulrush	*Scirpus americanus*
Trembling aspen	*Populus tremuloides*
Large-toothed Aspen	*P. grandidentata*
Hickory	*Carya* spp.
Paper birch	*Betula papyrifera*
Oak	*Quercus* spp.
Buckwheat	*Fagopyrum sagittatum*
Wild apple	*Malus pumila*
Crabapple	*M. baccata*
Blackberry	*Rubus* spp.
Clover	*Trifolium* spp.
Crown vetch	*Coronilla varia*
Soybean	*Glycine max*
Grape	*Vitis*
Autumn olive	*Elaeagnus*
Gray dogwood	*Cornus racemosa*
Huckleberry	*Gaylussacia frondosa*
Lowbush blueberry	*Vaccinium angustifolium*
Highbush cranberry	*Viburnum trilobum*

APPENDIX II.

EXAMPLES OF BIRD NEST BOX STRUCTURES.
FROM SHOMON, 1961; GILLAM, 1973.

TABLE NUMBER 1: Recommended Bird Houses

Species	Diameter of Interior (inches)	Depth from Entrance (inches)	Diameter of Entrance (inches)	Height from Ground (feet)
House wren	4½	8	1	8–18
Chickadee	4	8	1⅛	8–15
White-breasted nuthatch	4	9	1¼	12–20
Tufted titmouse	4	9	1¼	12–20
Tree swallow	4½	9	1½	8–30
Bluebird	5	9	1½	8–20
Crested flycatcher	6	11	2	15–40
Purple martin	6	7	2½	14–30
Flicker	7	7	1½	10–25
Sparrow hawk	7	7½	3⅛	20–40
Long-eared owl	8	8½	4	15–35
Robin	7	8	*	6–20
Wood duck	9½	13	5	15–35

* One side open.

Nesting Shelves

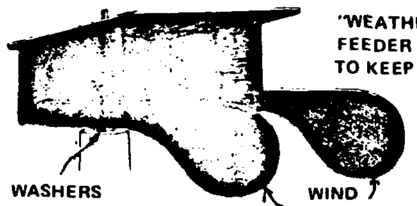
Species	Width (inches)	Length (inches)	Height from Ground (feet)
Phoebe	3½	7	8–20
Robin	5	7	8–30

There are dozens of practical, proven types of bird houses which are recommended. Wood houses are probably the best. The solid log sawed in halves, gouged, roofed and hinged, is a good one. Almost any hollowed log with a roof and a suitable opening can be made into a tempting bird house. Other recommended types are gourds, coconuts, wood nail kegs, wood packing boxes, and similar devices. Bird houses should be as natural as possible, and vivid painting should be avoided.

Bird homes should be so constructed that they will permit house cleaning at the end of the season. Birds, like humans, enjoy clean homes and will be more prone to occupy places that are attractive to them. A well-constructed bird house will always provide for some section to be easily removed so that old nests and trash can be cleaned out.

In choosing your bird homes, always remember that the simpler the construction the better. There are hundreds of different types of bird houses on the market, but one need not go to any expense if he has the tools, the material, and the interest to do his own construction.

The following diagrams show only a few of the more popular types of bird houses:



"WEATHER–VANE" FEEDER PIVOTS ON IRON ROD TO KEEP OPEN SIDE DOWNWIND.

WASHERS

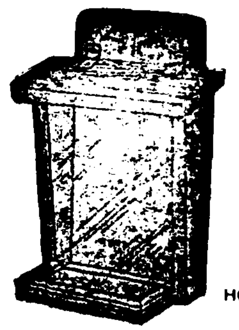
WIND VANES

HARDWARE CLOTH SUET HOLDER

SHORT LOG HUNG ON WIRE MAKES NATURAL FEEDER. PACK 1" HOLES WITH SUET, OR PEANUT BUTTER.

FEEDS AND PRIME CUSTOMERS

Suet . . . . .Woodpeckers, nuthatches
Sunflower seed . . . Cardinals, grosbeaks
Peanut butter . . Mockingbirds, creepers
Raisins . . . . . Mockingbirds, nuthatches
Chick scratch . . . . Sparrows, juncos
Table scraps . . . . . .Jays, mockingbirds
Cracked corn . . . . .Cardinals, doves
Bread . . . . Starlings, blackbirds
Cracked nuts . . . . .Chickadees, creepers
Commercial mix . . most of above except suet and raisen eaters.

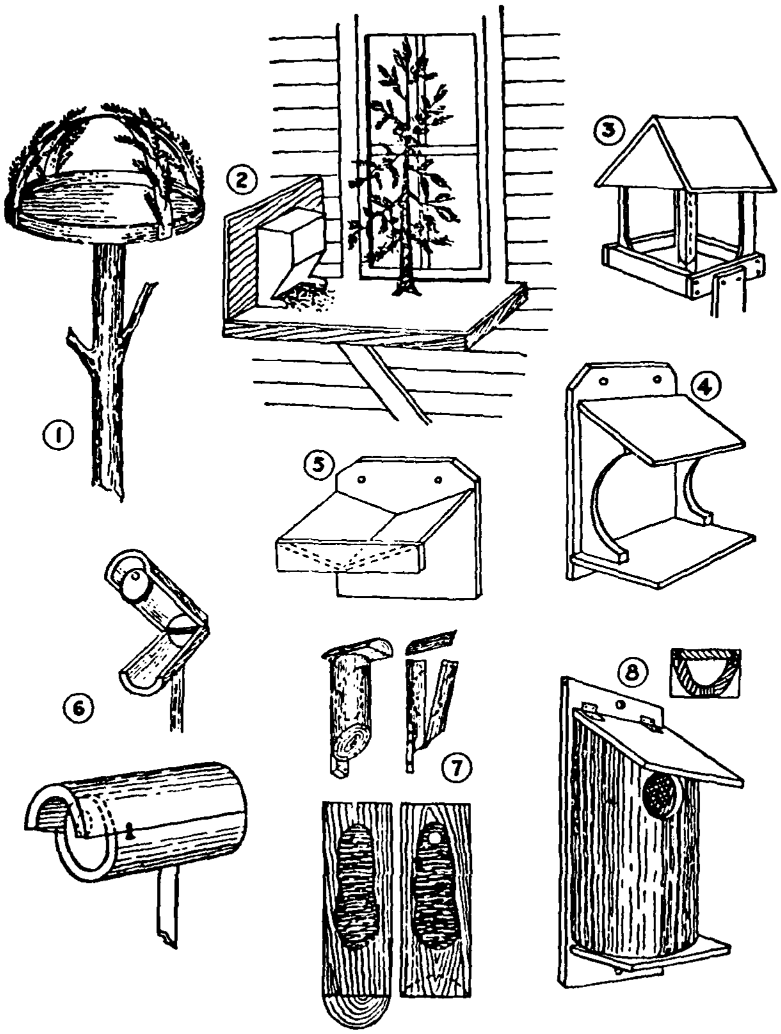


HOPPER TYPE–GLASS FRONT

NEST BOXES

	FLOOR OF CAVITY	DEPTH OF CAVITY	ENTRANCE ABOVE FLOOR	DIAMETER OF ENTRANCE	HEIGHT ABOVE GROUND
Bluebird	5 x 5	8	6	1 1/2	5-10
Chickadee	4 x 4	8-10	6-8	1 1/8	6-15
Titmouse	4 x 4	8-10	6-8	1 1/4	6-15
Nuthatch	4 x 4	8-10	6-8	1 1/4	12-20
House wren	4 x 4	6- 8	1-6	1	6-10
Carolina wren	4 x 4	6- 8	1-6	1 1/8	6-10
Tree swallow	5 x 5	6	1-5	1 1/2	10-15
Barn swallow	6 x 6	6			8-12
Purple martin	6 x 6	6		2 1/2	15-20
House finch	6 x 6	6	4	2	8-12
Starling	6 x 6	16-18	14-16	2	10-25
Crested flycatcher	6 x 6	8-10	6-8	2	8-20
Flicker	7 x 7	16-18	14-16	2	6-20
Red-headed woodpecker	6 x 6	12-15	9-12	2	12-20
Downy woodpecker	4 x 4	8-10	6-8	1 1/4	6-20
Hairy woodpecker	6 x 6	12-15	9-12	1 1/2	12-20
Screech owl	8 x 8	12-15	9-12	3	10-30
Saw-whet owl	6 x 6	10-12	8-10	2 1/2	12-20
Barn owl	10 x 18	15-18	4	6	12-18
Sparrow hawk	8 x 8	12-15	9-12	3	10-30
Wood duck	10 x18	10-15	3	6	4-20
Squirrel	7 x 7	10-18	16	2 1/2	10-30

When fastening nest boxes to living trees, use wires that will stretch to allow for tree growth.

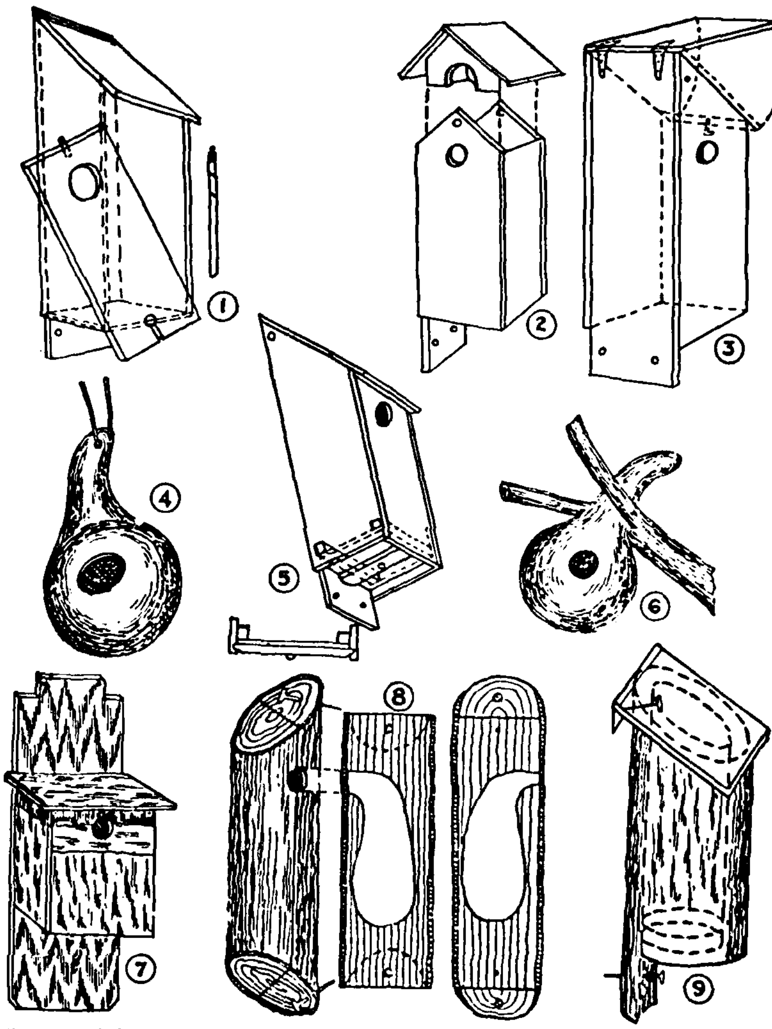


Courtesy Pennsylvania Game Commission

Recommended bird feeders, nest brackets, shelves, and nest boxes: 1. pole feeder for yard; 2. window sill feeder; 3., 4., 5. brackets and shelves for robins, phoebes; 6., 7., 8. nest boxes for wrens, bluebirds, etc.

scraps, and suet for the smaller birds; peanut butter for robins and chickadees.

Yellow corn is one of the few known complete foods -- whole corn for game birds such as turkeys and quail, and cracked corn for a host of other birds. It is one of the few foods on which certain birds can live without other foods and retain their body weight.

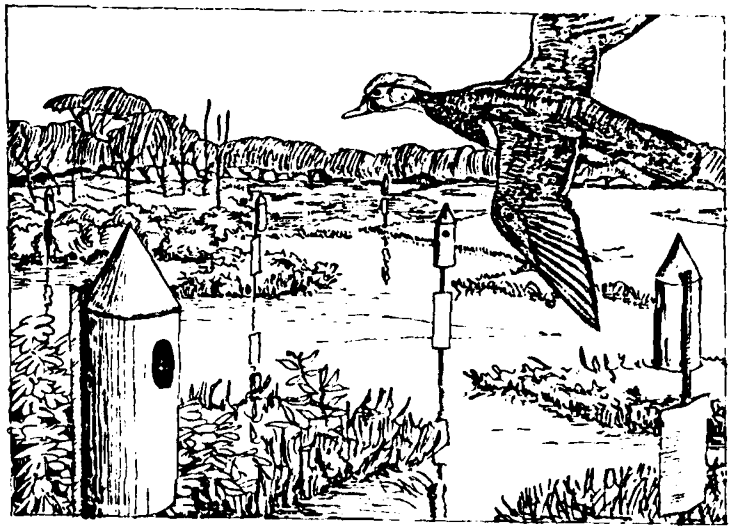


Courtesy U. S. D. A.

Some recommended bird homes: 1. swinging front nest box, held in place by pin and screws; 2. and 3. removable and hinged-top nest boxes; 4. common dried gourd suspended by wire will attract wrens; 5. removable bottom type home, released by the slight turn of a cleat; 6. stable gourd in tree fork; 7. simple hinged-top bluebird box; 8. cavity log type for chickadees, wrens, and nuthatches; 9. rough hollow log with roof.

APPENDIX III.

INFORMATION ON WOOD DUCK NEST BOXES.
FROM MCGILVREY, 1966; GILES, 1971.



NEST BOXES

Nest boxes, properly built, placed, predator-proofed, and maintained, can produce many more wood ducks per acre than natural cavities. The most important factors limiting wood duck production are lack of suitable cavities, predators, and competitor pressure on available cavities. These factors increase in importance as bottomland timber is removed. Also, as timber utilization and management intensify, overage trees that provide cavities are no longer available.

How to build and maintain nest boxes and predator guards will not be discussed in this manual. This has been done elsewhere, particularly by Webster and Uhler (1964) and Bellrose (1955).

BOX REQUIREMENTS

A well-built box should last 25 years or longer if made of cypress lumber, 26-gauge galvanized sheet metal, or aluminum. If it is desirable to erect less durable boxes (5 years or less), rough-cut pine or spruce lumber is satisfactory. Satisfactory boxes can be built for $5 or less for material and labor.

Boxes should be inspected each winter and needed repairs made. If annual maintenance is not possible, inspection should be made at least every third year. The less durable the material, the more often inspection is required.

When a nest box program is first started, acceptance by wood ducks is generally greater in wooden than in metal boxes. Once a population begins to use artificial structures, the type of box seems to make little or no difference, and other, more durable or more predator-proof materials can be used. There has been some concern that metal boxes may get so hot as to lower hatching success or increase desertion. This has not been found to be true.

Likewise, when a nest box program is first started, vertical boxes may receive greater acceptance than horizontal ones. Once a population accepts boxes, the shape appears to be immaterial.

Boxes should be 24 inches in length and 11 inches in diameter or 10 by 10 inches square inside. These are the recommended dimensions, although birds will sometimes use boxes as small as 18 inches in length and between 8 and 15 inches in diameter.

If predators cannot reach the box, the best entrance hole is a 4-inch-diameter circle. In areas where goldeneyes may nest, a 5-inch circular entrance is preferable. Where there is starling competition, horizontal boxes with

5- by 11-inch entrances may solve the problem. North of the Mason-Dixon Line, 3- by 4-inch elliptical entrances (3 vertical, 4 horizontal) will keep out most raccoons. This hole size is the minimum that will admit all wood duck hens. In the south, raccoons are smaller and cannot be excluded by this means. In vertical boxes the entrance should be placed so that the lower edge of the hole is 18 inches from the bottom of the box.

Wood ducks do not carry nesting material; therefore, it must be provided for them. Among the more desirable materials are wood shavings, a mixture of sawdust and shavings, shredded sugarcane, crabgrass hay, Spanish-moss (in the South), rotted wood, and ground corncobs. Nesting material should be provided to a depth of 3 to 5 inches. Whatever material is used should be porous and light and have good insulating qualities.

Young wood ducks leave the nest box shortly after hatching, usually within 24 hours. The young get out of the nest by a progressive series of upward leaps until the entrance is reached. From the entrance they jump to the ground or water below. The interior of the nest box therefore must provide the necessary toe holds for clinging to the site before the entrance is reached. This may be done by using rough-cut lumber for board boxes. In metal boxes, hardware cloth or screen approximately 4 inches or more wide, extending from the entrance to the nest basin, is satisfactory.

MOUNTING, PROTECTION, AND PLACEMENT OF BOXES

Where feasible, posts are the most suitable mounts for boxes because they are easier to predator-proof and can be placed where desired. It may be better to mount boxes on trees under certain situations, including--

1. Extreme water fluctuation (3 feet or more).

2. Depth of water too great.

3. A very soft, unstable bottom.

4. Extreme ice movement.

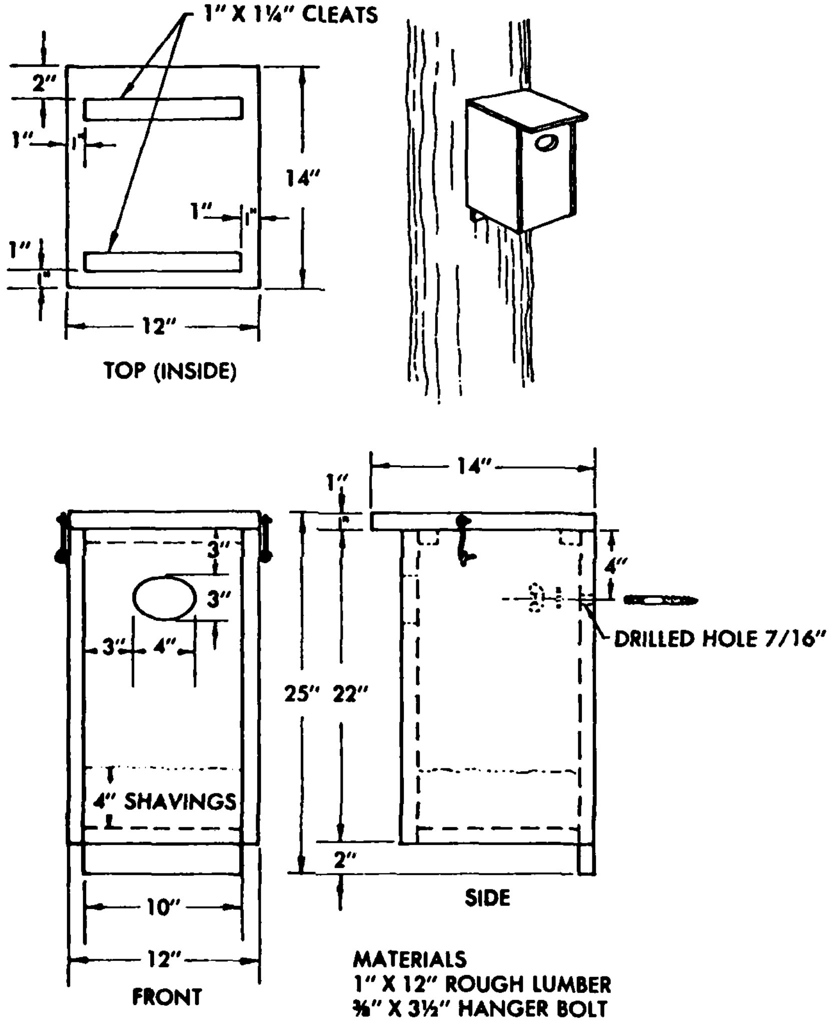
5. Economy.

The best height for boxes is 4 to 5 feet above the highwater mark where boxes are on posts over water. In the upland woods of Illinois, boxes placed on trees have greatest use when up about 45 feet, although they will be used when as low as 15 feet. The direction of the entrance is immaterial as long as it is easily visible to the ducks.

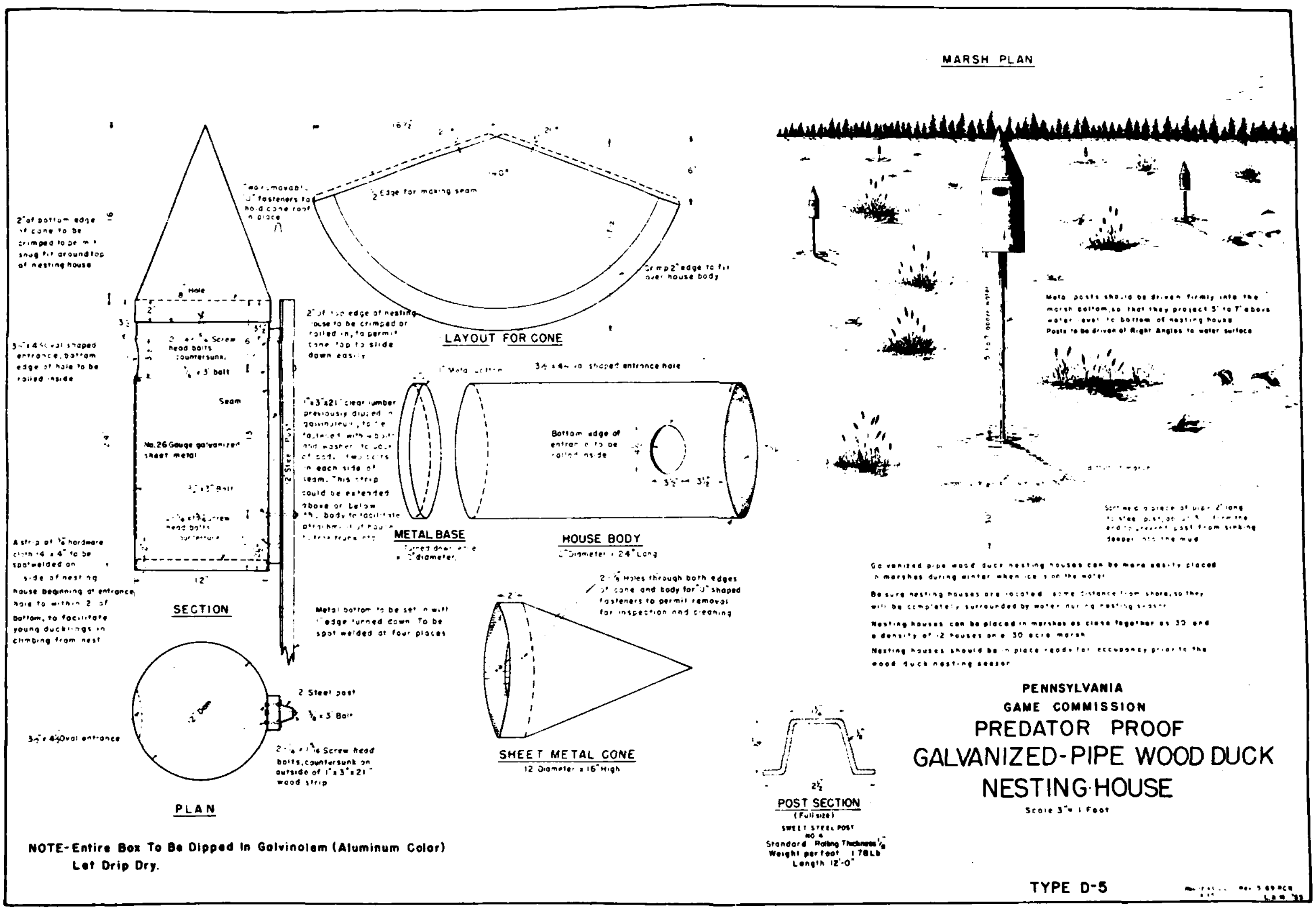
A nest box program should not be attempted unless every effort is made to predator-proof the boxes. Poorly protected nest boxes can be death traps for nesting ducks. If possible, climbing predators should be prevented from reaching the boxes. Whatever type of predator protection is used, it must be effective in preventing raccoon predation. For metal posts, an excellent guard is a 9-inch-wide by 38-inch-long .020-gauge aluminum sleeve that is slipped over the post. The sleeve has a tight fold on one edge and rivets to close the other edge. For wooden posts and small trees, an inverted cone shield is effective. An effective guard for large trees is a metal band 50 inches wide. This width is particularly necessary in areas with a snake problem. As previously mentioned, a 3- by 4-inch elliptical entrance will exclude raccoons over 10 pounds, usually making it effective in the North but not in the South.

Boxes should be erected in clusters of five to ten and spaced at 50- to 100-foot intervals within clusters. If possible, they should be erected over water within or adjacent to the brood habitat. It is not advisable to erect boxes more than half a mile from suitable brood areas. When initiating a program, it is important that boxes be placed so they are quite visible to ducks. They should not be placed in thick stands of trees or beneath shrub growth.

It is best to start with a few boxes and add to them as they are accepted. Begin with five to ten, for example, and provide more when use reaches 30 to 50 percent. Do not put up more boxes than can be maintained.



MATERIALS
1" X 12" ROUGH LUMBER
⅜" X 3½" HANGER BOLT
⅜" WING NUT AND WASHER
2" SCREEN DOOR HOOKS AND EYES
SHAVINGS AS SHOWN


MARSH PLAN
Metal posts should be driven firmly into the marsh bottom so that they project 5' to 7' above water level to bottom of nesting house
Posts to be driven at Right Angles to water surface
Galvanized pipe wood duck nesting houses can be more easily placed in marshes during winter when ice is on the water
Be sure nesting houses are located some distance from shore, so they will be completely surrounded by water during nesting season
Nesting houses can be placed in marshes as close together as 30 and a density of 12 houses on a 30 acre marsh
Nesting houses should be in place ready for occupancy prior to the wood duck nesting season
PENNSYLVANIA
GAME COMMISSION
PREDATOR PROOF
GALVANIZED-PIPE WOOD DUCK
NESTING HOUSE
Scale 3" = 1 Foot
TYPE D-5
LAYOUT FOR CONE
Edge for making seam
Crimp 2" edge to fit over house body
2" of bottom edge of cone to be crimped to permit snug fit around top of nesting house
3½"x 4½" oval shaped entrance, bottom edge of hole to be rolled inside
No. 26 Gauge galvanized sheet metal
Seam
SECTION
A strip of ½" hardware cloth to be spotwelded on side of nesting house beginning at entrance hole to within 2" of bottom, to facilitate young ducklings in climbing from nest
METAL BASE
HOUSE BODY
Bottom edge of entrance to be rolled inside
3½"x 4½" oval shaped entrance hole
Metal bottom to be set in with 1" edge turned down. To be spot welded at four places
2 Steel post
⅜ x 3" Bolt
3½"x 4½" Oval entrance
PLAN
SHEET METAL CONE
12 Diameter x 16" High
2-⅛" Holes through both edges of cone and body for "J" shaped fasteners to permit removal for inspection and cleaning
POST SECTION
(Full size)
Standard Rolling Thickness
Weight per foot 1.78Lb
Length 12'-0"
NOTE-Entire Box To Be Dipped In Galvinolem (Aluminum Color)
Let Drip Dry.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
One Gateway Center, Suite 700
NEWTON CORNER, MASSACHUSETTS 02158

IN REPLY REFER TO:

SEP 2 8 1979

Colonel Max B. Scheider
Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Scheider:

Enclosed is our Fish and Wildlife Coordination Act Report on the Big River Reservoir Project, Coventry and West Greenwich, Kent County, Rhode Island.

We appreciate the cooperation by your staff in the field evaluation and preparation of this report.

Sincerely yours,

ACTING Regional Director

Enclosure

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
One Gateway Center, Suite 700
NEWTON CORNER, MASSACHUSETTS 02158

IN REPLY REFER TO:

9226-305-11.5

BIG RIVER RESERVOIR PROJECT
RHODE ISLAND

Fish and Wildlife Coordination Act Report by the U.S. Fish and Wildlife Service on a plan being developed for water supply, flood control and recreation by the New England Division, U.S. Army Corps of Engineers.

Approved:

SEP 28 1979
Date

Howard D. Woon
ACTING Regional Director
Northeast Region

TABLE OF CONTENTS

PREFACE

This fish and wildlife report supplements our Preliminary Planning Aid Letter (USFWS, November 1978). It provides the results of an evaluation of the wildlife habitat, a fisheries study by the Cooperative Fishery Research Unit, University of Massachusetts, and a preliminary wildlife and fisheries management plan for the proposed Big River Reservoir, Coventry and West Greenwich, Kent County, Rhode Island. It was prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Corps of Engineers' feasibility study is authorized by a resolution of the Committees on Public Works of the U.S. Senate and House of Representatives, dated March 29, 1968. The purpose of the study is to satisfy needs for water supply, flood control and recreation in an area which includes the Pawtuxet and Providence River Group and the Narragansett Bay Area.

DESCRIPTION OF THE PROJECT

The Big River Reservoir site is located on the Big River near the Coventry-West Greenwich town line and is about 16 miles southeast of Providence, Rhode Island. The project description was taken from the Preliminary Report and Appendixes prepared by the New England Division, Corps of Engineers (June 1979), and personal communications with Corps representatives. The Big River Dam would be located where the Harkney Hill Road crosses the Big River. The Flat River Reservoir (about 850 acres at spillway crest elevation 248 feet msl) extends to the Big River dam site.

The Nooseneck, Congdon and Carr Rivers are tributaries to Big River. The South Branch of the Pawtuxet River starts at the Flat River Reservoir dam and flows eastward then turns northward to join the North Branch. The Pawtuxet then flows to the northeast to empty into Narragansett Bay at Warwick. The confluence of the North and South Branches is located 10.9 river miles upstream from the Pawtuxet Dam at the mouth of the river. The Flat River Dam is located at river mile 19.9 with a drainage area of 56.7 square miles, and the Big River dam site is located at river mile 23.0 with a drainage area of 29.7 square miles.

The Big River Dam would be an earth fill dam about 2,240 feet long, 70 feet high with a top elevation at 312 feet msl. A 1,000 acre conservation pool would be created at elevation 267 feet msl. The maximum water storage pool would lie at elevation 300 feet msl and have a surface area of about 3,240 acres, while a flood storage pool at spillway crest elevation 303 would have a surface area of about 3,400 acres. The maximum depth of the water supply pool would be 60 feet (assuming a streambed elevation of 240 feet msl) and an average depth of about

25.9 feet (84,000 acre-feet divided by 3,240 acres). The project would provide a minimum downstream release of 6 cfs, equivalent to 0.2 cfs per square mile of drainage area. The reservoir would be cleared of trees to elevation 303. It would take about 4 years to build the dam and about 3 years to fill the reservoir.

The reservoir would occupy part of the Big River Management Area that is presently owned by the Rhode Island State Water Resources Board. Since 1968 the area has been open to public use under an agreement with the Department of Environmental Management. The area of the State's land and the area within the water supply pool at elevation 300 was planimetered by this Service, from maps provided by the Corps, to determine acreages for habitat evaluation. There are 8,189 acres within the Big River Management Area, 3,348 acres are within the proposed water supply pool and 4,841 acres are in the remaining area between elevation 300 msl and the management area boundary.

The water supply, low flow and flood control functions would be provided through construction of a gate house at the left abutment of the dam. Water would be conveyed to the gate house through a channel 20 feet wide with an invert elevation of 240 feet msl. The gate house on the upstream face of the dam would have a transition section where water would be fed into a 90-inch conduit, 3,200 feet long (capable of carrying 155 cfs) to a water treatment plant and/or through a 5' x 5' concrete conduit to the Flat River Reservoir.

A 90-inch pipeline would connect the water treatment plant to an existing shaft of an aqueduct 43,000 feet to the northeast.

ENVIRONMENTAL SETTING WITHOUT THE PROJECT

A. Fishery Resources

Introduction

The fishery resources have been described in Normandeau's report (CE, Appendix H, June 1979) and in the report of the Massachusetts Cooperative Unit (Mass. Coop. Unit, July 1979). Fish species collected in both these studies are shown in Table 1. The Normandeau report presents data on water quality, phytoplankton, periphyton, zooplankton, benthic macro-invertebrates, reptiles, amphibians and finfish while the latter report concentrates on finfish. An evaluation of human utilization of the fishery resources is contained in the Preliminary Planning Aid Letter (USFWS, November 1978).

Fishery Resource Evaluation

The aquatic habitat can be divided into the project area streams (lotic habitat) and standing water in lakes and ponds (lentic habitats). The stream resource consists of a total of 20.8 miles in the Management Area of which 16.9 miles or 81 percent are located in the proposed pool area. The larger streams include the Big River, Nooseneck River and the Congdon River. They provide a variety of stream habitat and public fishing. The headwaters of these and other streams support native brook trout and species such as white sucker and fallfish. The remaining portions of these streams support mixed populations of both cold-water and warm-water fish species. We do not have sufficient information to define standing crop or productivity of the streams in the project area. Rhode Island Fish and Wildlife has indicated that standing crop in similar cold-water and warm-water streams in the State ranges from 21-130 lbs./A and 20-198 lbs./A, respectively. We would expect standing crop in streams in the study area to fall within these ranges.

The larger ponds in the project area are Carr (89 acres), Capwell Mill (27 acres), and Tarbox (22 acres). Approximately 15 smaller ponds of less than five acres are also found in the project area. Except for Carr Pond, all ponds in the study area are shallow, ringed by wetland vegetation, and many of these provide limited fishing opportunities for species such as largemouth bass and chain pickerel. Carr Pond is deeper, has a rocky shoreline, clear water and, in addition to supporting the above warm-water fish, also contains smallmouth bass. Data are lacking on standing crop or productivity for the ponds. Using values for similar waters, however, we would expect a range of 40-80 lbs./A (Guthrie and Stolgitis, February 1977).

Fishery management in the project area consists primarily of supplemental stocking in streams of 1,000-2,000 trout annually, for "put-and-take" fishing. Warm-water game fish populations are self-sustaining and are not intensively managed.

The Flat River Reservoir, an 850-acre impoundment, is located immediately downstream from the proposed project. This reservoir supports typical warm-water fish populations of largemouth bass, bluegill, chain pickerel, and bullhead. Rhode Island Division of Fish and Wildlife has repeatedly stocked northern pike in the Reservoir. It is an important fishery site and supports a large amount of fishing pressure, primarily for northern pike and largemouth bass (Guthrie and Stolgitis, February 1977). Data are lacking for productivity and standing crop.

Downstream from Flat River Reservoir, the South Branch of the Pawtuxet, the main stem Pawtuxet and parts of the North Branch Pawtuxet contain typical warm-water fish habitat. Below Scituate Reservoir, located on the North Branch, a trout fishery is maintained by cold-water releases and stocking. Scituate Reservoir is closed to public fishing. We assume that a warm-water fishery has developed from the species present prior to impoundment. Although water quality in the main stem Pawtuxet and South Branch Pawtuxet currently limits fishery development, they have potential for restoration of American shad.

B. Wildlife Resources

Introduction

The wildlife resources of the project area have been discussed in other project documents containing information on terrestrial and aquatic wildlife and plants (CE, Appendix H, June 1979). This report draws from that source and additional information was obtained from personnel of the Rhode Island Division of Fish and Wildlife. We have not attempted to reiterate information already available in the Corps' report.

The wildlife habitat value of the study area has been determined by using the Habitat Evaluation Procedures (HEP) as revised in 1979 (USFWS, March 1979). The HEP were originally published utilizing a subjective evaluation method and Habitat Suitability Index (HSI) values were scored on a scale of 1 to 10. The revised procedures utilize a quantitative approach and HSI values are scored on a scale of 0.0 to 1.0. Thus, caution must be used if one tries to compare projects evaluated under the old procedures with projects evaluated with the revised procedures. These revised procedures produced an evaluation of wildlife habitat in non-monetary terms and provided a standard format for predicting and assessing changes in habitat quality and quantity in a quantitative manner. These procedures were also used to determine the number of acres of each habitat type needed to compensate for habitat losses. This is done by increasing habitat values through wildlife management practices and balancing these gains against habitat losses. Increase in habitat values vary for each habitat type and some types, especially wetlands, cannot be managed to produce much additional value. As a result, it is extremely difficult to fully compensate for wetland losses.

It is a basic assumption of HEP that wildlife populations are in equilibrium with habitat carrying capacities. Thus, as habitat values change so do wildlife populations.

The Big River Management Area receives a considerable amount of hunting pressure and wildlife-oriented recreational use from both State and local area residents. We can predict that such use will greatly increase in the future (SCORP, 1978). An evaluation of human utilization of the wildlife resources is contained in the Preliminary Planning Aid Letter (USFWS, November 1978).

The project area is inhabited by a variety of wildlife. Appendix H, Volume 2 (CE, June 1979) lists 55 species of mammals and 221 species of birds that could be found in the project area. Volume 3 of the same report lists 39 species of reptiles and amphibians that might be found in the project area. This information provided a general indication of the diversity of the area's wildlife resources.

Wildlife Habitat Evaluation

The project area was divided into two sections with the potential water supply pool being called the Reservoir Pool Area, and the area between the pool and the Big River Management Area boundary being called the Remaining Area.

The basic decisions pertaining to habitat types, species evaluated, and the value of habitat types were made by a Habitat Evaluation Team. This team was composed of wildlife biologists representing the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the Rhode Island Division of Fish and Wildlife.

Forest and other land-use types in the project area were identified and condensed into six major habitat types for evaluation purposes. A brief description of these six habitat types are as follows (for a more detailed description of plant species see CE 1979, App. H, Vol. II):

Deciduous Forest - Woody vegetation at least 5 meters tall with a canopy closure of at least 25 percent. Over 50 percent of the trees are seasonally deciduous with white, red, and black oaks predominating.

Evergreen Forest - Woody vegetation at least 5 meters tall with a canopy closure of at least 25 percent. Over 50 percent of the trees are evergreens with white pine and pitch pine predominating.

Agricultural and Open Fields - Areas of herbaceous vegetation including broadleaf forbs and grasslands such as pastures, hay fields and old or abandoned fields with less than 25 percent crown cover of woody vegetation.

Shrubland - Dominant woody vegetation between 0.5 and 5 meters tall with a crown cover of at least 25 percent. Represented here primarily by old fields reverting to forest land and includes a wide variety of shrub and tree species both deciduous and evergreen.

Scrub/Shrub Wetland - Dominant woody vegetation between 0.5 and 5 meters tall. Surface water usually is visible throughout the year. Common woody vegetation includes buttonbush, sweet gale, silky dogwood, leatherleaf, red maple and white cedar. Herbaceous vegetation interspersed throughout the area, especially abundant near areas of open water.

Forested Wetland - Woody vegetation over 5 meters tall. Surface water may or may not be present throughout the year. Represented here primarily by floodplain areas dominated by red maple with an understory of highbush blueberry, pepperbush, arrowwood, spicebush, swamp-azalea, and skunk cabbage.

The Terrestrial Habitat Evaluation Criteria Handbook was used as the basic source for selection of wildlife species as evaluation elements for the various habitat types (USFWS, April 1979). This is a species-oriented data base handbook designed specifically for use with the HEP. Wildlife species selected as evaluation elements represent a broad cross section of mammals, birds and herpetofauna associated with each habitat type. A total of 26 species were evaluated for the six habitat types as shown in Table 2.

Baseline conditions had to be established for each species by habitat type in order to compare future changes in habitat values under either without-the-project or with-the-project conditions. This was done by a random selection of sites to be sampled for each habitat type. The team tried to select six sample sites for each habitat type, three within the Reservoir Pool Area and three within the Remaining Area. However, only one sample site for scrub/shrub wetland could be located in the Remaining Area. Thus, a total of 34 sites were selected for sampling, 18 within the Reservoir Pool Area and 16 within the Remaining Area.

Baseline data were established by measuring or estimating habitat characteristics important to the species used in the evaluation of a particular habitat type. Those characteristics inventoried for each sample site are shown by habitat types in Table 3.

Field data were processed according to the functional relationships displayed in the handbook. These functional relationships convert the habitat characteristics measured or estimated for a species to a HSI value for each species by habitat type. These HSI values were used to calculate a mean HSI value for each habitat type. Table 4 depicts the baseline HSI values, the acreage, and the Habitat Units (HSI x acres) for each habitat type. It is particularly important to note that all HSI values are above average (0.5 being average), which indicates that wildlife habitat within the area evaluated is above average in quality. The statistics of these baseline HSI values are shown in Table 5.

A number of basic assumptions concerning the project area had to be made in order to project future conditions without the project for the period of analysis (100 years). These assumptions were based on present trends in the area and the HEP team's best estimate of future conditions without-the-project. Basic assumptions are as follows:

a. The project area would remain in State ownership and be utilized for hunting, fishing and general recreation.

b. Wildlife management would be low-key but would at least maintain baseline HSI values of existing habitat types.

c. Sand and gravel would continue to be removed until the supply is exhausted at year 25.

d. The area utilized for general recreation would substantially increase by year 25.

e. Land-use changes that are expected to occur would be primarily associated with the expansion of general recreation areas and the expansion of sand and gravel pits which are expected to double in area by year 25. Through the process of natural succession, these sand and gravel areas would revert to other habitat types over the period of analysis. Projected land use for the project area by target years and habitat types is shown in Table 6.

Based on these assumptions, the without-the-project conditions were annualized for the 100-year life of the project (Table 7). Inspection of the table shows that while changes in the acreage and Habitat Units occur for all habitat types, except wetlands, the total annualized change of 20 Habitat Units is relatively insignificant.

On an average annual basis, wildlife habitat within the Reservoir Pool Area is valued at 1,844 Habitat Units and the Remaining Area at 2,567 Habitat Units for a total of 4,411 Habitat Units.

C. Rare, Threatened or Endangered Species

This Service has submitted a letter dated July 19, 1979, concerning endangered species in relation to this project (copy attached).

ENVIRONMENTAL IMPACTS WITH THE PROJECT

A. Fishery Resources

Introduction

The proposed project would convert a stream-pond system into a 2,980-acre reservoir with a volume of 67,000 acre-feet and an average depth of 22.5 feet (at average elevation 295 msl) which would support a lake-type fishery.

With the water supply release outlet at elevation 243, and downstream release at elevation 264, withdrawal of relatively large amounts of water for water supply could exhaust most of the cold water below the thermocline during the summer (CE, Appendix E, June 1979). The result of this would be to limit the fishery to warm-water species. The productive area of the reservoir would be the upper levels because a low dissolved oxygen concentration in the hypolimnion is anticipated (CE, Appendix E, June 1979).

We do not have sufficient data to define standing crop or productivity in the proposed reservoir. Based on values for other lakes and reservoirs in the State, the estimated standing crop would range from 14-80 lbs./A (Guthrie and Stolgitis, February 1977).

A second estimate of potential productivity was calculated using Ryder's regression formula (personal communication, Mass. Coop. Fisheries Research Unit) to be 3-6 lbs./A/yr. Assuming productivity to be roughly 30 percent of standing crop, fish biomass would range from 10-20 lbs./A in the reservoir.

We also used the multiple regression formulas developed by the National Reservoir Research Program (FWS), which show potential standing crop to be from 132-229 lbs./A. This final estimate is roughly 10 times that of the first two, attributable most likely to the FWS regression formulas being based on southern reservoirs.

Based on the above estimates, we expect standing crop to be approximately 20-30 lbs./A, which would be a value similar to that for Wallum Lake, an oligotrophic lake in northwestern Rhode Island.

Beneficial Impacts

Big River Reservoir could provide a warm-water fishery. The magnitude of this impact is not great, however, because the State already has adequate warm-water fishing opportunities (SCORP, 1978).

Adverse Impacts That Cannot be Avoided

The proposed project would inundate 16.9 miles of both cold- and warm-water streams. Capwell Mill, Tarbox and several smaller ponds would also be inundated by the project. This would eliminate the stream trout fishing, which is the most significant fishery in the project area, and the warm-water fisheries in the affected ponds.

Diversion of water for water supply would result in reductions in stream flow in Big River (to the Flat River Reservoir), from the Flat River Dam affecting the South Branch, and in the main stem. The effect of Big River operations on Flat River Reservoir would be to cause more frequent drawdown and slower refills (CE, Appendix D, June 1979). The average annual stream flow at the Big River dam site is about 60 cfs. With the project this flow would be reduced to 6 cfs, a reduction of 90 percent. We believe that the impact of reducing flows into the Flat River Reservoir and more frequent drawdowns would adversely impact the warm-water fishery. These adverse impacts could be caused by changes in surface elevation, affecting centrarchid nests in shallow water, by upsetting circulation patterns in Flat River Reservoir, by changing nutrient cycling and by reducing overall biological production.

Reducing stream flows in the South Branch and the main stem would adversely affect the fish habitat of these streams. The project would reduce average annual stream flow below Flat River Reservoir by as much as 40 percent and as much as 15 percent in the main stem Pawtuxet. This would jeopardize potential restoration of American shad in the Pawtuxet River. Reduced flows also would hamper pollution abatement in the river.

Because no detailed study has been made of the extent of the resources downstream from the Big River site, including the Flat River Reservoir, the South Branch, the North Branch, and the main stem, we cannot be certain of the magnitude of the potential impacts over the project life. We feel that such studies are required, especially in view of the potential fish habitat that these streams could provide if adequate and stable flows were provided.

Adverse Impacts That Can be Mitigated

The existing stream and pond warm-water fish habitat would be offset by the habitat of the proposed reservoir. The reduced stream flow into Flat River Reservoir and downstream could be mitigated by increasing outflows from the Big River Reservoir. Access for fish from Flat River Reservoir into the Big River watershed could be mitigated by the installation of appropriate fish passage facilities at the Big River Dam. The loss of cold-water fish habitat could be mitigated by the installation of a multiple level outlet structure and stripping the reservoir pool of organic material to elevation 270 msl.

B. Wildlife Resources

Introduction

Within the study area of 8,190 acres, some 3,300 acres of land and water would be inundated by the proposed water supply reservoir. The resulting impact upon wildlife resources was determined by comparing the future conditions without-the-project against the future conditions with-the-project. Our basic assumptions concerning future habitat conditions with the project are as follows:

a. The water supply pool would have little value to terrestrial wildlife species.

b. Habitat within the Remaining Area would be managed for wildlife in order to offset the Habitat Unit losses of the Reservoir Pool Area. Wildlife management would be initiated with project construction.

c. Management for recreation or other land uses would be limited to those that are compatible with wildlife management objectives. Existing recreational lands (27 acres) would revert to open fields by the time the project is completed.

d. The State would make every effort to remove sand and gravel deposits before project completion; thus doubling the area of pits from 184 acres to 368 acres in the Remaining Area and destroying equal amounts of deciduous and evergreen forest.

e. During the project construction period, sand and gravel pit areas would be rough graded, topsoiled with material from the Reservoir Pool Area, and seeded with a conservation mixture to prevent erosion and provide an additional 368 acres of open fields. By year 5, this area would be managed as 331 acres of shrubland and 37 acres of open fields.

f. Potential subimpoundment areas identified during the course of this study are assumed to be feasible and have been included in the overall management plan.

Wildlife Habitat Evaluation

Based on the above assumptions, a wildlife management plan was developed for the Remaining Area and the potential subimpoundment areas. This plan is discussed in the management section of this report and shows the increase in HSI values achievable through management. These future conditions were annualized for the life of the project and the results are displayed in Table 8. The target year -5 represents baseline conditions when project construction starts and the wildlife management plan is initiated. Target year 0 is when the project becomes operational.

The without- and with-the-project comparison and the net average annual gain or loss of Habitat Units by habitat type is shown in Table 9. These data revealed that even with wildlife management, the Habitat Unit losses cannot be compensated for within the limits of the study area. While deciduous forest, agricultural and open fields, shrubland, and the subimpoundment areas show a net gain of 289 Habitat Units, evergreen forest and the two wetland types show a net loss of 927 Habitat Units. Compensation in-kind for these Habitat Unit losses would require acquisition and management of an additional 8,437 acres of land as shown in Table 9.

The 8,437 acres of land required for in-kind compensation can be substantially reduced by giving credit to the Habitat Units gained by other habitat types within the study area. This is done through development of Relative Importance Values (RIV) that adjust habitat values to a common basis so that direct comparisons can be made between different habitat types.

The first step in this procedure is to develop a set of RIV criteria and rate each habitat type on a 1-10 scale for each criterion as shown in Table 10. These criteria must be weighted before a final prioritization by habitat types can be achieved. This is done by a pairwise comparison where each criterion is compared to every other criterion as shown in Table 11. A final matrix was constructed from the product of the values from Tables 10 and 11, and the RIV obtained for each habitat type as shown in Table 12. These RIV's indicate that wetlands have the highest resource priority among the six habitat types evaluated. The RIV's as utilized for determining the adjustment to areas required for compensation are shown in Table 13. The net gain in Habitat Units for deciduous forest, agricultural and open fields, and shrubland were used to adjust the net loss of evergreen forest Habitat Units. Thus, the net loss of evergreen forest Habitat Units was reduced from -542 to -279 Habitat Units and the acres required for compensation of habitat losses was reduced from 2,464 to 1,268 acres.

The net gain in Habitat Units for the subimpoundment areas was used to adjust the net loss in Habitat Units of both scrub/shrub wetland and forested wetland. Thus, the net loss of scrub/shrub wetland Habitat Units was reduced from -102 to -68 Habitat Units and the area required for compensation of losses was reduced from 3,400 to 2,267 acres. Net loss of forested wetland Habitat Units was reduced from -283 to -250 Habitat Units and the area required for compensation of losses was reduced from 2,573 to 2,273 acres.

Total adjustments shown in Table 13 reduced the net loss of Habitat Units from -927 to -597 Habitat Units and reduced the area required for compensation of losses from 8,437 to 5,800 acres.

Beneficial Impacts

The large open water area of the reservoir would probably prove attractive to diving ducks such as scaup, common goldeneyes and buffleheads; however, no large concentration of these birds is anticipated. Canada geese may find the area attractive and be induced to nest on the islands and peninsulas of the reservoir area. Management could significantly increase the goose population through establishing and maintaining nesting sites and grazing fields; however, this would have to be approached with caution since: 1) habitat used for this purpose would reduce the amount of habitat available for mitigation of other wildlife losses, and 2) a large goose population might not be compatible with water supply objectives.

A fringe area of herbaceous vegetation, primarily grasses, sedges and rushes, would develop along the reservoir shoreline. This shoreline area should provide for a general increase in the number of various shore and wading birds in the Big River area. The fringe area would also be utilized to some extent by other terrestrial wildlife and waterfowl.

In addition, an osprey population might be established by providing nesting platforms on some of the islands and remote shoreline areas of the reservoir.

Adverse Impacts That Cannot be Avoided

If the project is constructed, it would result in the inundation of over 3,000 acres of wildlife habitat within the Big River Management Area. Management of the Remaining Area would mitigate some of the wildlife losses; however, the loss of 570 acres of wetlands would be extremely difficult to mitigate even with acquisition and management of lands outside the study area. With-the-project there would be less wildlife habitat and less wildlife even with management of the Remaining Area.

The shoreline of the reservoir would be alternately flooded and drained as a result of operations for flood control and water supply. Temporary habitat might develop along the shoreline when the lake is low and be lost when the lake returns to a higher elevation.

A secondary impact of the project would occur when wildlife must seek other habitat in surrounding areas when their habitat is inundated. These areas already support wildlife populations which are at carrying capacity. Thus, they cannot support displaced wildlife. There are numerous adverse impacts that take place when displaced individuals compete with residents for space, food, shelter and nesting sites.

Adverse Impacts That Can be Mitigated

A partial recovery of some of the loss of wildlife could be accomplished by managing remaining wildlife habitat as explained in the next section. This action primarily would affect the species listed in the management plan because it is based on their needs even though many other species would be benefited.

The same management procedures would be used on lands acquired outside of the Management Area. The magnitude of mitigation depends upon the amount of land managed. While use of the Remaining Area would mitigate about 68 percent of the total Habitat Unit losses, it would only mitigate 20 percent of the wetland losses. Acquisition and management of an additional 5,800 acres of land would be required to compensate for all of the Habitat Unit losses as shown in Table 13.

PROJECT MODIFICATIONS REQUIRED FOR MITIGATION

A. Fishery Resources

Structural and Operational Modifications

The reservoir would provide a fishery for warm-water fish such as largemouth bass, chain pickerel, yellow perch and sunfish. If modifications are made it may be possible to provide some habitat for cold-water species.

One of the Corps of Engineers' predictions of reservoir conditions showed that it may be possible to maintain a volume of cold water in the reservoir. A prediction of deep water temperatures was made with the water supply outlet at elevation 268 and the downstream release outlet at elevation 264 (CE, Appendix E, June 1979). This prediction shows that the water in the hypolimnion below about elevation 268 should be cold enough for cold-water fishes. The cold-water zone would amount to about 1,060 acres at elevation 268. Its volume would be about 12,500 acre-feet or about 18 percent of the entire volume of the average water supply pool at elevation 295. The Corps also predicted that there would be limited dissolved oxygen in the lower levels of the reservoir. This would make the hypolimnion unsuitable for cold-water species. It is possible, however, that the organic material left on the bottom of the reservoir would completely decompose so that the dissolved oxygen level would increase. This may take years, however, and would assume that annual organic inputs from the watershed and reservoir would be small.

Stripping the bottom area of organic material to elevation 270 would improve water quality and could make the pool suitable for cold-water species soon after filling. A multiple-level outlet for both the water supply and downstream outlets would provide flexibility in controlling the quality and temperature of released water and could allow some control of water temperature in the pool, thereby increasing the cold-water habitat zone. Other factors, such as dissolved oxygen levels, turbidity and dissolved solids, also might be subject to some control with a multiple-level outlet.

The minimum downstream release of 6 cfs should be increased in order to sustain most requisite life cycle needs for the endemic aquatic organisms downstream of the project area. An adequate aquatic base flow is defined by the Fish and Wildlife Service for the New England Area as 30 percent of the average annual flow of the stream at the project site or 0.60 cubic feet per second per square mile of drainage area (USFWS, June 1979). During low flow conditions when inflows into the reservoir fall below the aquatic base flow, outflows from the project shall, as a minimum, be set equal to inflows. These conditions are to be maintained until inflows once again exceed the aquatic base flow. Based on these criteria the minimum downstream release of 6 cfs should be increased to 18 cfs in order to mitigate some of the adverse impacts upon Flat River Reservoir, the South Branch and main stem Pawtuxet.

Recommended Fishery Management Plan

A final management plan for fisheries would be developed during Advanced Engineering and Design Studies if the project is authorized. If our recommendations are followed the reservoir should be suitable for both cold- and warm-water fisheries.

Installation of multiple-level outlets and stripping the reservoir bottom below elevation 270 of organic material should be done. Under these conditions a two-story fishery could be developed (warm-water species in warmer upper levels and cold-water species generally wide-ranging throughout the pool except during the summer when they would be confined to the lower levels). If a cold-water fishery should develop, the average annual fisherman use would substantially increase.

A cold-water fishery would be created and maintained by stocking salmonid fish such as landlocked salmon, brown and rainbow trout. These species would not be expected to reproduce in sufficient numbers in the pool or its tributaries to maintain expected fishing pressure because of lack of spawning habitat. Artificial hatchery and rearing would be required and could be accomplished by expanding existing facilities, constructing a hatchery at the reservoir site, or purchase from a commercial hatchery. The preferable alternative has not been determined. As an example, a minimum of 6,000 (two trout per acre) catchable brown trout (12 inch) would be required. Current costs would be about $9,000 for these trout.

If the pool habitat is found to be suitable, the expected warm-water fishery could be improved by initial and maintenance stocking of additional game fish such as northern pike and/or walleye. Natural reproduction of northern pike is not anticipated. However, walleye reproduction might be sufficient to maintain adequate populations.

Fishery Studies Needed

1. Temperature Simulation

   Conduct additional simulation studies to predict temperature in the hypolimnion under varied hydrologic conditions utilizing a multiple level outlet from the reservoir. The results of this study would assist in determining type and quality of the potential fishery to be addressed in the final fishery management plan.

2. Dissolved Oxygen Studies

   Conduct additional studies to predict dissolved oxygen concentrations in the hypolimnion. Studies should be performed for a variety of hydrologic conditions and amount of organic material removed. This information would be used to determine availability of cold- and warm-water fish habitat.

3. Downstream Flows

Conduct additional studies of the downstream flow regimen utilizing a minimum instantaneous flow of 18 cfs from Big River Reservoir. This information would be used to determine the impact of changed stream flow regimen upon the environmental characteristics of Flat River Reservoir, the South Branch and main stem Pawtuxet.

4. Pre-impoundment Studies in Big River Area

Conduct baseline studies in the impoundment area to determine productivity and standing crop of fish and invertebrate populations. This information is needed to calculate the HSI for the areas that would be impounded by the reservoir.

5. Limnological Studies on Flat River Reservoir

Conduct a detailed limnological investigation of Flat River Reservoir to provide baseline data on water chemistry, benthos, macrophytes and fisheries. This information would be used to develop the HSI for Flat River which in turn would allow better evaluation of the project's impacts on the reservoir.

6. Baseline Studies on South Branch and Main Stem Pawtuxet River

Conduct studies on water chemistry, temperature, dissolved oxygen, benthos and fish populations to develop HSI for these areas.

7. Studies in Scituate Reservoir

Conduct a limnological investigation of Scituate Reservoir to determine standing crop and productivity of fish and benthos. Measure temperature and dissolved oxygen in the hypolimnion and biological oxygen demand in the sediments. This information would be used to predict conditions in Big River Reservoir.

B. Wildlife Resources

Acquisition of Additional Lands

In order to compensate for wildlife losses an additional 5,800 acres of land would have to be acquired and managed for wildlife. This would encompass 1,268 acres of evergreen forest, 2,267 acres of scrub/shrub wetland, and 2,273 acres of forested wetland. Specific areas to be acquired outside of the project area would have to be identified in future studies since this was not considered a part of the current study. Management of these lands would be the same as for project lands. The estimated acquisition, development and annual operation and maintenance costs are $2,249,600, $789,800 and $17,600, respectively, as shown in Table 14.

Recommended Wildlife Management Plan for the Project Area

We assumed that the Remaining Area and certain portions of the Reservoir Pool Area would be available for wildlife management purposes. An assumption of this nature is necessary to (1) arrive at some definite figure for the capability of these areas to mitigate wildlife losses, and (2) to determine if additional lands are needed and the extent of these lands. Management would be initiated at year -5, the year project construction starts.

This management plan was developed to determine the mean HSI values for various habitat types as they change over time. These mean HSI values were utilized to calculate the annualized Habitat Unit values shown in Table 8.

The following outlines our basic management plan, assumed land-use changes, and the HSI values as calculated for each habitat type:

Sand and gravel operations: It was assumed that the State would make every effort to remove sand and gravel deposits before project completion and the area of pits would increase from 184 acres to 368 acres within the Remaining Area. Fifty percent of the new pits would come from deciduous forest areas and 50 percent would come from evergreen forest areas. All pit areas would be rough graded, topsoiled with material from the Reservoir Pool Area, and seeded with a conservation mixture during the project construction period.

Area:

Baseline	= 184 acres
Year -5	= 184 acres
Year 0	= Ninety-two acres would come from deciduous forest and 92 acres from evergreen forest. All pit areas would be topsoiled and seeded by year 0. They would be open fields for 5 years (368 acres).
Year 5	= Thirty-seven acres would remain as open fields and be managed as such. Three hundred thirty-one acres would revert to shrubland and be managed as such.
Years 25-100	= Remains as above

General recreation areas: We assume that the only recreation allowed would be that compatible with wildlife management purposes such as hunting, fishing, birdwatching, hiking trails, boating, etc. With this assumption, there would be no utilization of the habitat for intensive recreation such as ball fields, etc., particularly since this land is included in the mitigation values. Twenty-seven acres of recreation fields would revert to open fields by year 0.

Deciduous forest: This type would be managed by selective cutting on a 10-year basis. The canopy closure would be maintained between 50-70 percent. At least four den trees per acre would be retained or created by girdling. Mast producing trees would be managed to retain an average DBH of 8-10 inches. Conifers would be managed to make up 10 percent but no more than 25 percent of this type preferably in clumped areas. Apple trees would be released by cutting and suppressing vegetation. These trees would be pruned and grafted if needed. About one small opening per 10 acres would be created. These would be about 1/2 acre in size (approximately 5 percent of area) and would be created and/or maintained by cutting on a scheduled basis. All logging roads and trails would be seeded with a conservation mixture.

Area:

Baseline	= 2,488 acres
Year -5	= 2,488 acres
Year 0	= 92 acres to gravel pits = 2,396 acres
Year 5	= 2,396 acres
Years 25-100	= Remains as above

Management potential: (HSI Values)

Species	Baseline	Year -5	Year 0	Year 5	Years 25 thru 100
White-tailed deer	.66	.66	.80	.90	.90
Gray squirrel	.54	.54	.55	.65	.80
Short-tailed shrew	.96	.96	.96	.96	.96
Ruffed grouse	.47	.47	.75	.85	.85
Wood thrush	.53	.53	.60	.70	.75
Red-backed salamander	.25	.25	.30	.50	.55
Mean HSI	.57	.57	.66	.76	.80

Evergreen forest: This type would be selectively cut on a 10-year basis. The canopy closure would be maintained between 50-70 percent. A minimum of five mast producing trees per acre should be maintained. An average DBH of 10 inches would be sought. At least four den trees per acre should be retained or created by girdling. Apple trees would be released, pruned and grafted as needed. Small openings of about 1/2 acre in size would be created and maintained. All logging trails or roads would be seeded with a conservation mixture. Travel lane areas for hare would be created by lining trees in various areas.

Area:

Baseline	= 1,586 acres
Year -5	= 1,586 acres
Year 0	= 92 acres to gravel pits
Year 5	= 1,494 acres
Years 25-100	= Remains as above

Management potential: (HSI Values)

Species	Baseline	Year -5	Year 0	Year 5	Years 25 thru 100
White-tailed deer	.57	.57	.75	.85	.85
Snowshoe hare	.51	.51	.65	.80	.80
Red squirrel	.48	.48	.55	.65	.80
Great horned owl	.86	.86	.86	.86	.86
Downy woodpecker	.63	.63	.75	.85	.85
Red-backed salamander	.25	.25	.30	.40	.50
Mean HSI	.55	.55	.64	.74	.78

Agricultural and open fields: Fields would be kept open primarily by mowing but burning or rough disking or a combination of all three methods might be used depending upon circumstance. They should be limed about every 3-5 years. Shrubs at field edges would be encouraged and maintained by mowing. Old apple trees would be released, pruned and grafted if needed. Large fields should have small patches of shrubs to break up the openness of the field. Snags should be maintained or created at edges as hunting perches for birds of prey.

Area:

Baseline	= 186 acres
Year -5	= 186 acres
Year 0	= 27 acres from recreation land + 368 acres from gravel pits
Year 5	= 331 acres revert to shrubland (leaves 250)
Years 25-100	= 250 acres as above

Management potential: (HSI Values)

Species	Baseline	Year -5	Year 0	Year 5	Years 25 thru 100
White-tailed deer	.54	.54	.75	.85	.85
Eastern cottontail	.55	.55	.75	.85	.85
Meadow vole	.32	.32	.50	.65	.65
American kestrel	1.0	1.0	1.0	1.0	1.0
American goldfinch	.52	.52	.55	.75	.75
Northern black racer	.61	.61	.70	.80	.80
Mean HSI	.59	.59	.71	.82	.82

Shrubland: This type would be managed to maintain a variety of shrub sizes (from 1-15 feet high) in twisting strips. One-third of the area would be cut every 5 years to create new low growth and to keep shrubland from reverting into forest. A controlled spring burn to open up the area every 3-5 years might be considered.

Area:

Baseline	= 120 acres
Year -5	= 120 acres
Year 0	= 120 acres
Year 5	= 331 acres from reverting open fields (451 acres)
Years 25-100	= 451 acres

Management potential: (HSI Values)

Species	Baseline	Year -5	Year 0	Year 5	Years 25 thru 100
White-tailed deer	.62	.62	.75	.85	.85
New England cottontail	.66	.66	.75	.85	.85
Ruffed grouse	.52	.52	.60	.75	.75
American woodcock	.53	.53	.60	.75	.75
Common yellowthroat	.72	.72	.75	.80	.80
Northern black racer	.93	.93	.95	.95	.95
Mean HSI	.66	.66	.73	.83	.83

Scrub/shrub wetland: Not much can be done to make major improvements in this type. Low level dikes with water control structures would be considered or potholes created to maintain approximately 10-25 percent of the area in permanent water. Small openings could be created in heavily overgrown areas to increase habitat diversity.

Area:

Baseline = 20 acres
No loss or new areas anticipated

Management potential: (HSI Values)

Species	Baseline	Year -5	Years 0 thru 100
Mink	.72	.72	.75
Muskrat	.55	.55	.70
Black duck	.84	.84	.85
Song sparrow	.94	.94	.94
Wood frog	.98	.98	.98
Mean HSI	.81	.81	.84

Forested wetland: This type also is difficult to improve, especially when a wide spectrum of wildlife species are evaluated. Low-level water control structures would be considered or potholes created to try and maintain approximately 10-25 percent of the area in permanent water. Trees would be girdled to maintain a canopy closure of 50-60 percent. Mast trees and all potential den trees would be retained. Wood duck boxes would be installed where needed.

Area:

Baseline = 126 acres
No loss or new areas anticipated

Management potential: (HSI Values)

Species	Baseline	Year -5	Year 0	Year 5	Years 25 thru 100
White-tailed deer	.62	.62	.70	.75	.75
Raccoon	.38	.38	.40	.45	.55
Short-tailed shrew	.88	.88	.88	.88	.88
Wood duck	.56	.56	.85	.85	.85
Downy woodpecker	.86	.86	.86	.86	.86
Eastern box turtle	.57	.57	.60	.65	.65
Mean HSI	.65	.65	.72	.74	.76

Subimpoundments: Creation of subimpoundments at the edge of the pool (below elevation 300) seems to be the most promising measure for mitigation of wetland losses within the study area. All areas have not been fully explored but we have located three sites amounting to about 90 acres within the Reservoir Pool Area. One site is located where the Congdon River would enter the reservoir. The site is about 8 acres in size and is now dominated by deciduous and evergreen forest. Elevations range from 296 to 300 feet msl. The second site is located upstream from Sweet Pond near the New London Turnpike. This site is about 12 acres in size and is now a forested wetland. Elevations range from 292 to 300 feet msl. The third site of about 70 acres is a forested wetland located in the Mud Bottom Brook area between elevations 292 to 300 feet msl.

These sites could be developed by constructing dikes with water level control structures that would retain desired water levels during periods of reservoir drawdown. The length of time these desired water levels could be maintained depends upon the interior drainage of the subimpoundment area. Control of desired water levels would be essentially lacking under full reservoir pool conditions. The feasibility of the sites, including location and design of the dikes, water control structures, expected frequency of filling, and the most desirable water levels, needs to be determined. In addition, the reservoir shoreline needs to be more fully explored for potential areas that could be utilized for wetland mitigation purposes.

These subimpoundment areas would be cleared of undesirable trees, brush, etc., during construction; however, most of the woody vegetation would be retained. Trees and shrubs in the deeper portions (4-8 feet) would die shortly after filling while those in the shallow fringe area, which is not subject to constant inundation, would probably survive. Wood duck boxes would be installed wherever needed and small areas of shoreline would be cleared to encourage herbaceous vegetation. Without these subimpoundments and management the three potential areas totaling 90 acres would be clear-cut (they are now forested wetlands) and become open reservoir water. With management they would become a mixture of types (scrub/shrub wetland, forested wetland, and open water) and afford a means of mitigating some of the wetland losses. Wildlife species from both scrub/shrub wetlands and forested wetlands were evaluated to obtain the management potential.

Area:

Baseline	= 0
Year -5	= 0
Year 0	= 90
Years 5-100	= 90

Management potential: (HSI Values)

Species	Baseline	Year -5	Year 0	Year 5	Years 25 thru 100
Mink	0	0	.75	.75	.75
Muskrat	0	0	.50	.60	.60
Black duck	0	0	.60	.80	.80
Wood duck	0	0	.85	.85	.85
Downy woodpecker	0	0	.86	.86	.86
Song sparrow	0	0	.50	.50	.50
Mean HSI			.68	.73	.73

The estimated development and annual operation and maintenance costs for project lands are $2,446,100 and $27,700, respectively, as shown in Table 14.

Wildlife Studies Needed

1. Subimpoundments

   A. Determine the feasibility of constructing the subimpoundments discussed in this report, the location of dikes, design of water control structures, and the most favorable water level to be maintained.

   B. Conduct additional studies of the reservoir shoreline to determine if other opportunities exist for creating wetland habitat. Creation of additional wetland habitat would reduce the total area required for compensation of wetland losses.

2. Studies of Additional Land

   Conduct studies to identify areas outside of the Big River Management Area required for compensation of wildlife Habitat Unit losses. Application of HEP would be required for any lands considered for compensation purposes.

SUMMARY

Construction of the Big River project would cause significant adverse impacts to fish and wildlife resources that are existing on lands open to public use. The fishery resource losses are not expected to be as significant as the wildlife losses.

The proposed reservoir would provide a warm-water recreational fishery that would contribute to the State's resources, but it could be a major contribution if a cold-water fishery could be developed. Decrease in downstream flows to the Flat River Reservoir, South and North Branches, and main stem of the Pawtuxet River would cause adverse fishery impacts but the potential magnitude of this impact has not been clearly defined.

Wildlife losses would need to be mitigated and adequate mitigation would mean the development and management of the 4,700 acres of land remaining in the Big River Management Area after construction as well as the acquisition, development, and management of an additional 5,800 acres of land.

RECOMMENDATIONS

WE RECOMMEND THAT THE PROJECT NOT BE CONSTRUCTED. This recommendation is based strictly upon the predicted adverse impacts to fish and wildlife resources in the Big River Management Area, potential adverse impacts to fisheries in the Flat River Reservoir, and potential adverse impacts to stream fisheries in the Pawtuxet River system.

In the event the project is authorized and constructed, despite our objections, then we further recommend that:

1. The Remaining Area between the proposed reservoir pool and the boundary of the Management Area be utilized for mitigation of wildlife resource losses. These lands be managed in accordance with the concepts of the plans presented in this report.

2. An additional 5,800 acres of land be acquired, developed and managed for wildlife in order to compensate for wildlife resource losses.

3. The Rhode Island Division of Fish and Wildlife be designated as the agency to manage fish and wildlife resources on all project lands and waters, and funds be provided to that agency for initial development, plus annual operating and maintenance costs.

4. The minimum downstream release from Big River Reservoir be increased from 6 cfs to 18 cfs.

5. That studies identified in this report be funded as a project cost in order to determine:

   a. The probable impact of changes in stream flow regimen upon downstream environmental characteristics in the Flat River Reservoir and the South Branch and main stem Pawtuxet Rivers.

   b. The productivity and standing crop of fish and invertebrate populations in the project area.

   c. If a multiple level outlet and removal of organic material is required in order to produce a cold-water fishery in the reservoir.

   d. The type and quality of the potential reservoir fishery that should be addressed in the final fishery management plan.

   e. The feasibility and costs of development and maintenance of three subimpoundments and opportunities for additional wetland developments within the Reservoir Pool.

   f. The location and management potential of the 5,800 acres of additional land required to compensate for wildlife resource losses.

REFERENCES

Corps of Engineers, New England Division, June 1979. Pawcatuck River and Narragansett Bay Drainage Basins, Water and Related Land Resource Study Preliminary Draft Big River Reservoir Project:

Main Report and Summary of Environmental Considerations
Appendix B. Plan Formulation
Appendix D, Hydrologic Analysis
Appendix E, Hydraulics and Water Quality
Appendix G, Design and Cost
Appendix H, Volume II, Terrestrial Ecosystem Assessment Report (Normandeau Associates, Inc.)
Volume III, Aquatic Ecosystem Assessment Report (Normandeau Associates, Inc.)

Guthrie, Richard C. and John A. Stolgitis, February 1977, Fisheries Investigations and Management in Rhode Island Lakes and Ponds; Fisheries Report No. 3, Rhode Island Division of Fish and Wildlife.

Massachusetts Cooperative Fishery Research Unit. July 13, 1979. Big River Reservoir (unpublished).

SCORP, Rhode Island State Comprehensive Outdoor Recreation Plan, SCORP Amendment No. 2.

U.S. Fish and Wildlife Service. November 27, 1978. Preliminary Planning Aid Letter, Big River Reservoir Project.

U.S. Fish and Wildlife Service. March 1979. Habitat Evaluation Procedures, Revised March 1979 (draft), Office of Biological Services.

U.S. Fish and Wildlife Service. April 1979. Terrestrial Habitat Evaluation Criteria Handbook (draft), Office of Biological Services.

U.S. Fish and Wildlife Service. June 1979. Policy on Flow Regulation Criteria (draft), New England Area.

Table 1. Finfish species collected during sampling in project area.[1]

	Capwell Mill Pond	Carr Pond	Flat River Reservoir	Rathbon Pond	Tarbox Pond	Bear Brook	Big River	Lower Carr River	Upper Carr River	Lower Congdon River	Upper Congdon River	Lower Nooseneck River	Upper Nooseneck River
Brook trout	-(-)	-(NS)	NS(-)	-(NS)	-(-)	5(NS)	-(-)	-(-)	-(NS)	-(NS)	8(NS)	6(-)	1(4)
Chain pickerel	-(-)	-	(-)	1	1(1)	-	-(2)	-(1)	-	-	-	-(-)	-(-)
Redfin pickerel	-(-)	-	(-)	2	-(-)	-	-(1)	1(-)	-	-	2	-(-)	1(7)
Redfin x chain pickerel	-(-)	-	(-)	-	-(2)	-	-(-)	-(-)	-	-	-	-(-)	-(-)
Golden shiner	46(6)	-	(-)	-	25(5)	-	-(-)	-(-)	-	-	-	-(-)	-(-)
Bridle shiner	-(-)	-	(1)	-	-(-)	-	-(-)	-(-)	-	-	1	-(49)	-(-)
Fallfish	-(-)	-	(-)	-	-(-)	-	-(-)	-(-)	-	-	-	1(-)	-(6)
White sucker	-(-)	-	(-)	3	-(-)	-	-(-)	-(-)	-	1	-	22(-)	-(5)
Creek chubsucker	-(-)	-	(-)	2	1(4)	-	-(-)	-(-)	-	-	-	-(3)	-(-)
Brown bullhead	-(-)	-	(-)	-	3(-)	-	-(-)	-(1)	-	2	-	-(-)	2(1)
Banded sunfish	-(1)	1	(-)	-	-(5)	-	-(-)	-(-)	-	-	-	-(-)	-(-)
Bluegill	-(-)	-	(-)	-	-(-)	-	-(-)	1(-)	-	-	-	-(-)	3(-)
Pumpkinseed	-(-)	-	(-)	1	2(8)	-	-(8)	-(-)	-	-	-	-(-)	-(-)
Largemouth bass	-(3)	-	(1)	-	-(15)	-	-(3)	-(1)	-	-	-	-(-)	-(5)
Smallmouth bass	-(-)	-	(0)	2	-(-)	-	-(-)	-(-)	-	-	-	-(-)	-(-)
Swamp darter	-(-)	17	(3)	-	-(-)	-	-(10)	-(-)	-	-	-	-(-)	-(-)
Yellow perch	-(-)	-	(0)	-	32(8)	-	-(-)	-(-)	-	-	-	-(-)	-(-)

[1]Data modified from the Massachusetts Cooperative Fishery Research Unit, July 1979, and Appendix H, Vol. III, CE, June 1979. Appendix H data shown in ( ). NS = no sampling.

Table 2. Evaluation elements by habitat type.

Evaluation Elements (Species)	Habitat Types					
	Deciduous Forest	Evergreen Forest	Agricultural and Open Fields	Shrubland	Scrub/Shrub Wetland	Forested Wetland
Mammals						
Eastern cottontail (Sylvilagus floridanus)			X			
Gray squirrel (Sciurus carolinensis)	X					
Meadow vole (Microtus pennsylvanicus)			X			
Mink (Mustela vison)					X	
Muskrat (Ondatra zibethicus)					X	
New England cottontail (Sylvilagus transitionalis)				X		
Raccoon (Procyon lotor)						X
Red squirrel (Tamiasciurus hudsonicus)		X				
Short-tailed shrew (Blarina brevicauda)	X					X
Snowshoe hare (Lepus americanus)		X				
White-tailed deer (Odocoileus virginianus)	X	X	X	X		X
Birds						
American goldfinch (Spinus tristis)			X			
American kestrel (Falco sparverius)			X			
American woodcock (Philohela minor)				X		
Black duck (Anas rubripes)					X	
Common yellowthroat (Geothlypis trichas)				X		
Downy woodpecker (Dendrocopos pubescens)		X				X

Table 2. (continued)

Evaluation Elements (Species)	Habitat Types: Deciduous Forest	Evergreen Forest	Agricultural and Open Fields	Shrubland	Scrub/Shrub Wetland	Forested Wetland
Birds (cont'd)						
Great horned owl (*Bubo virginianus*)		X				
Ruffed grouse (*Bonasa umbellus*)	X			X		
Song sparrow (*Melospiza melodia*)					X	
Wood duck (*Aix sponsa*)						X
Wood thrush (*Hylocichla mustelina*)	X					
Herpetofauna						
Eastern box turtle (*Terrapene carolina*)						X
Northern black racer (*Coluber constrictor*)			X	X		
Red-backed salamander (*Plethodon cinereus*)	X	X				
Wood frog (*Rana sylvatica*)					X	
Total Species 26	6	6	6	6	5	6

Table 3. Matrix of inventory characteristics by habitat types.

Inventory Characteristics	Habitat Types: Deciduous Forest	Evergreen Forest	Agricultural and Open Fields	Shrubland	Scrub/Shrub Wetland	Forested Wetland
Percent bare ground exposed				X		
Percent debris ground cover					X	
Percent effective ground cover	X					X
Percent herbaceous canopy cover	X		X	X		
Percent herbaceous canopy cover that is grasses or grass-like plants			X			
Percent herbaceous canopy cover of bank vegetation					X	
Percent herbaceous canopy cover within 100 m of water					X	
Percent herbaceous ground cover including fungi						X
Percent shrub crown cover	X	X		X	X	X
Percent low shrub crown cover	X	X		X		
Percent deciduous shrubs					X	
Percent shrub crown cover of bank vegetation					X	
Percent shrub crown cover within 100 m of water					X	
Percent tree canopy closure	X	X				X
Percent deciduous trees						X
Percent coniferous cover	X					X
Percent mast- and cone-producing trees in stand		X				
Water regime						X
Wetland cover						X
Abundance of _Typha_ spp. to other emergent vegetation					X	
Ratio of open water to cover						X
Abundance of emergent vegetation to open water					X	
Average height of herbaceous vegetation			X			
Average height of herbaceous vegetation within 100 m of water					X	
Average height of shrubs	X			X	X	
Average height of shrubs within 100 m of water					X	
Average height of trees	X	X		X		X
Average dbh of trees	X	X		X		X

Table 3. (continued)

Inventory Characteristics	Habitat Types					
	Deciduous Forest	Evergreen Forest	Agricultural and Open Fields	Shrubland	Scrub/Shrub Wetland	Forested Wetland
Average dbh of mast-producing trees	X					
Average dbh of snags		X				X
Average dbh of cavity trees						X
Basal area of mast-producing trees	X					
Number of mast-producing trees per 0.4 ha	X	X				X
Stem density	X	X		X		
Snag density		X				X
Number of nest cavities per 0.4 ha						X
Number of den trees (dbh 40 cm & over) per 8.0 ha						X
Woody stem distribution	X			X		
Abundance of logs and stumps	X	X				
Size of forest land	X	X				
Aquatic habitat size						X
Water depth (emergent zone)					X	
Percent of water area 1 m or greater in depth					X	
Percent of water between 7.5 and 45 cm deep						X
Water current					X	X
Water level stability					X	
Percent slope				X		
Percent bank slope					X	
Soil texture	X			X	X	X
Bank soil texture					X	
Soil moisture	X	X				X
Distance to emergent vegetation					X	
Distance to opening	X	X		X		X
Distance to shrubland or forest land			X			
Distance to open fields or agricultural rowcrops				X		
Distance to suitable perch sites			X			
Distance to forest land			X	X		
Distance to water	X	X	X	X	X	X

Table 4. Evaluation of terrestrial baseline conditions - habitat types, Habitat Suitability Index (HSI), and Habitat Unit values.

Habitat Types	HSI	Reservoir Pool Area		Remaining Area		Total	
		Acres	Habitat Units	Acres	Habitat Units	Acres	Habitat Units
Deciduous Forest	0.57	794	453	2,488	1,418	3,282	1,871
Evergreen Forest	0.55	1,556	856	1,586	872	3,142	1,728
Agricultural and Open Fields	0.59	192	113	186	110	378	223
Shrubland	0.66	63	42	120	79	183	121
Scrub/Shrub Wetland	0.81	124	100	20	16	144	116
Forested Wetland	0.65	446	290	126	82	572	372
Sub-total	-	3,175	1,854	4,526	2,577	7,701	4,431
Sand & Gravel Pits[1]	0.0	66	0.0	184	0.0	250	0.0
Recreation Land	0.0	51	0.0	27	0.0	78	0.0
Open Water	0.0	56	0.0	104	0.0	160	0.0
Total	-	3,348	1,854	4,841	2,577	8,189	4,431

[1]Sand and gravel pits, recreation land (golf course, game fields, etc.) and open water were not evaluated and are included only to depict the total area.

Table 5. Statistics of baseline Habitat Suitability Index (HSI) values.

Habitat Types	No. of Sample Points	Mean HSI Value	Standard Deviation	Coefficient of Variation	Standard Error of the Mean	Standard Error of the Mean / Mean[1]
Deciduous Forest	36	0.570	0.250	0.439	0.042	0.074
Evergreen Forest	36	0.549	0.212	0.386	0.035	0.064
Agricultural and Open Fields	36	0.590	0.234	0.397	0.039	0.066
Shrubland	36	0.662	0.184	0.278	0.031	0.047
Scrub/Shrub Wetland	20	0.810	0.199	0.246	0.044	0.054
Forested Wetland	36	0.646	0.263	0.407	0.044	0.068

[1] Data are considered to be biologically sound, in general, and represent good ecological information if the standard error of the mean is equal to or less than eight (8) percent of the mean (general rule of thumb).

Table 6. Projected change in major land-use types by target year, without the project.

Area Target Year	Deciduous Forest[1]	Evergreen Forest[1]	Agricultural and Open Fields[2]	Shrubland[3]	Scrub/Shrub Wetland[4]	Forested Wetland[4]	Sand and Gravel Pits[5]	General Recreation Areas[6]	Open Water[4]	Total Acres
	Land-Use Type (acres)									
Reservoir Pool Area										
0	794	1,556	192	63	124	446	66	51	56	3,348
25	761	1,523	180	58	124	446	100	100	56	3,348
50	761	1,523	180	108	124	446	50	100	56	3,348
75	761	1,523	180	158	124	446	0	100	56	3,348
100	786	1,548	180	108	124	446	0	100	56	3,348
Remaining Area										
0	2,488	1,586	186	120	20	126	184	27	104	4,841
25	2,396	1,494	176	100	20	126	300	125	104	4,841
50	2,396	1,494	176	250	20	126	150	125	104	4,841
75	2,396	1,494	176	400	20	126	0	125	104	4,841
100	2,471	1,569	176	250	20	126	0	125	104	4,841

[1]One hundred twenty-five acres to sand and gravel pits by year 25 with 100 acres gained from reverting shrubland by year 100.

[2]Twenty-two acres to general recreation by year 25.

[3]Twenty-five acres to general recreation by year 25, 200 acres of reverting sand pits by years 50 and 75, 100 acres to deciduous forest, and 100 acres to evergreen forest by year 100.

[4]No change in these types.

[5]Area doubles in size by year 25 with 100 acres into general recreation, 200 acres to shrubland by year 50, and 200 acres to shrubland by year 75.

[6]One hundred acres from sand and gravel pits, 25 acres from shrubland, and 22 acres from agricultural and open fields by year 25.

Table 7. Annualized Habitat Unit changes for entire analysis period (100 years) without the project.

Habitat Types (HSI)[1]	Target Year	Reservoir Pool Area: Acres	Reservoir Pool Area: Habitat Units	Reservoir Pool Area: Annualized Habitat Unit Change	Remaining Area: Acres	Remaining Area: Habitat Units	Remaining Area: Annualized Habitat Unit Change	Total Annualized Habitat Unit Change
Deciduous Forest								
(0.57)	0	794	453		2,488	1,418		
	25	761	434		2,396	1,366		
	75	761	434		2,396	1,366		
	100	786	448	-15	2,471	1,408	-41	-56
Evergreen Forest								
(0.55)	0	1,556	856		1,586	872		
	25	1,523	838		1,494	822		
	75	1,523	838		1,494	822		
	100	1,548	851	-14	1,569	863	-39	-53
Agricultural and Open Fields								
(0.59)	0	192	113		186	110		
	25	180	106		176	104		
	100	180	106	-6	176	104	-5	-11
Shrubland								
(0.66)	0	63	42		120	79		
	25	58	38		100	66		
	50	108	71		250	165		
	75	158	104		400	264		
	100	108	71	+25	250	165	+75	+100
Scrub/Shrub Wetland								
(0.81)	0	124	100		20	16		
	100	124	100	0	20	16	0	0
Forested Wetland								
(0.65)	0	446	290		126	82		
	100	446	290	0	126	82	0	0
Total Annualized Habitat Unit Change				-10			-10	-20

[1]Habitat Suitability Index.

Table 8. Annualized Habitat Unit changes for entire analysis period (100 years) with the project, with management.

Habitat Types (HSI)[1] Target Year[2]		Reservoir Pool Area Acres	Habitat Units	Annualized Habitat Unit Change	Remaining Area Acres	Habitat Units	Annualized Habitat Unit Change	Total Annualized Habitat Unit Change
Deciduous Forest								
(0.57)	-5	794	453		2,488	1,418		
(0.66)	0	0	0		2,396	1,581		
(0.76)	5	0	0		2,396	1,821		
(0.80)	25	0	0		2,396	1,917		
(0.80)	100	0	0	-464	2,396	1,917	+482	+18
Evergreen Forest								
(0.55)	-5	1,556	856		1,586	872		
(0.64)	0	0	0		1,494	956		
(0.74)	5	0	0		1,494	1,106		
(0.78)	25	0	0		1,494	1,165		
(0.78)	100	0	0	-877	1,494	1,165	+282	-595
Agricultural and Open Fields								
(0.59)	-5	192	113		186	110		
(0.71)	0	0	0		581	412		
(0.82)	5	0	0		250	205		
(0.82)	100	0	0	-116	250	205	+108	-8
Shrubland								
(0.66)	-5	63	42		120	79		
(0.73)	0	0	0		120	88		
(0.83)	5	0	0		451	374		
(0.83)	100	0	0	-43	451	374	+288	+245
Scrub/Shrub Wetland								
(0.81)	-5	124	100		20	16		
(0.84)	0	0	0		20	17		
(0.84)	100	0	0	-103	20	17	+1	-102
Forested Wetland								
(0.65)	-5	446	290		126	82		
(0.72)	0	0	0		126	91		
(0.74)	5	0	0		126	93		
(0.76)	25	0	0		126	96		
(0.76)	100	0	0	-297	126	96	+14	-283
Subimpoudments[3]								
(0.0)	-5	0	0		0	0	0	
(0.68)	0	90	61		0	0	0	
(0.73)	5	90	66		0	0	0	
(0.73)	100	90	66	+67	0	0	0	+67
Total Annualized Habitat Unit Change				-1,833			+1,175	-658

[1]Habitat Suitability Index.

[2]Management would be initiated with project construction and would start at year -5 and not year 0 when project is completed.

[3]Represents a new habitat type that would include standing timber, scrub/shrub and open water. Includes three (3) subimpoundments of 8, 12, and 70 acres.

Table 9. Average annual change in Habitat Units with and without the project and area required for in-kind compensation of Habitat Unit losses.

Habitat Types	Average Annual Change in Habitat Units[1]: Without the Project	Average Annual Change in Habitat Units[1]: With the Project	Net Average Annual Change HU's	Average Annual[2] Management Increment	Area Required for Compensation (Net Loss HU's / Mgmt Increment = Acres)
Deciduous Forest	-56	+18	+74	0.22	0
Evergreen Forest	-53	-595	-542	0.22	2,464
Agricultural and Open Fields	-11	-8	+3	0.23	0
Shrubland	+100	+245	+145	0.17	0
Scrub/Shrub Wetland	0	-102	-102	0.03	3,400
Forested Wetland	0	-283	-283	0.11	2,573
Subimpoundments	0	+67	+67	0.74	0
Total	-20	-658	-638	-	8,437

[1] Average annual change in Habitat Units from Tables 7 and 8.

[2] The annualized change of the HSI values shown in Table 8.

Table 10. Relative importance value criteria by habitat types.

RIV Criteria	Range of Value[1]	Habitat Types: Deciduous Forest	Evergreen Forest	Agricultural and Open Fields	Shrubland	Scrub/Shrub Wetland	Forested Wetland
Abundance	1 - most abundant 10 - least abundant	1	3	4	6	10	8
Vulnerability	1 - lowest probability 10 - greatest probability	2	4	10	8	1	1
Replaceability	1 - easily managed and/or created 10 - little or no possibility to manage or create	6	5	1	2	10	8
Aesthetic Value	1 - lowest value 10 - highest value	10	8	1	4	5	6
Recreational Diversity	1 - low 10 - high	10	6	1	3	4	8
Species Richness	1 - lowest 10 - highest	6	4	1	8	10	10

[1] A scale of 1-10 was used for filling each square of this matrix.

Table 11. Pairwise comparison matrix.

RIV Criteria	Pairwise Comparisons[1]																					Sum	Weight[2]
Abundance	1	0	1	1	0	1																4	0.19
Vulnerability	0						0	1	1	0	1											3	0.14
Replaceability		1					1					1	1	0	1							5	0.24
Aesthetic			0					0				0				1	0	1				2	0.10
Recreational Diversity				0					0				0			0			0	1		1	0.05
Species Richness					1					1				1			1		1		1	6	0.28
Dummy Variable						0					0				0			0		0	0	0	0.00
Total																						21	1.00

[1]This technique requires that each criterion be compared to every other criterion, and a decision made as to which criterion of any pair is the most significant. A dummy criterion is included to insure that all criteria will have some weighting value.

[2]The sum total is divided into each criterion sum and the resulting value entered in the weight column representing the relative importance of each criterion.

Table 12. Relative importance values.

RIV Criteria	Habitat Types					
	Deciduous Forest	Evergreen Forest	Agricultural and Open Fields	Shrubland	Scrub/Shrub Wetland	Forested Wetland
Abundance	0.19[1]	0.57[1]	0.76[1]	1.14[1]	1.90[1]	1.52[1]
Vulnerability	0.28	0.56	1.40	1.12	0.14	0.14
Replaceability	1.44	1.20	0.24	0.48	2.40	1.92
Aesthetics	1.00	0.80	0.10	0.40	0.50	0.60
Recreational Diversity	0.50	0.30	0.05	0.15	0.20	0.40
Species Richness	1.68	1.12	0.28	2.24	2.80	2.80
Total	5.09	4.55	2.83	5.53	7.94	7.38
Relative Importance[2] Value (RIV)	0.64	0.57	0.36	0.70	1.00	0.93

[1]Represents the product of the values from Tables 10 and 11.

[2]The relative importance value is obtained by dividing the sum for each habitat type by the greatest individual sum.

Table 13. Adjustment to areas required for compensation using relative importance values.

Habitat Types	RIV[1]	Net Gain or Loss of HU's	$\frac{\text{RIV Habitat Type 1}}{\text{RIV Habitat Type 2}}$	=	$\frac{\text{HU's Type 1}}{\text{HU's Type 2}}$	X HU's	Adjusted HU's	Area Required for Compensation $\frac{\text{Adj HU's}}{\text{Mgmt Inc}}$[2]	=	Acres
Deciduous Forest (A)	0.64	+74	-		-	-74	0	0		
Evergreen Forest (B)	0.57	-542	$\frac{0.64(A)}{0.57(B)}$	=	$\frac{74(A)}{X(B)}$	+83	-459	-		
Agricultural and Open Fields (C)	0.36	+3	-		-	-3	0	0		
Evergreen Forest (B1)	0.57	-459	$\frac{0.36(C)}{0.57(B1)}$	=	$\frac{3}{X(B1)}$	+2	-457	-		
Shrubland (D)	0.70	+145	-		-	-145	0	0		
Evergreen Forest (B2)	0.57	-457	$\frac{0.70(D)}{0.57(B2)}$	=	$\frac{145(D)}{X(B2)}$	+178	-279	$\frac{279}{0.22}$	=	1,268
Subimpoundments (E)	-[3]	+67[3]	-		-	-67	0	0		
Scrub/Shrub Wetland (F)	1.00	-102	$\frac{1.00(E)}{1.00(F)}$	=	$\frac{34(E)}{X(F)}$	+34	-68	$\frac{68}{0.03}$	=	2,267
Forested Wetland (G)	0.93	-283	$\frac{0.93(E)}{0.93(G)}$	=	$\frac{33(E)}{X(G)}$	+33	-250	$\frac{250}{0.11}$	=	2,273
Total adjusted area required for compensation										5,808

[1] Relative importance values from Table 12.

[2] Management increment from Table 9.

[3] Assume 34 HU's would be scrub/shrub wetland and 33 HU's forested wetland. Each is assumed to have the same RIV as parent type.

Table 14. Estimated acquisition, development, and operation and maintenance costs of wildlife habitat for compensation purposes.

	Initial Cost[1] Acquisition	Initial Cost[1] Development	Annualized[1] Operation & Maintenance Cost
Additional Lands			
Evergreen Forest	@$700a = $ 887,600	@$ 50a = $ 63,400	@$ 5a = $ 6,300
Scrub/Shrub Wetland	@$300a = $ 680,100	@$ 160a = $ 362,700	@$ 2a = $ 4,500
Forested Wetland	@$300a = $ 681,900	@$ 160a = $ 363,700	@$ 3a = $ 6,800
Sub-total	$2,249,600	$ 789,800	$17,600
Big River Project Lands			
Sand & Gravel Pits	-	@$6,000a = $2,208,000	-
Deciduous Forest	-	@$ 50a = $ 119,800	@$ 5a = $12,000
Evergreen Forest	-	@$ 50a = $ 74,700	@$ 5a = $ 7,500
Agricultural & Open Fields	-	@$ 50a = $ 10,600	@$10a = $ 2,600
Shrubland	-	@$ 50a = $ 6,000	@$10a = $ 4,400
Scrub/Shrub Wetland	-	@$ 160a = $ 3,200	@$ 2a = $ 100
Forested Wetland	-	@$ 160a = $ 20,200	@$ 3a = $ 400
Subimpoundments	-	@$ 40a = $ 3,600	@$ 8a = $ 700
Sub-total	-	$2,446,100	$27,700
TOTAL	$2,249,600	$3,235,900	$45,300

[1]Cost of topsoiling and seeding sand and gravel pits estimated by CE. The construction and maintenance costs for subimpoundment dikes have not been determined. All other costs were estimated by the RI Division of Fish and Wildlife and this Service based on 1979 dollars. These costs are subject to revisions as management plans are finalized.

JUL 19 1979

Colonel Max B. Scheider
Division Engineer
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Colonel Scheider:

We have reviewed the proposed Big River Reservoir Project in Kent County, Rhode Island, relative to the presence of Federally listed or proposed endangered or threatened species within the project impact area.

Except for occasional transient individuals, no Federally listed or proposed species under our jurisdiction are known to exist in the project impact area. Therefore, no Biological Assessment or further Section 7 Consultation is required with the Fish and Wildlife Service (FWS). Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to endangered species under our jurisdiction. It does not address other FWS concerns under the Fish and Wildlife Coordination Act or other legislation.

Lists of Federally listed and proposed endangered and threatened species in Rhode Island are enclosed for your information. Thank you for your interest in endangered species. Please contact us if we can be of further assistance.

Sincerely yours,

Howard D. Woon

ACTING Regional Director

Enclosure

cc: NEAO

ADDENDA AND ERRATA TO APPENDIX I,
"Social and Cultural Resources"

1. Section 2 - Cultural Resource Reconnaissance

   a. P. 50 - CEM - 6 "Door War" should read "Dorr War"

   b. P. 132-137:

      TRN-5 should be New London Turnpike
      (s)-TRN-6 should be site of Webster Gate
      TRN-7 should be Nooseneck Hill Road
      TRN-8 should be Big River Bridge, #34
      TRN-9 should be Nooseneck River Bridge, #36
      TRN-10 should be Interstate 95

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX I

SOCIAL AND CULTURAL RESOURCES

Section 1 - Social Resources

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

APPENDIX I

SOCIAL AND CULTURAL RESOURCES

SECTION 1 - SOCIAL RESOURCES

TABLE OF CONTENTS

INTRODUCTION

Through the plan formulation process, the development of a reservoir on Big River has been carried as a major element and thus forms the basis of the detailed plans. Development of Big River Reservoir responds to the planning objectives and makes positive contributions to the water supply, flood control, and recreation needs of the study area.

This section of the Social and Cultural Resources Appendix is specifically devoted to the social well-being contributions of the detailed plans. According to the Water Resources Council, a plan's effects on social well-being can best be described in terms of its effects on the distribution of real income, its effects on health, safety, and community well-being, its effects on educational, recreational, and cultural opportunities, and some indication of the probability it would cause community disruption or injurious displacement of people. This description has been adapted to the present planning effort to provide a framework for presenting the impacts of the detailed plans. These impacts are displayed in the System of Accounts as developed during the plan formulation process documented in Appendix B, "Plan Formulation", and are described in more detail in the following pages.

Impacts of varying magnitude and longevity can be expected to occur during the two phases of project implementation: construction and post-construction. Impacts likely to occur during the construction phase are generally short term and site-specific. The post-construction phase is characterized by long term impacts that have regional as well as site-specific implications.

EFFECTS ON HEALTH, SAFETY, COMMUNITY WELL-BEING

CONSTRUCTION

The actual construction activities would result in increased air, noise, and dust levels, and increased truck travel on local roads. Because the construction area is sparsely settled and residents within the area would be relocated, these effects are not expected to have significant impacts on health and safety. Areas affected by construction activities include the Big River Reservoir site, the water treatment plant site located nearby the impoundment area in West Greenwich, and the beginning and terminating areas of the proposed aqueduct from the water treatment plant to the junction shaft provided in the existing Providence water system supplemental aqueduct near the West Warwick Country Club in West Warwick. Disruptions would also occur in the areas of Burrillville and Glocester, Rhode Island and Rehoboth, Massachusetts for the development of groundwater resources. The major disruption involved in this groundwater development would result from the construction of water transmission mains. The exact locations of transmission routes have not been identified at this stage of study, although it is probable that they would follow existing roads where possible. Impacts resulting from this activity would, however, be minimized by the location of transmission mains during advanced engineering and design activities.

POST-CONSTRUCTION

Beneficial impacts to public health and safety would result over the long term from project implementation. Study area residents would have adequate water supply of dependable quality to meet their daily needs. The project would also assure sufficient water pressure to combat fires. The reservoir would marginally reduce the flood stages along the mainstem of the Pawtuxet River, although substantial damages would still occur.

EFFECTS ON ECONOMIC ACTIVITY

CONSTRUCTION

A project of Big River Reservoir's magnitude would require a fairly large construction work force over the estimated four year construction period and may result in some permanent and temporary relocations to the surrounding area. Increased employment opportunities would benefit the entire State of Rhode Island, where the unemployment problem is typically significantly more severe than the national average, and particularly to those towns adjacent to the impoundment area, including West Greenwich, Coventry, East Greenwich, and Exeter. Increased employment in the area may have an especially beneficial impact on nearby North Kingstown, where many employment opportunitites were lost as a result of the closing of military installations located there. Increased aggregate income consequent to increased employment could also be expected.

Commercial activity would increase during project development. The local construction industry and local retail and eating establishments would benefit with the influx of construction workers into the area.

POST-CONSTRUCTION

The major commercial activity in the impoundment area that would be eliminated by the construction of the reservoir is the mining of sand and gravel in the vicinity of Division Street and Interstate Route 95. Three private contractors are currently removing one million cubic yards each under agreement with the State, a task that should be accomplished during 1983. It is estimated that over thirty million cubic yards of sand and gravel remain in the area, with a commercial value of \$1.00 to \$1.50 per cubic yard, depending on the texture and quality of the product at the pit. Total commercial value is, therefore, estimated to be between \$30 million and \$45 million at the present time.

The value of the resource and the effects of eliminating the mining of the sand and gravel on the area economy acquire increased significance when weighed against the predicted scarcity of sand and gravel for construction purposes in southeastern New England and, in particular, Rhode Island. Those contractors currently involved in excavation operations at the Big River site claim that this source provides the highest quality sand and gravel for the lowest cost possible within the State. Although none of the three contractors employ any workers solely to complete their contractual agreement with the State, several of their employees are involved in that operation at various times. While two of the three contractors regard activities in the Big River area as a small portion of their overall operation, one claimed that his business was largely dependent on the contract to remain profitable. Alternative sources of sand and gravel exist but involve much greater transportation distances at greater expense. Transportation costs have been estimated at $30 per hour per truckload of approximately 20 cubic yards. It is also estimated that one hour is required to complete a round trip delivery for each additional seven to eight mile distance from the source to the purchaser. These additional transportation costs are reflected in the price of sand and gravel in the local market, and therefore passed on to the construction industry.

The State of Rhode Island is currently undertaking a study to determine the feasibility of removing more or all of the sand and gravel prior to construction of a reservoir at the Big River site and store it at another site. The study is expected to result in a resource management plan designed to mitigate the potential loss posed by reservoir construction.

One activity in the impoundment area with significant recreational and commercial value is golf. A nine-hole course is located along Harkney Hill Road in Coventry and would be completely eliminated by the construction of the proposed Big River Reservoir. Usually open from mid-March to mid-December, the club employs five persons full time with a total payroll of approximately $25,000. Although no figures for annual revenue are available, they can be estimated using the known green fees and utilization rates. On the average day, 150 to 175 golfers use the course for a fee of $3.00 for nine holes or $5.00 for eighteen holes. On Sundays, the peak day of use, up to 200 golfers are common. Thus, an average of 168 golfers per day for an average fee of $4.00 use the course on approximately 260 days, resulting in a total gross revenue of $181,400. This estimate could be considered minimal because it ignores the additional revenues obtained from equipment sales and rentals and the operation of a snack bar. Golf is the only recreational activity in the area for which a fee is required.

Other commercial activities at the proposed reservoir site include the operation of a single drinking establishment in a building rented from the State and the harvesting of a small quantity of timber under agreement with a private contractor. Most of the vegetative cover is of a scrub variety, with little or no commercial value. Several sections of softwood sawtimber do exist and could be harvested before any proposed development occurs. Although the hardwood trees in the area are not generally large enough for sawtimber, they could be sold for other purposes such as pulp, poles, posts, and firewood.

EFFECTS ON LAND USE

CONSTRUCTION

Construction activities would have limited affects on existing land use activities. Most land use impacts of project implementation would be felt over the long term and are addressed in the next section. The construction phase, however, would initiate the eventual transformation of the area from a sparsely settled, wooded, open space area to one dominated by the existence of a reservoir. The overall character of the area in regards to its open space and undeveloped nature would stay much the same. The fact that the State of Rhode Island has owned the land since the mid-1960's for the development of a water supply reservoir accounts for the limited development within the Big River site.

No temporary easements would be required for construction of the reservoir since the land is currently owned by the State. Temporary work areas for the aqueduct would be necessary only at the beginning and terminating areas of the line. No temporary easements would be required since lands at the beginning area have been obtained for reservoir purposes and lands at the terminating area are publicly controlled for water supply services. Some permanent and temporary easements would also be required for construction of water transmission mains associated with well-field development.

Land taking for groundwater well sites and pumping facilities would be required in those communities not served by the Providence water system.

POST-CONSTRUCTION

Permanent subsurface easements would be acquired for a distance of approximately seven miles from the beginning of the aqueduct at the site of water treatment facilities to the termination point in West Warwick. Generally, the tunnel would pass below approximately 200 private ownerships, approximately 50 streets, two rivers, two cemeteries and a golf course. Preliminary investigations, conducted for this study, indicate that the acquisition of subsurface easements would not affect the highest and best use of any of the affected properties.

The State Water Supply Plan, published in 1969, designated the Big River site as a major source for future water supply. This designation has been maintained by State land use plans and projections which indicate the area as remaining in open space. The Corps' project plans, therefore, are compatible with State needs and desires. The recreational aspects of the Corps' plan also correspond with the State's desires to develop some regional recreational facilities.

Aside from the actual site, reservoir development may have implications in future growth and development throughout much of the State of Rhode Island. Development of the reservoir would provide sufficient water supply for the study area and would accommodate the projected population growth without water being a limiting factor. Also, industrial growth would be allowed to continue as at present, bringing with it an increased economic base for the study area. Commercial activities would increase with the establishment of new residences and industries.

EFFECTS ON TRANSPORTATION

CONSTRUCTION

Development of the Big River Reservoir would create temporary disruptions of existing traffic patterns on the roadways providing access to the construction area. A sufficient number of roads and trails in reasonable locations traverse the project locale to accommodate construction access. The impoundment area provides a source for some construction materials although some sands and gravels may have to be transported from deposits that are within 25 miles of the site. Route I-95 is the major route of access to and through the project area. Construction activities would not disrupt this access, however, there would be an increase of heavy truck traffic on certain portions of I-95 with the transport of materials and equipment to and from the site including the removal of excavated material from the aqueduct. Road relocation activities may hinder normal traffic patterns to some extent. This effect is not expected to be significant since the roads being altered are not heavily utilized and alternate access routes would be provided.

POST-CONSTRUCTION

Several roads within the impoundment area would be abandoned with others being permanently relocated. The extent of the relocation and reconstruction activities differ with the different plans and are discussed in the comparison section of Appendix B, "Plan Formulation." Abandoned roads include Division Street south of Hopkins Hill Road. Portions of Nooseneck Hill Road and Harkney Hill Road would be relocated.

EFFECTS ON RECREATION

CONSTRUCTION

Recreational access to the reservoir site would likely be prohibited during the 4-year construction period. This would temporarily displace boating, fishing, hunting, hiking, picnicking, and camping activities. Recreationists would be forced to seek alternative sites during this period. Other sites for all of these activities do exist within the local area. However, some facilities, most especially those for boating, are already in short supply. Other activities, such as golf, would not only be eliminated during the construction period, but also after construction has been completed. Reference should be made to Appendix H, "Recreation and Natural Resources" for detailed discussion of these impacts.

POST-CONSTRUCTION

Recreational demand at the Big River site is only a small percentage of total statewide demand. Therefore, impacts on recreational opportunities resulting from plan implementation would be minimal on the State as a whole. An impact analysis of recreational activities at the Big River site, presented in Appendix H, considered three options for development ranging from Option I, no development of recreational facilities to Option III, development of large-scale recreation facilities. Option II suggested intermediate development. For purposes of this study, Option III was selected for analysis as an element of the detailed plans.

Reference to Appendix H should be made for a more detailed assessment of recreational demand and supply and the effect of the Big River Reservoir development. Generally, however, development of the site would result in the following:

. continuation of a shortage of boating facilities in the local area, although there would be a slight reduction in this deficit,

. elimination of a golf club (an activity with projected shortage prior to 2020) without any provision to provide for a replacement facility,

. reduction in hunting acreage although existing supply far exceeds projected demands for the local area,

. replacement of stream fishery resources with lake fishery,

. loss of three outdoor game fields to be replaced at other areas,

. slight reduction in the existing shortage of swimming facilities, and

. provision of camping and picnicking facilities currently not available within the Big River site.

DISPLACEMENT OF RESIDENTS

Development of the Big River Reservoir would cause the relocation of a total resident population of about 440 people. One hundred nine residents are scattered throughout the proposed reservoir site and the Maple Root Trailer Park with 79 mobile homes presently located at the site of proposed water treatment facilities. These tenants have been renting from the State with the knowledge that relocation would become necessary once the proposed reservoir development occurred.

COMPARISON OF PLANS

Differences among the detailed plans are actually quite few. Therefore, impacts on social well-being considerations are much the same for each of the plans and as described heretofore.

The Big River Reservoir is the major element for satisfying future water demands as depicted in each of the detailed plans. Groundwater development would be the same in Plans A and B, being less extensive in Plan C. These differences in the presentation of detailed plans, however, do not appear to be significant in terms of social well-being considerations. All the detailed plans satisfy the water supply needs of the study area.

The major difference between Plan C and Plans A and B is that Bristol County would receive some water from the Big River Reservoir/Scituate Reservoir system rather than phased development of groundwater from Rehoboth, Massachusetts. Construction of transmission mains would be much more extensive in Plan C, requiring an additional main, approximately 12.4 miles in length, from the Providence water system in Cranston, crossing the Providence and Warren Rivers, and terminating in the existing Bristol County Water Company distribution system in Warren. The route of the transmission main would follow existing roads over most of its length and could be expected to cause some disruption of local activities. Final design for location of the transmission main would attempt to minimize adverse impacts associated with its construction.

One other significant difference among the de.ailed plans considers road relocations within the impoundment area. Plans A and C are similar in this respect, with Plan B suggesting more intensive road reconstruction. Therefore, under Plan B, maximum access within the project area would be offered.

All detailed plans provide the same degree of flood protection and recreational development.

CULTURAL RESOURCE RECONNAISSANCE

The following study consists of two reports considering potential cultural resource impacts of the proposed project.

The first portion is an archaeological resource reconnaissance prepared by the Public Archaeology Laboratory of Brown University covering recorded site data and potential of unrecorded resources within the project impact area.

The second portion of this report is a study of historic resources within the project area, prepared by the Rhode Island Historic Preservation Commission. This study located all historic sites and structures within the property limits of the proposed reservoir and recommends further study of selected historic features.

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX I

SOCIAL AND CULTURAL RESOURCES

Section 2a - Archaeological Resources

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

BIG RIVER RESERVOIR PROJECT, RHODE ISLAND

A PILOT STUDY:

DATA INVENTORY AND DATA EVALUATION

HISTORIC AND PREHISTORIC

ARCHAEOLOGICAL RESOURCES

DECEMBER 1978

COMPILED FOR: U.S. ARMY CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

BY: PUBLIC ARCHAEOLOGY LABORATORY
DEPARTMENT OF ANTHROPOLOGY
BROWN UNIVERSITY
PROVIDENCE, RHODE ISLAND

Peter Thorbahn, Principal Investigator
Nain Anderson, Director

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

<u>Figures</u>

INTRODUCTION

The main objectives of this pilot study were:

A. To identify and inventory known sources of documentary and oral information related to archaeological resources in the proposed main flood pool area of the Big River Reservoir project.

B. To conduct a preliminary field reconnaissance to establish "ground truth" of environmental and cultural data recovered from documentary sources.

Secondary objectives in this study were:

C. To make a preliminary evaluation of the utility and quality of documentary and oral information.

D. To identify particular field problems and research questions which might be addressed in a full scale reconnaissance survey.

E. To make rough estimates on the archaeolgical sensitivity for the five projected alternative feeder reservoirs.

These categories of information would ultimately be used to develop a research design for a full scale reconnaissance of the Big River Reservoir system. A pilot study for the archaeology of the Big River project is necessary because the main reservoir alone is some 3,800 acres in area. Obviously, it would be impractical to survey all of the area to be impounded so some sort of sampling scheme would have to be employed in reconnaissance survey. This study provides the known data base to be used for sampling design. The sample might be systematically or randomly selected or a combination of both, but in any case the results of the survey would have to be interpreted within a framework of known and expected classes of information. The pilot study serves as a foundation for this interpretative framework.

PROJECT LOCATION

Located in the west central section of Rhode Island, the proposed Big River Reservoir system is currently under consideration as a supplement to the Providence water supply system. The objective of this system is to meet the needs of the city and its environs for the year 2020 when the projected metropolitan population will exceed 798,000 persons. The Big River system would factor into a larger statewide master plan, with a project completion date in the early 1980's for most of the workscope. At present a main catchment reservoir utilizing a varying combination of 5 alternative areas is under study.

The proposed catchment reservoir would be situated within the towns of Coventry and West Greenwich, Kent County, Rhode Island, as located on the Crompton, Slocum, Coventry Center and Hope Valley USGS quadrangle maps. Tapping the Big River watershed, the reservoir would have a surface area of approximately 15.3 square kilometers (5.9 square miles), at a standard pool elevation of 92.2 meters msl (302.5 feet msl) with an additional flood margin of .76 meters (2.5 feet) (Figure 1).

Of the different project areas, only the Big River Reservoir area received preliminary archaeological field reconnaissance.

In order to support the main Big River catchment several system models employing varying combinations of alternatives and feeders are presently undergoing initial examination by the Corps of Engineers. These options run the gamut from stream diversions and floodskims through possible feeder reservoir units. These alternatives focus on 5 potential sites located west and/or south of the main catchment.

The Wood River Reservoir would occupy sections of West Greenwich in Kent County and Exeter in Washington County as shown on the Hope Valley quadrangle (Figure 2). Here the potential pool of 3.6 square kilometers (1.4 sq. mi.) would stand at an elevation of 51.8m msl (170.0 feet msl).

A second possible reservoir site on Bucks Horn Brook in Coventry, Kent County, Rhode Island would entail a possible pool of 2.1 square kilometers (0.8 sq. mi.) with an average elevation of 137.1m msl (450 feet msl) outlined in Figure 3. This unit is located on the Coventry Center quadrangle.

A third possible reservoir could affect a section of the Moosup River on the western flank of Coventry, Kent County, Rhode

AD-A105 822   CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV   F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED   NL

6 OF 9
AD
A105 822

Island (Figure 4). Located on the Oneco quadrangle, this unit would also possess a pool of 2.1 square kilometers (0.8 sq. mi.) with a normal elevation of 106.6m msl (350.0 feet msl). The dam for this particular feeder would be near Oneco, in Sterling, Windham County, Connecticut.

A fourth possible reservoir site would utilize part of the Nooseneck River watershed, adjacent to the Big River catchment. As highlighted in Figure 5, this unit would pool an area of 2.1 square kilometers (1.1 sq. mi.) with an average elevation of 112.7m msl (370.0 ft. msl). This unit would occupy sections of the Coventry Center and Hope Valley quadrangles in West Greenwich, Rhode Island.

The fifth and final alternative under study is one along Fisherville Brook in Exeter, Washington County, Rhode Island (Figure 6). Located on the Crompton quadrangle, the pool line would probably hold at 60.9m msl (200 feet msl) with a surface area of less than 1.3 square kilometers (.5 sq. mi.).

Due to various limitations the Big River catchment received the preponderance of research attention including broadbrush windshield and walkover reconnaissance. For the 5 alternatives only a very basic level of research was entailed so that assessments of the prehistoric and historic background data in relation to a given feeder area's sensitivity for cultural resources is preliminary, being based primarily on extrapolation.

METHODOLOGY

In order to facilitate data assessment the Big River archaeological pilot study was organized into three categories of review, centering on an environmental component, a prehistoric component and an historic component. These components were in turn divided into research and field operations.

The research operation consisted, where applicable, of not only a primary and secondary literature search, but also various cartographic works, informant contacts, institution and agency resources review, and inventory assessments and collections review.

The field operations consisted of walkover and windshield surveys, including a photographic record and observation record. No subsurface testing was initiated. The Rhode Island Historic Preservation Commission's inventory of sites served as the framework for site identification.

ENVIRONMENTAL RESEARCH COMPONENT

Within the proposed Big River Reservoir area information has been obtained concerning a number of environmental attributes. Assessment of environmental data is one technique employed by archaeologists to determine the location, type and possible use of archaeological sites in a given region. By correlating, on a regional level, the locations of known sites with information about such attributes as bedrock and surficial geology, or the drainage and slope characteristics of soil types and vegetation, prehistorians can make estimates about the probability of sites occurring in similar environments. Historic period archaeological sites may cluster within a preferred geographic region, such as one with arable soils or water power with industrial potential. This type of information is included in the Big River Reservoir pilot study to shed light on the region's past environments and the cultures operating within them.

Prehistoric sites in New England are more likely to be found on gently sloping well-drained areas such as glacial kames above a source of fresh water (Dincauze, Thomas, Wilson & Mulholland, 1976:53). Many such areas are within the project bounds and should be explored as part of any program for sampling potential site locations. It would be interesting to see if indeed this is a valid model for site prediction in the project area, or whether sites are found in an entirely different drainage and slope zone. On the basis of the location of known sites in the project area, phehistoric occupation does occur on the base of large areas of higher elevation, such as the Huntry Hill drumlin, and within an area where soils support an extremely variable series of wildlife habitats.

ENVIRONMENTAL FIELD SURVEY

During the time that the crew spent on the Big River field survey, an effort was made to familiarize themselves with the ecozone and environmental potential of the area and to compare this more specific information with the data known from the background research. A series of environmental transects were performed on known historic and prehistoric sites and also in areas which exhibited archaeological potential. The procedure for gathering environmental data involved observing the different types of floral communites at environmental stations placed at fixed intervals along the transect. The types of shrubs, trees and grasses were noted as well as information on soil sequences and observing the succession of stages of growth in the area.

The background environmental research highlighted certain environments which the field crew specifically investigated for their archaeological potential. One such area was around Carr Pond, an elevated woodland region which contrasts with the rest of the predominately wetlands Big River area. The potential for prehistoric rock shelters is very high here. Another area, which is informally known as the Rhode Island Desert, was checked because of the indications that it was a former glacial lake bed. The shores of this ancient lake would be a potential location for prehistoric sites, particularly those of the Paleo-Indian period.

In other areas environmental transects were recorded at the location of previously unknown sites which were located in the field survey. One such example was a mid-eighteenth century cemetery located in the middle of the woods. There were no other known historic associations in the immediate vicinity with which it could be correlated. (By observing and recording ecological data in specific locales, more concrete and exact information can be gathered about the area and then applied to what is known about the archaeological potential.)

BEDROCK GEOLOGY

The proposed reservoir is located in the rolling uplands typical of western Rhode Island. Most of the project area rests on a foundation of Scituate granite gneiss which is one of the most widely exposed formations in Rhode Island. This formation is composed of older plutonic rocks, late Pennsylvanian in data (285-320 million years old) and is intruded upon by other formations such as the Ten Rod Granite and Ponagansett gneiss.

While it is known (Quinn, 1971) that mining of these granites occurred from an early date in the historic record, the precise location of these now abandoned quarries is not known, and might be a goal of archaeological investigation in the project area. Aboriginal peoples may have utilized locally obtained materials for tools, such as the smoky quartz and quartzite veins that occur in the Scituate Granite. An analysis of the lithic materials composing the recorded collections of the prehistoric sites in the project area would shed light on the use of such material.

Rock shelters occupied by aboriginal groups may be clustered in areas with a high frequency of bedrock outcrops. Four such sites (RI-WG-12-16) occupy an area of bedrock outcrops surrounding Carr Pond. Within the Crompton Quad three other similar areas exist (SGS surficial geological map, Crompton Quad, 1956).

SURFICIAL GEOLOGY

The layer of glacial deposit overlying the granite bedrock was derived from the last glacial advance--the Wisconsin. This glacial drift varies in composition and depth throughout the project area. Till, or unsorted material deposited directly from the melting ice, is distinguished from outwash, which is sorted and stratified material derived from the streams formed by the melting glacier. Till ranges between 10 and 30 feet (3m to 9.1m) in thickness. With outwash it is generally 15-50 feet (4.6-15.2m), although buried preglacial channels may fill to a depth of 100-150 feet (30.5-45.7m). Overlying these is a layer of windblown, or aeolian, deposits which may reach a depth of 5 feet (1.5m), especially in the southeastern part of the Crompton Quadrangle.

The exposed lake beds in the gravel pits between Lake Mishnock and Division Street, and the fine texture of the materials in the large flat outwash plain surrounding the Flat River Reservoir may mark the location of large shallow lakes formed by glacial meltwater (Smith, 1956). If so, it is the type of environment discussed by new England prehistorians Curran and Dincauze, 1977) when they attempted to correlate the presence of glacial Lake Hitchcock with the occurrence of Paleo-Indian sites in the Connecticut River Valley.

Varve chronologies have been established in which the rate of sedimentation is recorded and used to provide information about the environment surrounding the lake under investigation. Those published by Anteus (1922; 1928) and Ashley (1972) serve as examples of the type of work that might be attempted in order to define more closely the nature of the post-glacial environment as it was when first settled by Paleo-Indians between 12,000 and 10,000 B.P.

SOILS

Use of water and land by both prehistoric and historic populations was influenced by the soil types they encountered. Land use maps (RI map downs) and USDA soil surveys outline the various soil types in the area. As mentioned above, according to studies in Massachusetts, prehistoric sites tend to be located on well-drained soils with a slope of less than 8 percent (Dincauze and Meyer, 1977:54). Analyzing the location of prehistoric sites known by the RIHPC, it seems that while most open sites are on such soils, they are also positioned close to very poorly drained, wet areas that provide favorable habitats for wetland wildlife and flora, an important component of the aboriginal resource base. Testing for such sites, then, might be concentrated in areas with a varied environment, rather than exclusively on the summit of knolls or higher areas. The nature and extent of European land use was also affected by soil characteristics. Most of the soils analyzed are relatively unfavorable for the cultivation of seed crops and grains, as they are sandy loams, stony soils or swampy lowlands. Grasses, or pasture, are more likely to thrive on these soil types. A record of farm depopulation, or relatively late expansion into such a marginal area, might be expected in the historical archaeological record.

The former existence of a pastoral, timbering and rural industrial economy rather than a strictly agricultural one, should be noticeable in the archaeological record.

HYDROLOGY

Hydrologically the south branch of the Pawtuxet River, the major river drainage of the project area, has the potential to produce 15 billion gallons of water for storage. The lenses of outwash sand in the buried channel between Flat River Reservoir and Mishnock Swamp contain the area's major water-bearing deposits. The water table is, for the most part, shallow, but slopes steeply in the upland or hilly sections which contributes to the formation of many swamp areas such as those in the lowland beteeen the Flat River Reservoir and the Mishnock Swamp (Lang, 1961:21-22). Many streams cross the project area emptying into smaller ponds and lakes. Allen (1953:16) states that Rhode Island's greatest resource is this water, which contributed so heavily to the economic development of the project area. Mills, mill ponds, dams and other traces of water-related, historically documented industry are present along several of the streams in the project area, and should be part of any program for further investigation of historic period archaeological sites within the project's boundary.

CLIMATE

The problems of forest alteration, due to climatic changes, the influence of man, and natural catastrophe such as fires and disease, has been studied extensively. Ogden (1977:16-35) has outlined the regional forest sequence with the recession of the Wisconsin glaciation. Boreal spruce parkland environments composed the southern New England landscape at about 12,000 B.P., giving way to oak and other hardwoods by ca. 10,000 B.P. Hemlock pollen becomes more common after 8,000 B.P. A warm dry period occurred throughout the Northeast from 6,000 to 4,000 B.P., followed by a climatic deterioration that would produce vegetation very similar to the present forest cover. However, at about 2,000 B.P a brief warming period began, terminating at about 1,000 B.P. Historic records, cited by Ladurie (1971), do indicate a warm period in the 11th century and a cold period in the 17th and 18th centuries.

The present climate, then, with about 200 frost-free days a year, an average temperature of 50°F (10°C) and 40 inches (1m) of annual precipitation could resemble that of the years between 4,000-2,000 B.P. This may enable us to visualize one type of prehistoric environment.

FLORAL COMMUNITIES

The present flora of the region is primarily tree cover, according to the Rhode Island map downs. Braun (1953:248-249) places the entire project area within the "central hardwood" section of the oak-chestnut. Soil tables predict that the major species will be Eastern white pine, Northern red oak, sugar maple, red pine and red spruce. Environmental transects run on two major known prehistoric sites and confirm this general pattern, and also revealed the presence of cedars and birches.

Although Carr Pond was dammed in 1886, it is a natural feature, and is present on Jackson's map of 1840. Coring of both deeply buried sediments and the sediment/water interface could provide a detailed picture of the past vegetation and land use of the project area. Some pasture and abandoned fields break the forest cover. Within the transects mentioned above were found blueberries, dewberries, huckleberries and other plants edible by both man and wildlife. The question is whether this type of vegetation was present in the past and opens the way for new areas of investigation. If, as Day (1953:329-346) suggests, aboriginal groups burnt forest tracts to clear for such open land growth, this may reflect the contemporary cover of one phase of prehistoric occupation. The forest composition, however, may have been different. Elaborate investigation of the past vegetational history could be conducted. Some undisturbed deeply sedimented areas of open water or marsh could provide covers for pollen analysis. Such work has been done in similar environments by Davis (1969:409-422; 1977:219-230) at Rogers Lake, Connecticut; at Moulton Pond, Maine (Davis, 1975:436-465) and Brownington Pond, Vermont (Davis, 1960:346-357). Hopefully macrofossils and even large pieces of timber could be employed to give species identification and radiocarbon dates of the formation of the deposits themselves. Such information can contribute to research into the problem of environmental reconstruction for southern New England.

FAUNAL COMMUNITIES

Within the present forest, wetland, ponds and open land live a variety of fish, mammals and birds that could have been exploited by both aboriginal and European settlers. The original fish population in Rhode Island's ponds and streams were chain pickerel, yellow perch, common sunfish, brown bullhead and golden shiner (Guthrie and Stolgitis, 1977:6). Prehistoric fish weirs are located near Manchester Cemetery on the south branch of the Pawtuxet River, north of Tiogue Lake. The possibility of the existence of others near the area's natural ponds and lakes, for instance, or on the Big River south of the Reservoir, should be considered.

Nature game birds inhabiting the management area are ducks, quail and grouse. Jorgensen (1978:395) lists 38 varieties of birds common in summer in oak forest communities such as those in the project area. 35 more varieties prefer freshwater marshes, ponds and wetlands, of which several such as various duck species and geese, may be significant food resources.

Game mammals in the area include white-tailed deer, some cottontail rabbit and a few snowshoe hare. Others-marten, fisher and a few bears--were probably present prehistorically (Meyers, 1978: personal communication) and were valuable for both food and fur clothing.

The area, in short, would provide a broad base of both floral and faunal food resources for a prehistoric population.

LAND USE

Land use in western Rhode Island, as reflected by palynological investigation (Bernabo, 1977; Anderson, 1976) and measurement of sedimentation rate has been best preserved in the lakes and ponds of the region. In Carbuncle Pond, north of the Moosup River project area, a core was extracted and pollen and chronological vegetation sequence was constricted. This sequence sheds some light on the vegetational history of the "crystalline uplands" of this part of the state.

Prior to European settlement pine was more abundant than oak. There does not seem to be evidence for aboriginal clearing or agriculture. A slight rise in herbaceous pollen is evident at

35cm depth in the core, and is correlated with European colonization after 1700. This indicated some subsistence farming and logging was being carried out in the area. A great demand and use for the timber was generated by industrial development in the area. The establishment of acid-extraction mills, extension of railroads and use of the portable Corliss steam-powered sawmill hastened the deforestation of western Rhode Island. The last device, introduced into the region in the 1870's, was instrumental in reducing large tracts of Coventry to scrubby pine forest, as this saw provided a convenient method of using all the timber on a lot. White pine, oak, maple and chestnut formed most of the Coventry forest in 1878. In turn some of these logged-out lands were used for pasture until the swift decline of agriculture around 1900. It would seem, then, that most of the present oak/pine forest in the region consists of secondary growth less than 80 years old. First herbs, then birch, then the present composition of oak and pine are represented in the most recent strata of the pollen record.

PREHISTORIC RESEARCH COMPONENT

The literature search component of background study into prehistoric human activity in the project area investigated several sources of information. Previous investigations and descriptions of prehistoric activity on both the regional and local levels were reviewed and assessed in terms of their quality and relevance to the project area. Concurrently, various educational institutions and museums were contacted in an attempt to locate collections of prehistoric cultural material from the vicinity of the project area. Some of the more significant collections were inventoried and briefly analyzed.

Extant literature describing prehistoric activity on the regional level is limited, but provided a useful interpretive framework and chronological sequence for ordering the data which was located. Most of the regional literature is more directly relevant to Massachusetts and eastern Rhode Island (Dincauze, 1968; 1972; 1974; 1976; 1977) or even eastern New York (Ritchie, 1965) than interior, western Rhode Island or eastern Connecticut. These publications are the results of professional archaeological investigations and research.

The publication of state level avocational or amateur archaeological associations (Massachusetts Archaeological Society, Archaeological Society of Connecticut) were also reviewed. This literature is directly relevant to the project area and interior western Rhode Island and eastern Connecticut in general (e.g. Fowler, 1962; 1968; Arnold, 1969; Pope, 1952). This local literature was of particular value in making a determination of the extent and quality of available data on prehistoric activity in the project area.

Collections of prehistoric cultural material from the vicinity of the project area provided the data essential to reconstruct and fill out a cultural chronology and sequence of occupation for the area. The quality of provenience for these collections is quite variable, ranging from general locations within a town or village to exact vertical and horizontal location within a site.

Informants who are familiar with the prehistoric cultural resources in the vicinity of the project area were contacted during the research component. These are primarily avocational archaeologists and/or property owners with information about specific sites, collections or areas that could be expected to contain prehistoric sites. Several informants are also affiliated with museums.

PREHISTORIC FIELD SURVEY

The prehistoric field survey component for the project was basically similar to the procedures used during the historic field survey. A combination of windshield and walk over surveying was conducted in the main pool area in West Greenwich-Nooseneck. The main objective of the field survey was to verify the location and check the condition of known sites inventoried by the Rhode Island Historic Preservation Commission (RIHPC). During this field check operation some additional areas which have a high probability of containing prehistoric sites were located. While no subsurface testing was conducted (soil auger transects, test pits) environmental data was collected. Environmental transects were recorded in areas of expected sensitivity for prehistoric sites and on previously known sites.

The prehistoric field walk over survey focused on areas bordering wetlands associated with major drainages in the main pool area (Big River, Nooseneck River). This type of general environmental situation is expected to contain a majority of the prehistoric cultural resources. Another area which received attention during the walk over is the upland, elevated section of the project area near Carr Pond. This is an area of known sensitivity in terms of prehistoric cultural resources (rock shelters). In this way both areas of unknown (expected) and known sensitivity were given a preliminary investigation.

It should be emphasized that in both the research and field survey only the project area was investigated from a location-specific viewpoint. The proposed alternative feeder reservoirs did not receive the same level of investigation and the assessment of these areas is based on extrapolated data.

KNOWN PREHISTORIC SITES DATA

The project area is located in a variety of primarily upland, interior environmental zones. Most of the main pool area in West Greenwich is along several small interior river drainages with some extensive wetlands bordered by elevated glacial outwash deposits and hills. Other proposed feeder reservoirs are located on fairly narrow upland river drainages or smaller streams with wetlands/marshes associated with them.

Areas of Massachusetts and Rhode Island drained by interior upland river systems such as these usually contain few, if any, <u>known</u> prehistoric sites. However, the project area contains a substantial number of known prehistoric sites (10) with 5 in the flood pool itself, and there are many other known sites in the general vicinity of the project area (22). It is possible to document roughly 8,000 years of prehistoric occupation in the vicinity of the project area with the data currently available. The current inventory contains a wide range of site types related to both subsistence and specialized, nonsubsistence ceremonial activities. The known sites in or near the project area have the potential to provide data for exploring many research problems (see following section on Research Problems).

The large number of known sites is mostly the result of investigations by a number of avocational archaeologists. Some of the earliest and most extensive investigation and excavation of sites was done by the Hudson brothers of Rhode Island. The Hudsons located and excavated many upland rock shelters in central and western Rhode Island and their collection is now at Rhode Island College. Investigations by the Narragansett Chapter of the Massachusetts Archaeological Society have concentrated on some of the larger open multicomponent sites in riverine environments along the Flat River in Coventry, although some work has been done on rock shelters. More recent cultural resource surveys near the project area have located a few prehistoric sites (Route 102, Gero; Talmage, 1977). Preliminary surveys by the Rhode Island Historic Preservation Commission located the 10 sites within the project area (RIHPC, 1978).

Table 2 contains a summary of the data on the prehistoric sites for the project area, followed by sites in the vicinity of the project area. The latter are arranged according to distance away from the project area.

BIG RIVER: OUTLINE OF REGIONAL PREHISTORY/CULTURAL CHRONOLOGY

Only 2 of the sites within the project area had datable artifacts (in both cases, Late Archaic), therefore, the regional chronology for Big River is based almost entirely on sites in the general vicinity of the project or within southeastern New England as a whole.

I. Paleo-Indian ca. 11,000-10,000 B.P.

No definite Paleo-Indian components or sites are known in Rhode Island. A single fluted point may have marked a possible Paleo component and was found at the Twin Rivers site in Lincoln, Rhode Island. The known Paleo-Indian site locations in Massachusetts are on the shores of former glacial lakes and on large multicomponent Archaic/Woodland period sites on large drainage systems and lakes.

About 11,000 years ago southern New England may have been covered with an open spruce park woodland with willows, alders and other shrubs. This type of environment has been described for southeastern Massachusetts during the postglacial period (Hartshorn, 1967).

Paleo-Indian assemblages consist of Clovis type fluted points, flake tools including gravers, flake knives and scrapers. Bifacial knives and drills are also known. Paleolithic technology was based on high grade materials such as flint and jasper from sources outside New England such as New York and Pennsylvania.

Paleo-Indian social organization is unknown, but is thought to have been small bands of hunter/gatherers exploiting large territories. Long range trade/exchange of lithic raw materials is indicated. Sites may have been occupied for short periods by small groups of people. No burials or suggestions of religious-ceremonial activity are known.

II. Late Paleo-Indian (Plano Tradition) ca. 10,000-9,000 B.P.

Like the earlier Paleo-Indian, no definite components are known from southeastern Massachusetts or Rhode Island. Scattered finds of the characteristic projectile points are known from some of the larger Archaic/Woodland sites in the region. A possible component of this time period may have been found at the Flat River site in Coventry, Rhode Island where some unfluted Paleo-like points were found in the lowest cultural levels of the site (Fowler, 1968). Late Paleo-Plano settlement patterns are assumed to be similar to those known for earlier Paleo-Indians.

A mixed forest type dominated by pine with small amounts of oak probably covered Rhode Island about 9,000 years ago (Dincauze and Mulholland, 1977:447). Late Paleo-Indian tool assemblages consist mostly of a series of unfluted lanceolate and pentagonoid projectile points, some of which are parallel flaked. These points generally resemble diagnostic Plano Tradition points from New York, New Jersey and Vermont (Ritchie, 1965). Most of the projectile points are made from local southern New England lithic materials. The Flat River points were made of quartzite and argillite. Flake knives, scrapers and gravers may also be part of Late Paleo-Indian tool kits.

Late Paleo-Indian socio-political organization is unknown and is likely to have been very similar to the preceding Paleo-Indian period. Short-term stays at sites with more exploitation of localized resources and less exchange of exotic lithic materials is likely.

III. Early Archaic ca. 9,000-8,000 B.P.

Definitely Early Archaic components are unknown in Rhode Island. One concentration of diagnostic bifurcate base projectile points in the Taunton River basin of southeastern Massachusetts is known where there may be identifiable components (Dincauze and Mulholland, 1977). A single Early Archaic Kirk-like projectile point from the Elmdale Rock Shelter in Scituate, Rhode Island does not indicate a definite component but suggests that other material of this time period may be present in interior upland Rhode Island sites. Most bifurcate base projectile points in Massachusetts are known from large multicomponent Archaic/Woodland sites on major drainage systems, lakes and swamps. Similar environmental conditions are present in the Big River project area.

A warm postglacial climate and mixed species pine-oak forest types with an increasing number of deciduous types after ca. 8,000 years B.P. has been hypothesized. The sea level was rising over the continental shelf, possibly to move further up inland river systems (ibid.).

Early Archaic tool assemblages known to date contain mostly several varieties of bifurcate base projectile points. Some of them are like Early Archaic points from the Carolina Piedmont area and are the major diagnostic artifact. Other associated tool types in assemblages may be flake knives, scrapers and choppers. Lithic technology used mostly quartzites, felsites or rhyollite and occasionally exotic shale flint or chert.

Social organization is unknown. Small bands of people probably exploited territories somewhat smaller than those used in the preceding Late Paleo period. This is also indicated by more use of lithics from local southern New England sources. Groups of hunter-gatherers were probably staying briefly at small sites, leaving a few artifacts and small hearth or pit features.

IV. Middle Archaic ca. 7,500-6,000 B.P.

Middle Archaic components are represented in sites around the Big River project area, but not within it. This reflects a general increase of population and a diversified settlement pattern now recognizable during this time period (Dincauze and Mulholland, 1977), (Dincauze, 1974). Components of the Neville and Stark complexes (Dincauze, 1976) are known from both rock shelters (Elmdale, Sheep Rock Shelters in Scituate), Rattlesnake Rock Shelter, West Greenwich (Fowler, 1962) and open sites (Flat River, Wilcox Brook [Fowler, 1968; 1975]), Wilcox/Bowen Hill (Gero, 1977): Furnace Hill Brook (Waddicor and Mitchell, 1969), Cranston; E.D. Prey (Byers, 1958) Killingly, Connecticut; Sweet Meadow Brook, Locust Spring (Fowler, 1956; 1962), Apponaug; and Ponaganset Reservoir, Glocester, Rhode Island. These sites are located in varied environmental settings in both the coastal plain and the elevated interior upland. Exploitation of plant/animal resources from many different ecological niches/zones is indicated. This pattern has also been recognized in eastern Massachusetts (Dincauze, 1974; 1977) and included scheduling of subsistence activities to take advantage of seasonally available waterfowl migrations and anadromous fish runs. These would have been important resources in the Big River-Flat-Pawtuxet drainages where Middle Archaic populations could have focused on riverine zone resources.

About 8,000 years B.P. mixed hardwood forests with oak as the dominant species were present in Rhode Island. This was the beginning of the postglacial altithermal climatic period. Submergence of shorelines and former tidal-estuary zones continued during the Middle Archaic (Dincauze and Mulholland, 1977).

Neville and Stark complex artifact assemblages from the Middle Archaic component in and around the project area consisted almost totally of Neville and Stark projectile points. A single ground slate semi-lunar knife from the Rattlesnake Rock Shelter (West Greenwich) may also belong in this context. Large chopper, flake knives of quartzite from several of the rock shelters may also be associated with Neville and Stark components. Other items may have been associated with these components but because of excavation of these sites by avocational archaeologists, some provenience was lost. Nevill/Stark components at the Flat River and Wilcox Brook sites included assemblages of Neville points, flake knives, choppers, stemmed drills made of Stark points and hammerstones. They indicate the manufacture/maintenance of chipped stone tools and some processing--probably of meat or skins. Middle Archaic tool assemblages from upland rock shelters indicate hunting activities (points dominant). Quarrying of quartzite and the manufacture of chipped stone tools was apparently a major activity of Middle Archaic occupants of the prey site in Killingly, Connecticut (Dincauze, in Talmage, 1977) where tool blanks and point preforms were found (Byers, 1958). Middle Archaic lithic technologies in Rhode Island and Connecticut utilized quartzites, argillite and some quartz, all of which are locally available in this area.

There is very limited information available on the size of Middle Archaic hunter/gatherer groups. Some sites could have been used by fairly large groups during fish runs and/or waterfowl migrations. Rock shelters are more likely to have been used by very small social units (family groups, 5-10 persons) on hunting and general foraging trips in the upland forest areas.

V. Late Archaic

Late Archaic components belonging to these major cultural traditions (Laurentian, Small Stemmed Point, Susquehanna) are the most widely represented of all time periods at the known prehistoric sites within and in the vicinity of the Big River project area. Two sites in the project area, Burnt Sawmill Road (RI-WC-10) and Big River-Burnt Sawmill Road (RI-WG-18) produced artifacts associated with the Small Stemmed Point Tradition.

Sites with Late Archaic components near the project area included: Furnace Hill Road site, Hope, Rhode Island; Elmdale, Sheep Rock Shelters, Scituate; Ponagansett Rock Shelter, Lower West Connaug Brook; Foster Country Club sites, Foster, (Gero, 1977); Cherry Valley Pond (Talmage, 1977); Ponagansett Reservoir, Coventry; Flat River, Wilcox Brook, Coventry Golf Club, Priscilla Farm, Wilcox-Bowen Hill, Coventry; Rattlesnake Rock Shelter, West Greenwich; Church Brook Rock Shelter, Furnace Hill Brook, Oaklawn steatite Quarry (Fowler, 1967), Cranston; Sweet Meadow Brook, Locust Spring sites, Apponaug; Arnold Spring Rock Shelter (Arnold, 1969), Greene; and E.D. Prey, Killingly, Connecticut.

The climate during the Late Archaic was characterized by the altithermal--a period slightly warmer and dryer than the present which extended from ca. 8,000-3,000 years B.P. Temperate deciduous forest types (oak-hickory) were dominant. Components belonging to several cultural phases of the late Archaic Laurentian Tradition are known from many sites in the vicinity of the Big River project area. The majority of these sites are rock shelters located in elevated upland environments. In southern New England typical Laurentian artifacts are widely spread through the Coastal Plain but identifiable components are rare. Definite Laurential components are present on some of the small open sites and rock shelters in the upland areas. Sites in or near the Big River project area with Laurentian cultural material include the Elmdale, Sheep, Ponagansett, Rattlesnake, Arnold Spring Rock Shelters: the Flat River, Furnace Hill Brook, Sweet Meadow Brook and Furnace Hill Road sites. Typical artifact assemblages include Otter Creek, Vosburg, Brewerton, Eared-Notched, Eared Triangle projectile points, ulu/semilunar knives of ground slate, and probably large bifacially chipped choppers, flake knives, projectile point preforms. Chipped stone tools (points) were primarily made of local quartzites, occasional points were chipped of New York shale flint, felsite and argillite. They indicate hunting as a major activity. Some processing is indicated by the known assemblages (choppers, flake knives, ulus). Large amounts of point preforms were found at the Rattlesnake Rock Shelter indicating the replacement/repair of hunting equipment. Ground stone woodworking tools are generally lacking.

Socio-political organization is unknown. Rock shelter usage suggests small bands of hunter/gatherers on a seasonal subsistence round with significant use of upland environments for various activities.

Sites and components of the Small Stemmed Point Tradition appear frequently in southern New England as they are widely distributed in a range of environmental situations not used as extensively by people of other Archaic cultural traditions (Dincauze, 1974). In and near the Big River project area many prehistoric sites show evidence of Small Stemmed Point components in both coastal plain, riverine and upland, elevated environments. They show the most diversified and widest distribution of any other prehistoric culture in the project area. The Small Stemmed Point Tradition is probably very close in time or at least partly contemporary with the Laurentian Tradition (Brewerton phase). Sites in or near the Big River project area with Small Stemmed Point components are the Elmdale, Sheep, Ponagansett, Rattlesnake, Arnold Spring, Church Brook Rock Shelters, Flat River, Wilcox Brook, Furnace Hill Road, Wilcox-Bowen, E.D. Prey site, Foster Country Club, Cherry Valley Pond and Ponagansett Reservoir sites.

Small Stemmed Point artifact assemblages from these sites consisted mostly of several varieties of small stemmed points, Squibnocket Triangle projectile points (some of which share traits with Brewerton type points), oval, steepedge scrapers, bifacially chipped knives, tool blades, point preforms, cores. These items are almost always chipped from quartz, but also quartzite, argillite and other locally available materials. Assemblages from these sites generally indicate hunting in a variety of environments with significant use of upland interior, elevated areas (rock shelters). Processing of raw materials (skin, hides) with scrapers and knife blades and chipping of projectile points (repairing hunting equipment) were also common activities.

Socio-political organization is unknown but like the other Late Archaic cultures, it could have been small bands of hunter/gatherers in a regular seasonal round. Intensive use of local raw materials and resources is an outstanding characteristic of the Small Stemmed Point Tradition which suggests some type of social units structured to efficiently exploit a wide range of resources in a defined territory.

Late Archaic Susquehanna Tradition components can be recognized at a number of sites in and around the Big River project area. As with other areas of southern New England, Susquehanna components are less frequent and smaller on sites in elevated upland environments. Other environments such as those bordering large riverine wetlands or ponds and lakes contain more substantial Susquehanna components. In contrast to the partly contemporary Small Stemmed Point Tradition, Susquehanna Tradition components appear in a more restricted range of environmental zones.

Known sites with Susquehanna Tradition components located in or near the Big River project area include the Elmdale, Ponagansett, Rattlesnake, Arnold Spring Rock Shelters, and the Wilcox-Bowen Hill, Foster Country Club, Wilcox Brook, Ponagansett Reservoir, Locust Spring, Sweet Meadow Brook sites and probably the Oaklawn and Ochee Spring steatite quarries. At the Flat River site in Coventry, a significant Susquehanna cremation burial complex was excavated and C-14 (carbon-dated) to 1560 B.C. (3430 B.P.) (Fowler, 1968). Diagnostic projectile points of the earliest Susquehanna Tradition cultural phase (Atlantic phase) (Dincauze, 1972) have been found in several inland rock shelters and open sites. Atlantic points are known from the Arnold Spring, Elmdale, Ponagansett Rock Shelters, the Wilcox/Bowen Hill, Foster Country Club, Ponagansett Reservoir and Wilcox Brook sites. Some of the points were chipped from New York shale flints and fine grained volcanic rocks from eastern Massachusetts. Major evidence of the Watertown phase of the Susquehanna Tradition was found on the cremation burial complex at Flat River. These ceremonial deposits of burned artifacts are like others reported from Watertown phase cemeteries in Massachusetts (Mansion Inn, Vincent, Watertown Arsenal sites) (Dincauze, 1968). Items of Watertown phase hunting equipment (Wayland Notched points) have been found in rock shelters (Elmdale, Ponagansett, Rattlesnake, Arnold Spring) and open sites (Ponagansett Reservoir, Locust Spring, Sweet Meadow Brook, Flat River and Wilcox Brook).

The latest cultural phase of the Susquehanna Tradition, Coburn (Dincauze, 1968) is not as well represented in the known sites in the vicinity of the project area. Coburn-like projectile points are known from a few rock shelters (Elmdale and Ponagansett) and the Furnace Hill Road, Flat River and Sweet Meadow Brook sites.

Susquehanna Tradition artifact assemblages from the known sites near the project area consist primarily of projectile points (Atlantic, Wayland Notched, Coburn) and diagnostic tool blades (Mansion Inn variety). Susquehanna projectile points show high frequency of nonlocal highgrade lithic types as raw materials. New York shale flints, Pennsylvania jasper, fine-grained volcanics (felsite, rhyollite from eastern and southeastern Massachusetts) were often used, with some limited use of local quartzites and argillite/shale. At some of the open sites, steatite vessels have been found (Flat River, Sweet Meadow Brook, Furnace Hill Brook, Locust Spring). Steatite quarrying technology was apparently introduced into southern New England by Susquehanna Tradition people. Major production centers were at Rhode Island quarries such as Oaklawn and Ochee Spring in Cranston and Johnston. Steatite vessels were probably important exchange items that moved out of the quarry areas along drainage systems, major trails or transport routes.

These artifact assemblages indicate that hunting, and the manufacture/maintenance of hunting equipment was a major activity at both rock shelters and open sites. Assemblages of specialized tools were made for extracting and shaping steatite during the operation of the Rhode Island quarries (scrapers, abraders, chisels, etc.,).

Susquehanna Tradition socio-political organization is unknown for the most part. Several aspects of archaeological evidence suggest that fairly elaborate complex ceremonial-mortuary rituals were conducted periodically (cremation burials, Flat River site) and that social units participated in wide-ranging exchange-transport systems to obtain raw materials necessary to support lithic technologies (steatite, exotic lithic materials). This is quite different from the other late Archaic socio-political systems.

Terminal Archaic components are known from a few sites in the vicinity of the Big River project area. True components may not exist at some of the sites where the evidence for Terminal Archaic occupation consists of only a few projectile points. Site locations closer in proximity to the Narragansett Bay coastal lowland zone or major drainage show the strongest evidence of Terminal Archaic utilization. This corresponds to general patterns known for southern New England, which points to the disuse-abandonment of inland/upland site locations at the end of the late Archaic period (Dincauze, 1974). Terminal Archaic cultural material is known from the Locust Spring, Sweet Meadow Brook, Oaklawn Quarry, Furnace Hill Brook, Flat River, Furnace Hill Road sites and Sheep Rock Shelter.

Periods of deterioration of the altithermal warm, dry climatic phase began about 3,000 years B.P. with a gradual shift to cooler, wetter conditions. Currently available data suggests that forest types and other flora/fauna may have changed in response to this. A shifting forest type from hickory-oak mixed hardwoods to more oak-hemlock-white pine types is reflected in pollen profiles (Dincauze, 1974).

Terminal Archaic artifact assemblages from the known sites consist mostly of diagnostic Orient fishtail projectile points. A few points and bifacial tool blades showing attributes of both the Coburn and Orient types are probably also of Terminal Archaic provenience. Like the earlier Susquehanna cultures, some Terminal Archaic points were made of nonlocal or exotic lithic materials such as felsites, New York flints, Pennsylvania jasper. At the Oaklawn steatite quarry, Terminal Archaic tool kits would have included various chisels, scrapers, abraders, picks of quartz or quartzite for extraction/reduction of material into stone bowls.

Terminal Archaic socio-political organization is unknown and is assumed to be similar to other Late Archaic cultural groups--particularly the Susquehanna Tradition. The use of rock shelters was most likely done by fairly small groups of people (hunting groups-families). There was a lesser amount of long-range trade exchange for support of lithic technology, but it still continued (steatite vessels, exotic lithics, New York flint, Pennsylvania jasper) suggesting that the socio-political organization was capable of sustaining trade systems.

VI. Early Woodland ca. 2,600 B.P.

Very few Early Woodland components are known from the vicinity of the Big River project area. The known components are clustered on large multicomponent Archaic/Woodland period sites in the coastal plain--estuarine type environments (Sweet Meadow Brook, Locust Spring sites). Early Woodland activity is known from one steatite quarry (Oaklawn). Only one tentative component of this period in known from an inland site (Sheep Rock Shelter). This reflects the definite shift in settlement patterns that occurred in the Terminal Archaic-Early Woodland period in which inland upland site locations were abandoned in favor of coastal zone resources. This is a recognizable pattern in the Boston Basin area of eastern Massachusetts (Dincauze, 1974) where lower population densities marked the Early Woodland period.

The climate at this time (ca. 2,600 years B.P.) was more like the present day than the altithermal which characterized Archaic periods of ca. 8,000-3,000 years B.P. Forest types in southern New England were mostly northern hardwood types (oak-hemlock, white pine or other varieties of mixed hardwood-conifer).

Artifact assemblages/tool kits from the known Early Woodland components contain Meadowood, Rossville, Lagoon and other untyped side-notched projectile points. Meadowoods were often made of exotic lithics (New York flints). Diagnostic ceramic types are mostly tempered with crushed burnt rock and have cord marked interior and exterior surfaces. This corresponds to Vinette I ware (Ritchie, 1965). Some bone and/or antler flaking tools and awls are known. Steatite and/or chlorite smoking pipes in straight tube or elbow styles were manufactured at Rhode Island quarries.

Early Woodland socio-political organization is unknown. It is suspected that it may have been somewhat different from the preceding Terminal Archaic as whole subsistence/settlement patterns had changed. There was a minor amount of trade/exchange in steatite/chlorite smoking pipes and exotic lithic materials (New York flints, etc.). Cultural influences, particularly ceramic technology, were entering the area from the west and south (New York, New Jersey, etc.) possibly along old trade routes for steatite vessels.

VII. Middle Woodland ca. 1,650-1,150 B.P.

Known Middle Woodland components in the vicinity of the Big River project area show more diversity in locational and/or functional attributes than those of preceding Early Woodland times. Sites/components are still concentrated in coastal plain/estuarine environmental zones, such as shell middens, but there are also several mid-Woodland components in inland rock shelters (Furnace Hill Brook, Flat River, Elmdale Road, Sheep Rock Shelters).

Environmental, climatic conditions were similar to the Early Woodland, generally continuing a cool, wet trend.

Middle Woodland tool kits/artifact assemblages from the known Middle Woodland components include Jack's Reef Corner-Notched, Jack's Reef Pentagonal, Fox Creek, Greene and other untyped lanceolate and corner-notched projectile point types. Points of the Jack's Reef Corner-Notched and Greene types were often chipped from exotic lithic materials such as New York flints and Pennsylvania jasper. Middle Woodland ceramics were mostly grit or burnt rock tempered with some use of shell temper. Dentate-punctate and rocker stamping smoothed over cord marking and incised lines were common decoration techniques for ceramic vessels. Fragments of ceramic vessels with those attributes were found in several open sites and rock shelters near the project area (Elmdate Road, Sheep Rock Shelters, Flat River site). Other Middle Woodland assemblages from sites with associated shell midden contained bone/antler tools such as needles, awls, beaver incisors in antler handles and projectile points, steatite/chlorite smoking pipes in platform and elbow styles and two hole gorgets of the same material.

Middle Woodland socio-political organization is relatively unknown; however, a regular use of certain exotic lithic materials for chipped stone projectile points (New York flint, Pennsylvania jasper) and probably manufacture and trade/exchange of steatite/chlorite smoking pipes and gorgets/pendants indicate the existence of organized social-political networks for supporting this exchange. Several burials of this period from coastal shell midden are inhumations in large refuse pits in the midden; there were no organized cemeteries. Ceramic decoration techniques may have reached Rhode Island along trade routes from New York, Pennsylvania and areas to the southwest.

VIII. Late Woodland ca. 1,150-400 B.P.

Known Late Woodland components in the vicinity of the Big River project area occur in both coastal/estuarine (Sweet Meadow Brook, Locust Spring) and upland interior environmental zones. The coastal zone components also include shell middens. Upland Late Woodland components appear on both open sites (Flat River, Charles Tyler sites [Pope, 1952]) and in rock shelters (Church Brook, Furnace Hill Brook, Elmdale, Sheep, Ponagansett and Rattlesnake). Late Woodland components are more numerous and diversified than those of earlier Woodland periods and appear on sites as frequently as some of the Late Archaic cultural components. This reflects an apparent increase in population and diversification of subsistence/settlement strategies which has been recognized in the Boston Basin areas of eastern Massachusetts (Dincauze, 1974).

The climate during the late Woodland period was essentially similar to the present day. Forest types contining oak, chestnut with hemlock and white pine were prevalent.

Late Woodland tool kits/assemblages from the known components contain mostly chipped stone projectile points of the Levanna and Madison types chipped from quartz, quartzite, felsite and occasionally flint or jasper. Several components also had drill-perforators made on Levanna points, and a strike-a-light made on a quartz Levanna point was found in the Rattlesnake Rock Shelter. Late Woodland ceramics from the known components appear to be mostly undecorated, thin bodied wares with shell, sand or fine grit temper. Sherds from globular bodied vessels with cord decorated collars and rims, and fine shell or mineral temper were found in several Late Woodland components near the coast. Smoking pipes of both ceramic and chlorite or steatite are also known. There is some evidence of continued use of the Oaklawn quarry, Cranston, for manufacture of pipes during this period (Fowler, 1967).

Late Woodland socio-political organization and social structure are not known in any detail. Most of the current data is inference based on historic accounts of Contact period Indian cultures in the area. The generally accepted model of Late Woodland socio-political organization/structure is large, occasionally fortified villages located primarily in riverine areas, with smaller camps located in isolated upland areas. The larger settlements were often located near fishing stations or flood plain-terrace areas suitable for horticulture. Larger social groups may have occupied these villages during spring/summer fish runs and planting season. The smaller upland sites (open camps, rock shelters) appear to have been used by small extended family groups for hunting and trapping in the fall/early winter. There is some evidence for inter-group warfare, possibly leading to the construction of palisaded-fortified settlements. The trade networks that brought exotic lithic materials into the area during the Middle Woodland appear to have disintegrated during the Late Woodland with more emphasis on local resource exploitation.

IX. Contact Period ca. 400-350 B.P.

No definite Contact Period components are known in the vicinity of the Big River project area. Queen's Fort in Exeter is alleged to be an historic Narragansett fortified site contemporary with the King Philip's War. Sites of this period are more likely to occur in the coastal plain-estuarine area. There is one known Contact Period cemetery from Jamestown, Conanicut Island in Narragansett Bay (Simmons, 1970). None of the rock shelters near the project area with late Woodland components showed evidence of continued use during the Contact Period. Several historic Indian trails evidently crossed central Rhode Island near the Big River project area. One of these, the Pequot Trail, followed what is now Division Street in West Greenwich. Queen's Fort in Exeter is alleged to be a fortified Narragansett site contemporary with the

King Philip's War (Bacon, 1904).

The climate during the Contact Period was similar to the present with mixed conifer-hardwood forest types (pine, hemlock, oak, chestnut).

Artifact assemblages from known Contact Period sites in Rhode Island/Narragansett Bay are mostly from burials. European trade goods, such as glass trade beads, bottles, iron knives, axe blades, fishhooks, brass or copper kettles, brass "Jesuit" rings, firearms and articles of clothing are associated with minor amounts of aboriginal cultural materials such as chipped stone projectile points (Levanna-Madison type) and ground stone pestles and ceramic vessels (Simmons, 1970).

Historic accounts describe several fairly distinct tribal groups in central and western Rhode Island-eastern Connecticut during the seventeenth century. The Narragansetts occupied the vicinity of the Big River project area, with the Pequot-Mohegan and some Nipmuck groups in eastern Connecticut. Nipmucks also occupied most of northern-northeastern Rhode Island. Introduction of European material culture radically altered traditional subsistence technology and probably also altered other cultural systems such as political structure. Increased emphasis on trappings (beaver, muskrat, otter) to supply the English and Dutch traders in the early to mid-seventeenth century may have led to competition between various Indian groups for the European trade goods. This may have in turn initiated some small-scale conflict and reorganization of tribal territories.

During the King Philip's War the Narragansetts of southern Rhode Island were decimated (Great Swamp fight, Kingstown, December, 1675). Nipmucks, resident in eastern Connecticut and northwestern Rhode Island, left the area and went to southern Canada or New York. A few remaining groups settled in Christian Indian villages such as Wabaquasset near Woodstock, Connecticut.

PREHISTORIC RESEARCH PROBLEMS

The inventory of currently known sites in or near the Big River project area is a source of many categories of information on the location, cultural affiliation and distribution of prehistoric sites. However, the inventory of known sites and data also poses as many potential research questions as it answers.

There is a very definite scarcity of Paleo-Indian, Late Paleo-Plano Tradition and Early Archaic components and sites in the vicinity of the Big River project area. Even single artifacts of these time periods (ca. 11,000-8,000 B.P.) are rare in central, northern and western Rhode Island and eastern Connecticut. Data from systematic surveys of large inland drainage systems (Wood, Moosup, Big River) could provide data to expand current knowledge of earliest prehistoric activity in this area of Rhode Island. Large drainage systems are the only known areas where data from this time period is concentrated (Taunton, Mill Rivers in Massachusetts; Pawtuxet in Rhode Island).

EXPECTED PREHISTORIC SENSITIVITY OF PROPOSED ALTERNATIVE FEEDER RESERVOIRS BY PERIOD

In comparison with the main pool area of the Big River project in West Greenwich-Nooseneck, there are fewer known prehistoric sites near the proposed feeder reservoir project areas (Bucks Horn Brook, Nooseneck River, Moosup River, Wood River and Fisherville Brook). While they are fewer in number, the known sites near the feeder reservoirs are located in a variety of environmental situations and consist of both rock shelters and open sites and are expected to represent a fairly wide range of prehistoric cultural periods and activities. These sites are not well documented and cultural affiliations are known for only two sites in contrast to the more numerous and better documented sites in the vicinity of the main pool area in West Greenwich. However, projections can be made about the expected sensitivity of the feeder reservoir areas using the known site data from both sections of the Big River project area.

The feeder reservoir project areas contain environmental situations that are similar to others in or near the Big River main pool which have known sites. The following general expectations and estimates of sensitivity are based on these environmental similarities and the combined body of known site data.

I. Paleo-Indian

The known Paleo-Indian components and cultural materials from Massachusetts and Rhode Island are all from large multicomponent Archaic/Woodland period sites on major river systems such as the Flat River site in Coventry which contained a possible late Paleo-Indian component. The Moosup River project area has some possible site locations similar to Flat River that would contain Paleo-Indian components.

II. Early Archaic

One possible Early Archaic projectile point is known from an upland rock shelter in Scituate, Rhode Island (Elmdale); however, like the preceding Paleo-Indian, components of this time period are most frequently found on large multicomponent Archaic/Woodland sites near major rivers. The Moosup River project area has some general locational attributes that fit those known for Early Archaic components (terraces adjacent to large river systems, wetland/marsh areeas in close proximity).

III. Middle Archaic

Components of this time period are known from both rock shelters and open sites near the project area. Four of the project areas (Moosup, Wood Rivers, Nooseneck River, Buck Horn Brook) contain environments with locational attributes that are favorable for Middle Archaic sites and components. Riverine environmental zones that include terraces adjacent to marsh/wetland areas are particularly sensitive (Flat River, Wilcox Brook sites, Coventry). Significant Middle Archaic components have been found on sites such as these, where seasonally abundant resources such as spring/fall fish runs and waterfowl migrations were available. Known Middle Archaic components and sites in central/western Rhode Island are concentrated in the riverine environmental zones.

IV. Late Archaic (including Terminal Archaic period)

Sites and components of the Late Archaic period are known from a wide range of environmental situations. It is highly likely that sites containing one or more Late Archaic components will occur in all five of the feeder reservoir project areas (Wood, Nooseneck, Moosup Rivers, Fisherville and Bucks Horn Brook). All of these project areas contain riverine/wetlands, marsh environments with adjacent terraces that could be expected to contain Late Archaic sites. It is also very likely that any Late Archaic sites located in these areas will have components of one or more earlier (Paleo-Indian, Early, Middle Archaic) or later (Woodland) time periods. Late Archaic hunter-gatherer groups often occupied site locations that had been selected by previous groups, producing multicomponent sites. Some of the known sites of this type are quite extensive and complex (Flat River, Wilcox Brook, Coventry). These large riverine zone Late Archaic sites usually contain a variety of feature types (hearths, refuse pits, burials, workshops) and fairly diversified artifact assemblages reflecting the wide range of activities that were carried out during repeated occupations. For example the Flat River site contained a feature complex consisting of secondary deposits of burned artifacts and bone (probably human). This complex has been tentatively identified as a group of Late Archaic Susquehanna Tradition cremation burials. At Wilcox Brook in Coventry, one or more caches of unfinished chipped stone tools attributable to both the Archaic and Woodland periods were found (Fowler, 1975), indicating that necessary raw materials for hunting/gathering were left at the site by people who intended to return periodically. Most of the known sites (9) in the main pool of the project are expected to have Late Archaic components and this expectation can be extended to the Moosup, Bucks Horn Brook and Wood River project areas.

V. Woodland (Early, Middle, Late) Period

The known Woodland period components and sites in the vicinity of the project area are fewer in number and not as widely distributed as those of the Late Archaic. Early Woodland components are virtually unknown in central and western Rhode Island (one possible exception--Sheep Rock Shelter, Scituate). A definite Middle Woodland component is known from only one upland rock shelter (Elmdale Rock Shelter, Scituate). Known Late Woodland components are primarily from rock shelters and several open sites. In general Woodland components are most likely to occur on the large multicomponent Archaic period sites in riverine environmental zones, although a majority of Late Woodland components were located in rock shelters. The Flat River and Wilcox Brook sites in Coventry are large multicomponent riverine zone sites that contained Middle and Late Woodland components. The Woodland artifact assemblages from these sites are more diversified in terms of the activities they represent. Not only hunting (projectile points), but processing of raw materials (scrapers, awls, knives, drills) and food preparation or storage (ceramic vessel sherds) is indicated. This suggests that like the sites of the preceding Late Archaic period, Woodland components and sites are more likely to occur in riverine environments with associated wetland/marsh areas, and that when they do occur they will be fairly complex. In addition Woodland components are likely to occur on the same site locations as earlier Archaic components. The Late Woodland components known from upland nonriverine environments (rock shelters, open sites) are apparently smaller, with artifact assemblages oriented towards only a few activities (mostly hunting). The Noosenecκ and Fisherville Brook project areas could contain sites of this type.

The other three proposed feeder reservoir project areas (Moosup, Wood Rivers, Bucks Horn Brook) have potential locations for Woodland components. These project areas consist mostly of terraces adjacent to riverine wetland/marshes. Environments of this general type are known to contain a majority of Woodland period components in other sections of central and western Rhode Island.

VI. Contact Period

Contact Period components or sites are poorly known in the vicinity of the project area, making it difficult to make estimates or assessments of potential site locations. The single historically documented site of this period, Queen's Fort in Exeter, is associated with the King Philip War. An important cultural resource associated with the Contact Period may be former Indian trails such as the Pequot Trail which parallels Division Street in East and West Greenwich. It is also possible that Contact Period components could appear on multicomponent Archaic/Woodland period sites (both open sites and rock shelters) particularly those with Late Woodland occupations. In this regard the potential riverine zone site locations described for the late Archaic and Woodland periods in the Moosup and Wood Rivers and Bucks Horn Brook project area could also be sensitive for Contact Period sites.

EXPECTED PREHISTORIC SENSITIVITY OF PROPOSED ALTERNATIVE FEEDER RESERVOIRS BY AREA

Comparative prehistoric sensitivity of the five proposed feeder systems can be roughly estimated on two scales. The first scale would be a ranking of the likelihood of encountering prehistoric components on equal areas of land, i.e., density. For the purposes of preliminary estimation, the following data layout can be used:

A. Likelihood of occurrence of components based on environmental characteristics

	Moosup River	Bucks Horn Brook	Nooseneck River	Wood River	Fisherville Brook
Paleo	X				
Early Archaic	X				
Middle Archaic	X	X	X	X	
Late Archaic	X	X	X	X	X
Woodland	X	X	X	X	X
Contact	X	X	X		

Relative frequency of known components from sites in the region (See Table 2)

	Frequency	Scaled Score*
Paleo	1	1
Early Archaic	2	2
Middle Archaic	6	3
Late Archaic	21	5
Woodland	12	4
Contact**	1	1

*Scale is from least frequent component (1) to most frequent (5).
**Based on Queen's Fort in Exeter

If one substitutes the scaled scores of the components in the environmental characteristics matrix and sums by columns (proposed feeder), this gives the following matrix.

C. Feeder ranked by expected density of prehistoric components. Rank 4 is expected highest density to Rank 1, lowest.

	Moosup River	Bucks Horn Brook	Nooseneck River	Wood River	Fisherville River
Paleo	1				
Early Archaic	2				
Middle Archaic	3	3	3	3	
Late Archaic	5	5	5	5	5
Woodland	4	4	4	4	4
Contact	1	1	1		
Total Scores	16	13	13	12	9
Rank	4	3	3	2	1

The second ranking is by likelihood of locating total number of prehistoric components. This is done by taking the size of the feeder systems and expected prehistoric densities into account.

D. Size rank of feeder systems combined with density ranking:

	Wood River	Nooseneck River	Moosup River	Bucks Horn Brook	Fisherville Brook
Area (sq.km.)	3.6	2.8	2.1	2.1	<2.0
Size Rank	4	3	2	2	1
Density Rank	2	3	4	3	1
Size x Density	8	9	8	6	1

In summary the two rankings of archaeological sensitivity for the proposed alternative feeder systems are:

Rank	By Expected Densities	By Expected Totals
Highest	Moosup	Nooseneck
	Bucks Horn] tied	Moosup] tied
	Nooseneck] tied	Wood] tied
	Wood	Bucks Horn
Lowest	Fisherville	Fisherville

Please note that the scales are relative, not absolute, i.e., there is no absolute quantitative difference between feeder systems in the scale, only "greater" or "lesser" sensitivity.

HISTORIC RESEARCH COMPONENT

The historic research segment of the Big River archaeological assessment package was divided into five major categories. These categories entailed a local and regional literature search, a primary documents overview, cartographic evaluation, location of auxiliary resources, and an abbreviated walk over and windshield survey. In all cases emphasis was on a quantitative and qualitative evaluation of available data so as to better determine the course of further study, research and survey. Archaeological research activities for the historic segment of this pilot study targeted directly on the main Big River catchment area with major attention focused on the town of West Greenwich (Nooseneck Village) and the town of Coventry. Per advisement and due to time restrictions the outlying feeder units and the towns of East Greenwich, Exeter and Sterling received only limited and often tangential coverage with a minimum of literature search and no actual walk over survey.

HISTORIC SOURCES REVIEW

Local Literature

A quick review of the usual body of secondary sources indicates that works focusing on the proposed project region and local history are sparse. For example, no detailed town histories exist for either Coventry or West Greenwich, while the only county history extant is Cole's 1888 History of Washington and Kent Counties. The latter work was written nearly a century ago and is superficial in its treatment of the two counties most affected by the Big River reservoir system. Several more specialized works are available (i.e., Wood, 1936; Harpin, 1961, 1974, 1976; Levesque, 1969; Baker, 1976; Fowler, 1976; and Gustavson, 1976). In the main, however, there is an apparent paucity of published and unpublished materials reflecting the lack of major historic research about the area.

Regional Literature

Regionally, available sources on the development of Rhode Island's uplands in specific, and the New England uplands in general, are also scarce. A variety of state histories exist (Hoag, 1878; Field, 1902; etc.) but their treatment of the project area and its regional background is cursory at best. Rhode Island studies (such as Mayer, 1953, 1958; James, 1975; Tucker, 1966; and Anderson, 1976) are of some aid, while Coleman's Transformation of Rhode Island (1969) proved most helpful.

On the New England scene data on comparative or contrasting development may be contained in such works as Andrews (1889), Weedon (1890), Bidwell (1925), Wilson (1936), Black (1950) and McManis (1975). Lack of time precluded any attempt at comprehensively locating and evaluating pertinent master theses and doctoral dissertations which could further highlight the region's historic development.

Primary Documentation

The research team's reconnaissance of primary documents was strictly locational in nature; that is, no research, per se, was undertaken. Based on conversations with the town clerks for Coventry and West Greenwich, records for both towns are nearly complete back to 1741, while data prior to incorporation are still retained in the respective parent town.

Colonial and state records are another body of data which could prove useful in further research efforts. The best depository for such information is the Rhode Island Department of Records Management-State Archives, while various active and inactive state departments, bureaus and agencies also hold relevant data (e.g. Commission of Dams and Reservoirs, Factory Inspectors, etc.). Court records are variously on deposit in the Providence, Kent and Washington County Court Houses.

Census data is fairly complete. Colonial enumerations were undertaken in 1708, 1730, 1747, 1755 and 1774, while the Revolutionary War saw two censuses made--one in 1775 and the second in 1783. Besides the Federal census, which commenced in 1790 and is repeated every ten years, the State of Rhode Island began its own ten year census in 1865.

Given the lack of secondary sources further research on the Big River project zone will have to depend heavily on work in primary documents if the region's development is to be better understood. Hence further research designs should allow for a sizable amount of time and effort along such lines.

Cartographic Evaluation

A major effort was made in locating and evaluating cartographic sources. Although the number of maps located was fairly numerous, many of these sources were only of limited value. Maps range in date from 1730 to the present and sketch the basic picture of the region's development. The heaviest emphasis is, of course, on the nineteenth century.

Ancillary Resources

Data for the historic segment of the archaeological pilot package was gleaned from a variety of organs and sources. The research team contacted town officials in both of the main project towns, visited local libraries, located several informants and assessed the holdings of the more obvious institutions and departments, including libraries, historic societies and state agencies. The results of this brief reconnaissance indicated the lack of secondary sources and the apparent need to focus on primary works. If the informants located are any indication of the wealth of oral traditions available, then interviews may be in order, especially for the Nooseneck area.

HISTORIC FIELD SURVEY

The historic field survey component for the present archaeological pilot study consisted of a series of walk over and windshield surveys confined to the main Big River catchment area that noted and recorded any features encountered. This field component sought to expand on the site inventory compiled by the Rhode Island Historical Preservation Commission (RIHPC). There was no subsurface testing (i.e., no auger transecting or test pitting) involved, only visual observations. The survey team followed such major roads as Nooseneck Hill Road, Congdon Mill Road, Burnt Sawmill Road, Hopkins Hill Road, Hankney Hill Road, the New London Turnpike and Division Street, besides examining several minor tracks (Map 1). The team also probed stretches of the Big, Congdon, Carr and Nooseneck Rivers as well as Bear Brook. The major effort centered on the junction of Nooseneck Hill Road with the Nooseneck River, on the crossing of Congdon Mill Road with the Congdon River and in the vicinity around Sweets Pond. Hence attention was divided between areas with confirmed and unconfirmed historic resource potential.

REGIONAL HISTORIC BACKGROUND

During the seventeenth century the Europeans presence within the project area appears minimal. Presumably the fur trade tapped the region at a relatively early date, though the western uplands appear basically ignored in favor of white consolidation and exploitation along the coast. As the coastal settlements expanded colonial interest in the present Coventry and West Greenwich region may seasonally have focused upon the meadowlands along the Pawtuxet, Flat and Big River systems (Bates, 1941). The study area was traversed by trails now represented by Division Street (the Pequot Trail) and presumably sections of Nooseneck Hill Road. The Coventry segment of the project area was under nominal English control as of the Warwick and Shawomet Purchase of 1642, while West Greenwich and its parent town, East Greenwich, were considered part of the Narragansett County until 1677, after King Philip's War. Despite various land transactions in the later seventeenth century, any permanent colonial settlements, including farms and mills, appear relegated to the northeasterly corner of Coventry (Bates, 1941; RIHPC, 1978). Hence the remainder of that town, and the whole of West Greenwich, are thought to have stood empty of substantial European settlement until after 1700.

With the advent of the eighteenth century the tempo of white occupation radically increased. In 1709 the "vacant lands" of East Greenwich were auctioned off. This holding primarily comprised the present town of West Greenwich and its sale is presumed to have officially opened the area for settlement. According to readily available sources, settlement in the Coventry sector of Warwick appears concentrated at first towards the latter towns easterly flank. Over time the movement westward seems keyed into the river and road systems, focusing on well-placed hamlets and farms. The relationship of natural and cultural (roads, villages, land divisions) features to the Coventry settlement pattern is presently unknown.

By the 1740's population growth in the western sections of Warwick and East Greenwich was substantial enough to warrant the formation of new townships. Taking the 1748 census as a base year, a projection of 700 inhabitants each for the towns of Coventry and West Greenwich seems reasonable at their incorporation in 1741 (1748 census: Coventry, 792; West Greenwich, 766).

Development in both towns during the mid-to-late eighteenth century probably followed the same basic model, with Coventry, however, displaying tendencies towards a more clustered settlement pattern. Unlike the maritime oriented commercialism of the Rhode Island coast, the interior was much more self-contained and self-sufficient. In the mean artisan farmers formed the bulk of a given town's population (Levesque, 1969). Farmland was divided between plowland, pasture, meadowland and woods with a "crop" expected from each. Major crops included maize, barley, rye, oats, beans, hay, alfafa and flax. Maple sugar and syrup, cider and honey also were produced, while the forest provided oak, chestnut, maple and pine. Animals kept or raised included cattle, oxen, horses, sheep, goats, swine, geese and poultry, all of which saw use about the farm or in trade. The labor pool was primarily consanguineous, though apprentices, hirelings or slaves were tapped. Home industry products ran the gamut from homespun cloth and yarn to butter, cheeses, fish, ashes, charcoal and even irongoods.

Rounding out the upland population were the mill owners, craftsmen and village people. Grist mills and sawmills presumably gave a steady input into the community, while craftsmen--blacksmiths, coopers and the like--provided required services. The Greenes in Coventry quite early worked local bog ore sources with a forge and furnace for manufacturing iron.

Coventry, more than West Greenwich, was well-endowed with water resources and good roads, factors upon which the town could later capitalize. By 1775 it was obvious that Coventry was supporting several centralized villages and hamlets. West Greenwich, however, remained much more loosely knit.

By the first quarter of the nineteenth century a definite divergence between Coventry and West Greenwich was evident (Tables 5 and 6). Coventry on the one hand was tending towards an industrialized, more centralized socio-economic pattern, while West Greenwich held to a much more ruralized course. Where the town of Coventry appears to have divided into a series of distinct mill villages, farm hamlets and later railroad depots that punctuated mixed farming, pasturing and lumbering districts, the town of West Greenwich depended primarily on subsistence farming and lumber related operations supplemented by very small scale textile milling (Cole, 1889). This clustered versus dispersed settlement pattern displayed by Coventry and West Greenwich is best exemplified in Coventry's possession of eight or more village centers equal or larger in size to West Greenwich's single major hamlet at Nooseneck Village. While manufacturing was fundamental to Nooseneck's existence (as witnessed by at least six mill complexes located during survey), Coventry's dependence and emphasis on manufacture is best exemplified by the impounding of the Flat River mill reservoir in the 1850's.

Manufacturing in both towns focused on cotton goods including textiles, thread and cloth, with some woolen wares and yarns supplementing the above. Minimal heavy industries except small machine shops appear in evidence. The usual realm of grist and sawmills continued, with shingle mills, box mills and even acid works occurring in both towns. General lumbering, including charcoal making and wood cutting for the railroad, pushed the forests towards depletion, with supporting crafts and services, dairying, sheep raising, quarrying and dirt farming rounding out the bill.

According to Coleman, Coventry would be considered one of Rhode Island's static towns (i.e. a town which held its own over time, while displaying relatively slow steady growth). For example, Coventry's population in 1800 was roughly 2400; in 1820, 3100; in 1840, 3300; in 1860, 4300; in 1880, 4500 and in 1900, 5100. West Greenwich, however, would be considered a town in obvious decline. Population in 1800 stood at roughly 1800 inhabitants while by 1900 a mere 600 peole occupied the town's 50.6 square miles (Tables 3 and 4).

Coventry's emphasis and shift to industrialization and the coming of the railroads appear to have helped keep the town at parity. West Greenwich, however, was not so fortunate, for in the mean, no major alternative systems developed to pick up the slack as the land failed and the forests were depleted. Thus while Coventry remained fairly stable, West Greenwich slid into decline. If census figures are any indication, West Greenwich continued its decline well into the twentieth century as the town's population dropped from roughly 600 in 1900 to approximately 400 in 1940. According to the WPA Writer's Guide (1937) industry in West Greenwich was nonexistent with subsistence farming and small scale lumbering bearing the brunt of the town's working population. However the town was being somewhat "developed as a country resort by wealthy families from Providence and vicinity."

During the same period Coventry held its own in population while presumably suffering some economic dislocation during the Depression.

In the post war era, both Coventry and West Greenwich are experiencing something of a suburban metamorphosis, especially with I-95 so conveniently tying both towns into the metropolitan Providence area.

REGIONAL HISTORIC CHRONOLOGY

*Big River catchment

1636	Roger Williams located in Providence, founding the first permanent settlement in Rhode Island.
1643*	Samuel Gorton and Company secured the sixty thousand acre Shawomet Purchase from the Indian Sachem Miantenomo. This holding ran south along Narragansett Bay from Greene's Island to Warwick Point and ranged west to the Connecticut line. This tract encompassed the present towns of Warwick (1643), Coventry (1741) and West Warwick (1912).
1643	Massachusetts troops destroy the original Warwick settlement, imprisoning the inhabitants.
1643/44	Parliamentary committee under the Earl of Warwick grants Rhode Island its first or parliamentary charter.
1644	The Warwick outpost reoccupied by original settlers.
1647	A town government is officially incorporated at Warwick.
1658	Massachusetts relinquished claim to the Shawomet Purchase.
1663	Rhode Island receives new Royal Charter supplanting parliamentary charter.
1672*	"Seven and ten line" surveyed through the Warwick holdings.
1673*	Lands north of the Warwick "seven and ten line" divided into three blocks. The farms south of the Pawtuxet River were christened Wecochaconnet Farms. The five farms north of the river extending into Coventry were designated Natick Farms. The remaining lands (seven shares) were divided into seven holdings and extended from the Natick Farms line west to the Connecticut line.
1675/76	Indian activities during King Philip's War effectively disrupts the colony, with heavy raiding gutting Warwick and other settlements.
1676	In retaliation for the raid on Warwick, white troops massacre 171 Indians in an area west of the project bounds.

1677	With the conclusion of King Philip's War, the town of East Greenwich was organized from the northern extreme of the Narragansett country.
1692*	Survey and plat made of "meadows above the saw mill" in Warwick's Great Meadows (Flat River) area.
1701*	Seven men's holdings above the "seven and ten line" and west of Natick Farms begins process of land division. The second division occurred sometime between 1701 and 1729, with the third division in 1729 and the fourth in 1735. All affected the present Coventry area.
1709*	East Greenwich's "vacant land tract" of thirty-five thousand acres sold for $1,100. This area would become West Greenwich.
1713	Joseph Hopkins settles Hopkins Hill, West Greenwich, east of the project area.
1722	Plainfield Pike or the "Great North Road" traverses Coventry's northwest sector.
1727	Connecticut-Rhode Island boundary settled. The "head lots" granted to Rhode Island's western border increasing the state's land holdings in Coventry and West Greenwich.
pre-1728	Mill under Greene family control erected and abandoned at Zeke's Bridge, Coventry.
1728*	The original tract for Harkney Hill Road laid out from "Zeke's Bridge" at "Great River" on out to the Connecticut line.
1729*	Newport, King's and Providence Counties organized. The study area predominantly lies in the old Providence County tract.
c. 1736	A settlement started on the "Great North Road" at present day <u>Rice City</u>, eight miles northwest of the Big River catchment. In the 1790's this section of the road was abandoned by the Plainfield Pike and the settlement was dubbed Rice City. The village had variously seen several churches, taverns, grist mills and sawmills as well as several textile mills, stores and a slaughter house. Bypassed by the railroad, Rice City commenced its decline in the 1860's.

1739 Resurvey of colony line adds fourteen "head lots" to Coventry-Connecticut border.

c.1740 The Greene family established a forge in the vicinity of Coventry's Quidneck village (four miles east of the project area). During the nineteenth century this village would see several cotton mills, a calico printing mill and a paper mill.

1741* April: West Greenwich separates from East Greenwich and incorporates as Rhode Island's sixteenth town.

1741* August: Coventry partitioned from Warwick and incorporated as Rhode Island's seventeenth town.

West Greenwich-Exeter boundary surveyed (Exeter formed 1743).
1750* Kent County, including the towns of Warwick, Coventry, East Greenwich and West Greenwich, separated from southern Providence County.

c.1750 Captain Richard Rice opens saw and grist mills at present day Hopkin's Hollow, seven miles west of the Big River catchment and on the eastern flank of the Moosup River feeder. In 1825 Jeremiah Hopkins opened a textile mill and blacksmith shop in the village. Subsequent ventures, including an acid works, followed.

c.1750 A sawmill and grist mill were in operation at Coventry Center, a village three miles north, northwest of the project area. These mills were matched by a forge tapping local bog ore, by Waterman's Tavern, and a blacksmith shop. During the nineteenth century several textile mills provided employment, while the village served as the seat of town government.

1762 Maple Root Church gathered in Coventry. Present structure, slightly north of the project zone, erected in 1797.

1765 First schoolhouse erected in Coventry. Private homes originally used.

c.1767 Coventry's Washington village controlled by the Braytons, who owned several sawmills, grist mills and a fulling mill. By 1810 a cotton mill operated in this village 2.5 miles from the project locus. During the nineteenth century this village was the defacto focus of Coventry, containing several cotton mills, machine shops, carpet and twine mills, chandlering mill, blacksmith shop, carriage shop, etc., as well as heavy railroad stock. This area was reputedly settled prior to King Philip's War.

c. 1781-1790* J. and C. Hall opened blacksmith shop with trip hammer at Nooseneck on site later occupied by the "Old Red Mill." The Halls sold out to another blacksmith, Slocum Sweet.

c. 1790 Forge working in Coventry Center.

1791 Slater commences textile operations in Pawtucket, Rhode Island.

c. 1800* Bumble Bee carding mill opened at Nooseneck, West Greenwich.

1800 James Burlingame controlled the sawmill, grist mill and machine shop in Coventry's Arkwright village. By 1810 a yarn factory opened and the sawmill, grist mill and machine shop converted into a bleachery. The village, five miles northeast of the project area, later contained a dye house and bobbin shop.

c. 1806 The Coventry Manufacturing Company opens a cotton mill in the village of Anthony (three miles east of the project area). During the nineteenth century this village would see a grist mill, planing mill, turning shop and several other textile mills, tenements, mill stores and community hall.

c. 1812 James Matteson opens a sawmill near the present town of Summit (see 1856).

c. 1812* Messrs. Greene, Hall and Lewis open Nooseneck's second textile mill.

1812* Bumble Bee mill purchased by Hall Matteson and Company and converted to spinning cotton yarn.

1812* Yard mill opened at Nooseneck (yard pond?) occupying a sawmill site once run by Abel Matteson. The yard mill, started by Royal Matteson, produced cotton goods till 1850 when it failed. Mill next passed through a variety of hands until destroyed by fire and replaced by a sawmill.

1812* Hoxie, et al, opened mill at Nooseneck. Later matched by a "new mill a short distance downstream."

1814 Cranston-Providence turnpike chartered.

1815* New London Turnpike chartered; passes through West Greenwich and Coventry.

1821 Introduction of power loom in weaving.

1822* The "Old Red Mill" opened on the site of the Hall-Sweet blacksmith shop by David Hopkins. Structure was later enlarged and destroyed by fire pre-1840.

c.1822* Hall erects grist mill, store and tenement in Nooseneck contemporaneously with the "Old Red Mill."

1828 Fourteen school districts organized in Coventry.

1829 Twelve public school districts formed in West Greenwich.

1834-1835* The Greene, Hall and Lewis mill structure at Nooseneck burns.

1838* D. Hopkins starts new mill for cotton warp on the "hill above the bridge" at Nooseneck.

1840* Hopkins opens new cotton mill on the Greene, Hall and Lewis site along Nooseneck River.

1850's Flat River Reservoir installed as a water source for the eastern Coventry mill villages.

1852* D. Hopkin's warp mill destroyed by fire and rebuilt.

1856 Hartford, Providence and Fishkill Railroad completed through Coventry. This rail line would subsequently become the New York and New England Railroad.

1856 Coventry village of Summit, five miles west of the Big River catchment and directly east of the Bucks Horn Brook feeder, was founded as a railway depot and wood yard for the Hartford, Providence and Fishkill Railroad. The hamlet served as a focus for local farms as well as several saw and shingle mills. This area was known as Perry's Hollow in the eighteenth century and then possessed a grist mill, sawmill and store.

c. 1856	Coventry village of Greene was also a creature of the H.P.&F.R.R Seven miles west of Big River and adjacent to the western flank of the Bucks Horn Brook feeder, the town saw several railroad related structures--a warehouse for storing acid, a variety of sawmills, a shingle mill, a box factory, a tabernacle for revival meetings, a horn factory and stores.
1857*	Hopkin's Mill at Nooseneck gutted by fire.
1865*	D. Hopkin's warp mill sold to J.L. Spencer & Company, who later sold to Edwards.
1867*	D. Hopkins open New Mill "below the road" at Nooseneck, which by 1889 was owned by Edwin Hopkins and produced braided sash cord, warp and twine.
1880*	Population in West Greenwich dips below 1,000.
1880*	Population in Coventry stands at 4,500.
1920's*	First serious discussion of a reservoir in the Big River area.
1930*	Population in West Greenwich is 400.
1930*	Population in Coventry stands at 6,500.
1930's	Scituate Reservoir installed in the town of Scituate, north of the present project area.
1966*	Big River Reservoir area taken from the towns of Coventry and West Greenwich by eminent domain.

KNOWN HISTORIC SITES DATA

The quantity and quality of known historic archaeological sites within the Big River project zone is considered to be good and is thought suggestive of a substantial body of resources. Based on the preliminary 1977 survey work by the RIHPC and on the recent fieldwork by Brown University Public Archaeology Laboratory survey teams, historic sites in the Big River study area are known to include standing and nonstanding domestic, nondomestic and industrial structures and features indicative of a reasonably high density of historic occupations and utilizations.

Such sites include mill foundations, wheelpits, turbine pits, head races, tail races dams, empoundments and ponds. House foundations, outbuilding complexes, quarry sites, public structure sites, tavern and hotel sites, as well as a section of a major nineteenth century turnpike, were all noted during the pilot study's survey activities.

Lack of a comprehensive standing structures report (as of this writing in progress by RIHPC) has somewhat hampered formulating a balanced assessment of site presences and site densities. By definition extant sites possess an archaeological potential and application. However, since the large number of known archaeological sites are industrial in nature, these sites are considered to have supported a diverse constellation of structures and individuals whose presence will be localized in the immediate environs. The village of Nooseneck and its intricate mill complexes quite nicely exemplify this point. While not included in this survey's scope of work, the wealth of cemeteries within the project area, especially those standing in apparent isolation, are thought specifically to be suggestive of rural upland agricultural settlements.

It is anticipated that further archaeological work both in the field and through documentary sources will expand the site list inventoried in Table 7.

HISTORIC RESEARCH PROBLEMS

While the various research components of the Big River cultural resource assessment package will share many of the same basic procedural or research problems, certain facets and factors will occasionally weigh more heavily or specifically upon one given component than upon another. The main categories under consideration will be field procedural problems, research problems and research strategies. In all cases research components undertaken in Cultural Resource Reconnaissance and Survey will expand their focus into those alternative areas finally included in the Big River system.

Like its mates, future phases of the historic sites component will have to devise field sampling and testing procedures for physically dealing with the mechanics of assessing the 3,800 acre Big River catchment and whatever alternatives are chosen for development. Problems such as site and survey access, in part determined by physiographic and topographic factors, will have to be addressed as will seasonal scheduling for optimum coverage. Points as mundane as poison ivy eradication, site clearing and mapping will have to be dealt with and planned for.

Research problems facing the historic sites components will include the fluid integration of RIHPC's standing structures report into the overall research design, while dealing with obvious weaknesses in the historic literature. An accurate assessment of available primary documents and the development of a comprehensive regional history founded, in the mean, upon such documents will also be necessary. Cartographic resources should not be ignored, nor should oral sources be overlooked.

Research strategies available to the historic archaeological component can run a broad gamut. Locally one research approach can address not only the historic evolution of the various loci contained within the reservoir system, but the historic evolution of the respective towns and villages as well. On a broader, more regionalized basis, research into the Big River system can be applied towards several different developmental comparisons, such as that of Coventry versus West Greenwich, eastern versus western Rhode Island, and upland Rhode Island versus upland New England. A review of this rather unusual area could also be applied towards studies of population migration, settlement and abandonment, as well as the comparison of the rural industrial pattern versus the village/town industrial pattern. Such studies would be of further aid in understanding the historic relationship of rural land use to the rural labor pool, while reviewing in more detail a multi-faceted regional socio-economic and environmental evolution. Finally such research strategies could also provide data for further evaluation of historic transportation networks and their effect on locational patterns, commerce and general development.

EXPECTED HISTORIC SENSITIVITY OF PROPOSED ALTERNATIVE FEEDER RESERVOIRS

As noted in the Project Location section of this report, the as-built Big River Reservoir system could be derived from one of a variety of alternative combinations that might utilize five different areas to complement the final Big River catchment. To reiterate, these five areas would tap sections and tributaries of the Moosup River, Bucks Horn Brook, the Nooseneck River, the Wood River and Fisherville Brook. Unlike the main Big River catchment, these five areas received a minimum of attention during the present pilot study. Due to time constraints, these areas were only tangentially investigated with no attempt at physical survey and only limited attention paid to either literature or document search. As such, the expected historic sensitivities projected below are approximate at best and should be treated accordingly until tested during Phase I investigations.

The basic historic sensitivity of the 3,800 acre Big River flood pool is thought to range from medium to high with village centers like Nooseneck, and known historic sites like Congdon Mill Complex or the New London Turnpike rated highly sensitive.

Turning to the Moosup River site the present as-proposed reservoir area is rated overall at medium-low, in part due to the general thinness of the project zone, the fairly sizable percentage of wetlands, the lack of standing structures, the lack of recorded cemeteries and the lack of mill ponds. Located in western Coventry and impinging slightly into Sterling, Connecticut this area includes Roaring Brook, while lying just west of Hopkins Hollow and south of the old railroad right of way. Sections of the project area probably at one time fell within the thousand acre Nicholas holdings (RIHPC, 1978:51), the farmstead of which is presently in nomination for the National Register.

The second feeder area is the Bucks Horn Brook unit, situated in west central Coventry between the villages of Summit on the east, and Greene on the west. Even though this area possesses substantial wetlands, its overall sensitivity is rated high in part due to the presence of standing structures, the existence of several isolated cemeteries, the presence of the railroad right of way, and the proximity of the area to Summit and Greene.

The third feeder or alternative area is the Nooseneck River alternate standing due west of the Big River pool in West Greenwich. This alternative could encompass the Robin Hollow Pond as well as Yard Pond and another pond due west of Nooseneck Village. When one considers these three probable mill ponds combined with the presence of several standing structures, one known cemetery, the variety of dirt roads, the fairly level uplands topography and the area's proximity to the Cedar Swamp, this feeder's overall rating would be considered high.

Southwest of Nooseneck River is the proposed Wood River feeder, an area encompassing a good portion of Beach Pond State Park in the town of Exeter, with slight overlap into West Greenwich. The topographic plans for this feeder show no standing structures or mill ponds in the pool area, nor are any known cemeteries evident. The region seems to be something of a glacial outwash plain with several large pockets of wetlands. While the bi-part area is traversed by several roads, the easterly watercourse is known as Flat River, indicating the region's probable lack of mill-related industries. If the structures shown flanking Flat River are only recent seasonal cottages, then the tentative historic sensitivity rating of low to medium may be accurate.

The fifth and final alternative feeder area under discussion is the Fisherville Brook unit located in northeastern Exeter. This area's historic sensitivity is considered medium based on the existence of several standing structures, the presence of one mill pond, the proximity to two other apparent mill ponds and the interrelationship of evidently well-drained lands to several minor brooks.

BIBLIOGRAPHY-REFERENCES FOR ENVIRONMENTAL DATA

Allen, William, 1956: Groundwater Resources of the East Greenwich Quadrangle. Geological Bulletin #8, USGS and RI Development Council.

Anderson, Patricia, 1976: "The Historical and Palynological Record of Rhode Island in the 17th to 19th Centuries: A Methodological and Theoretic Consideration of Ecologic Approaches in Archaeology." M.A. Thesis, Brown University, Providence.

Anteus, E., 1922, 1928: "Recession of the Last Ice Sheet in New England." American Geographic Society Research Series 11. "The Last Glaciation." American Geographic Society Research Series 17.

Ashley, G.M., 1972: "Rhythmic Sedimentation in Glacial Lake Hitchcock, Massachusetts-Connecticut." Geology Department, University of Massachusetts, Amherst. Contribution 10.

Bernabo, J. Christopher, 1977: "Sensing Climatically and Culturally Induced Environmental Changes Using Palynological Data." Ph.D. Thesis, Brown University, Providence.

Braun, Lucy, 1950: Deciduous Forests of Eastern North America. The Blakiston Company, Philadelphia.

Curran, Mary Lou and Dincauze, Dena, 1977: "Paleo-Indians and Paleo-Lakes: New Data from the Connecticut Drainage." In Amerinds and Their Paleoenvironments in Northeastern North America. New York Academy of Sciences 288, pp. 333-349.

Davis, Margaret, 1969: "Climatic Changes in Southern Connecticut Recorded by Pollen Deposition at Rogers Lake." Ecology 50 (3), pp. 409-422.

Davis, R.B., et al, 1975: "Vegetation and Associated Environments During the Past 14,000 Years Near Moulton Pond, Maine." Journal of Quaternary Research 5, pp. 435-465.

Day, Gordon, 1953: "The Indians as an Ecological Factor in the Northeastern Forest." Ecology 34, pp. 329-346.

Dincauze, Dena, et al, 1976: Cultural Resource Survey and Impact Evaluation Report, State Route 2. Schoenfeld Associates Inc., pp. 1-7.

Fowler, William, 1968: "Archaic Discoveries at Flat River." Bulletin of the Massachusetts Archaeological Society, vol. 29, no. 2, pp.17-36.

Guthrie, Richard and Stolgitis, John, 1977: Fisheries Investigations and Management in Rhode Island Lakes and Ponds. Rhode Island Department of Natural Resources, Fisheries Report 3.

Jorgenson, Neil, 1978: A Sierra Club Naturalist's Guide to Southern New England. Sierra Club Books, San Francisco, pp. 376-398.

Lang, S.M., 1961: Appraisal of the Ground Water Reservoir Areas in Rhode Island. USGS and RI Department Council, RI Geologic Bulletin II.

Meyers, James, 1978: Personal communication.

Ogden, J. Gordon, 1977: "The Late Quaternary Paleoenvironmental Record of Northeastern North America." In Amerinds and Their Paleoenvironments in Northeastern North America. New York Academy of Sciences, vol. 289, pp. 16-35.

Quinn, Alonzo, 1971: Bedrock Geology of Rhode Island.. US Department of the Interior, Geological Survey Bulletin 1295.

Smith, J., 1956: Surficial Geology of the Crompton Quadrangle, RI. USGS map.

BIBLIOGRAPHY: PREHISTORIC BACKGROUND REFERENCES

Arnold, Henry N., 1969: "Arnold Spring Rock Shelter." Bulletin of the Massachusetts Archaeological Society, vol. 30, no. 2.

Bacon, Edgar M., 1964: Narragansett Bay. G.P. Putnam and Sons, New York and London.;

Byers, Douglas, 1958: "Two Sites in Southern New England." Bulletin of the Massachusetts Archaeological Society, vol. 20, no. 1.

Dincauze, Dena F., 1968, 1972, 1974, 1976: "Cremation Cemeteries in Eastern Massachusetts." Peabody Museum, vol. 58, no. 1. "The Atlantic Phase: A Late Archaic Culture in Massachusetts." In Man in the Northeast. "An Introduction to the Archaeology of the Boston Area." The Archaeology of Eastern North America. Eastern States Archaeological Federation, vol. II, no. 1. "The Nevill Site: 8000 years at Amoskeag." Peabody Museum Monograph, no. 4.

Dincauze, D. and Mulholland, M. 1977: "Early and Middle Archaic Site Distributions and Habitats in Southern New England." In Amerinds and Their Paleoenvironments. Annals of the New York Academy of Sciences, vol. 288.

Fowler, William S., 1956, 1962, 1967, 1968: "Sweet Meadow Brook: A Pottery Site in Rhode Island." Bulletin of the Massachusetts Archaeological Society, vol. 18, no. 1. "Rattlesnake Rock Shelter." Bulletin of the Massachusetts Archaeological Society, vol. 24, no.1. "Locust Spring Site: Its Occupational Activities." Bulletin of the Massachusetts Archaeological Society, vol. 24, no. 1. "Oaklawn Quarry, Stone Bowl and Pipe Making." Bulletin of the Massachusetts Archaeological Society, vol. 29, no. 1. "Archaic Discoveries at Flat River." Bulletin of the Massachusetts Archaeological Society, vol. 29, no. 2.

Gero, Joan M., 1977: "An Archaeological Properties Location Study for a Section of the Rhode Island 102/Victory Highway Reconstruction Project from Scituate to West Greenwich." Institute for Conservation Archaeology, Peabody Museum, Harvard University, Cambridge, Massachusetts.

Hartshorn, Joseph H., 1967: The Geology of the Taunton Basin, Bristol and Plymouth Counties, Massachusetts. USGS Bulletin 1163-D.

Pope, G.D., 1952: "Excavations at the Charles Tyson Site." Bulletin of the Archaeological Society of Connecticut, vol. 26.

Ritchie, William A., 1965: The Archaeology of New York State. Natural History Press, Garden City Press, New York.

Simmons, William, 1970: Kautantowit's House. Brown University Press, Providence.

Talmage, Valerie, 1977: "Phase I Archaeological Survey: Route 102 Extension (B), Glocester, Rhode Island." Institute for Conservation Archaeology, Peabody Museum, Harvard University, Cambridge, Massachusetts.

Waddicor, Arthur, 1969: "Church Brook Rock Shelter No. 1." Bulletin of the Massachusetts Archaeological Society, vol. 30, no. 2.

Waddicor, Arthur and Mitchell, Morris, 1969: "Furnace Hill Brook Site: A Salvage Dig." Bulletin of the Massachusetts Archaeological Society, vol. 30, no. 2.

BIBLIOGRAPHY: HISTORIC BACKGROUND

Aerial Topographical Survey Corporation, 1974: Aerial Photographic Index of the State of Rhode Island. Providence.

Alden, John Eliot, 1949: Rhode Island Imprints, 1727-1800. New York.

Andrews, Charles M., 1889: The River Towns of Connecticut: A Study of Wethersfield, Hartford and Windsor. Baltimore.

Anderson, Patricia, 1976: "The Historic and Palynological Record of Rhode Island in the Seventeenth to the Nineteenth Centuries: A Methodological and Theoretic Consideration of Ecologic Approaches in Archaeology." Unpublished M.A. Thesis, Brown University, Providence.

Anonymous, 1965: Souvenir Booklet: 225th Anniversary Celebration, Town of Coventry. Coventry, Rhode Island.

Arnold, James, 1892: Vital Records of Rhode Island: 1636-1860. Providence.

Arnold, Samuel G., 1859, 1860: History of the State of Rhode Island and Providence Plantations. New York, 2 volumes.

Baker, Roberta, 1976: Bits and Pieces of West Greenwich. West Greenwich (?).

Bartlett, John R. [ed.], 1864: Bibliography of Rhode Island: A Catalogue of Books and Other Publications. Providence.

Bates, Frank G., 1944: "The Seven and Ten Line in the Shawomet Purchase." Unpublished manuscript at Rhode Island Historical Society, Providence.

Bates, F.G. and Perry, C.M., ND: "The Shawomet Purchase in the Colony of Rhode Island and Providence Plantations in New England." Unpublished manuscript at Rhode Island Historical Society, Providence.

Beers, J.C., 1908: Representative Men and Old Families of Rhode Island. Chicago, 2 volumes.

Bicknell, Thomas W., 1920: History of the State of Rhode Island and Providence Plantations. New York, 2 volumes.

Bidwell, P.W. and J.I. Falconer, 1925: History of Agriculture in the Northern United States: 1620-1860. Washington, DC.

Black, John Donald, 1950: The Rural Economy of New England. Harvard University Press, Cambridge, Massachusetts.

Brayton, George A., 1883: "A Defense of Samuel Gorton and the Settlers of Shawomet." Rhode Island Historical Tracts, First Series, No. 17, Providence.

Brigham, Clarence S., 1903: "Report of the Archives of Rhode Island." Annual Report of the American Historical Association, Washington, DC.

Callender, John, 1739: Historical Discourse on the Civil and Religious Affairs of the Colony of Rhode Island and Providence Plantations. Boston.

Carroll, Charles, 1932: Rhode Island: Three Centuries of Democracy. New York, 4 volumes.

Cauchon, Henry Fabian, 1960: "The New London Turnpike." Unpublished M.A. Thesis, Brown University, Providence.

Chapin, Howard M., 1926: The Early Records of the Town of Warwick. Providence.

Clapp, R.J., 1950: "How Acid Factory Brook Got Its Name." [Clapp Acid Factory]. Proceedings of the Western Rhode Island Civic Historical Society, vol. 1, no. 4, pp. 1-8.

Clark, V.S., 1916: History of Manufacturers in the United States: 1607-1860. Carnegie Institution, Washington, DC.

Clancy, Paul, 1958: "Selected Aspects of Warwick History for Social Studies Teachers in Warwick, Rhode Island." Unpublished M.A. Thesis, Rhode Island College, Providence.

Cole, J.R., 1889: History of Washington and Kent Counties, Rhode Island. Preston and Co., New York.

Coleman, Peter J., 1963: The Transformation of Rhode Island: 1790-1860. Brown University Press, Providence.

Consolidated Illustration Company (comp.), 1896: Rhode Island: 1636-1896, A Brief Sketch. New York.

Curtis, Harold R., 1927: "Warwick Proprietor's Division." Rhode Island Historical Society Collections, Providence.

Dyer, Elisha, 1871: Valuation of the Cities and Towns in the State of Rhode Island: 1860-1869. Providence Press Co., Providence.

Field, Edward, 1902: State of Rhode Island and Providence Plantations. Boston.

Fowler, Gail, 1976: "Rice City: An Evaluation of the Evidence." Unpublished M.A. Thesis, Brown University, Providence.

Fuller, Oliver, 1875: History of Warwick, Rhode Island. Angell, Burlingame and Co., Providence.

Greene, Daniel H., 1877: History of the Town of East Greenwich and Adjacent Territory from 1677 to 1877. Providence.

Greene, Welcome A., 1866: The Providence Plantations for Two Hundred and Fifty Years. J.A. & R.A. Reid, Providence.

Greven, P.J., 1970: Four Generations: Population, Land and Family in Colonial Andover, Massachusetts. Cornell University Press, Ithaca, New York.

Gustafson, Helen H., 1965: Reflections of Coventry's Yesterdays (1741-1900). Coventry Public Library, Coventry, Rhode Island.

Harpin, Mathais P., 1961, 1974, 1976: Trumpets in Jericho. Commercial Printing & Publishing Co., West Warwick, Rhode Island. Prophets in the Wilderness. Harpin's Connecticut Almanac. The High Road to Zion. Harpin's American Heritage Foundation.

Hasse, Adelaide R., 1908: Index of Economic Material in Documents of the States: Rhode Island, 1789-1904. Carnegie Institution, Washington, DC.

Hoag, Wade & Co., 1878: History of the State of Rhode Island. Philadelphia.

Huling, Ray Greene, 1884, 1885: "Early Owners of Land in West Greenwich, Rhode Island." The Narragansett Historical Register.

Jackson, C.T., 1840: Report on the Geological and Agricultural Survey of the State of Rhode Island. Providence.

James, Sydney V., 1975: Colonial Rhode Island. Scribner's Sons, New York.

Leblanc, Robert G., 1969: Location of Manufacturing in New England in the Nineteenth Century. Geography Publications of Dartmouth College, Hanover, New Hampshire.

Levesque, George, 1969: "Coventry: The Colonial Years, 1741-1783." Unpublished M.A. Thesis, Brown University, Providence.

Matteson, George E., 1966: Map of West Greenwich. Matteson Map Service, Coventry, Rhode Island.

Mayer, Kurt B., 1953: Economic Development and Population Growth in Rhode Island. Brown University Press, Providence.

Mayer, Kurt B. and Goldstein, Sidney, 1958: Migration and Economic Development in Rhode Island. Brown University Press, Providence.

McLane, Louis, 1833: "Report of the Secretary of the Treasury: Documents Relative to Manufacture, 1832." House Executive Documents, no. 308, Washington DC.

McManis, Douglas R., 1975: Colonial New England: A Historic Geography. Oxford University Press, New York.

McPartland, Martha R., 1960: The History of East Greenwich, Rhode Island: 1677-1960, with Related Genealogy. East Greenwich, Rhode Island.

Monahon, Clifford P., 1965: Rhode Island: A Student's Guide to Local History. Teacher's College Press, Columbia University, New York.

Moriarty, G. Andrews and Miller, William Davis [eds.], 1937: A Petition for the Settlement of Lands West of East Greenwich. Rhode Island Historical Society Collections, Providence.

Munro, Wilfred Harold, 1881: Picturesque Rhode Island. J.A. & R.A. Reid, Providence.

National Society, Daughters of the American Revolution, 1934, 1951, 1933: West Greenwich Wills: 1743-1816. Report of the General Records Committee, 4 volumes. Index of West Greenwich Wills: 1743-1760. Record Book. Gravestone Records, Hopkins Cemetery, West Greenwich. Report of the General Records Commission of Rhode Island, vol. 1.

Place, John W., 1947: "The History of Rice City and Its Suburbs." Unpublished manuscript at Rhode Island Historical Society, Providence.

Pratt, 1849: New England Mercantile Union Business Directory: Part 5: Rhode Island. New York.

Preston, H.W., 1930: Rhode Island's Historic Background. Providence.

Rhode Island Commission of Dams and Reservoirs, 1882-1892: Reports 1-10, 1882-1892. Providence.

Rhode Island Department of Community Affairs, Planning and Development Division, ND: Towns of West Greenwich, Rhode Island: Map Study. Providence.

Rhode Island Department of Economic Development, 1977: Rhode Island City and Town Monographs: Coventry. Providence.

Rhode Island Development Council, 1957, 1965: Rhode Island Towns and Cities, Community Facts: Coventry. Providence. Comprehensive Community Plan for the Town of West Greenwich. Providence.

Rhode Island Factory Inspectors, 1894-: Annual Report of the Factory Inspectors Made to the General Assembly. Providence.

Rhode Island Historic Preservation Commission, 1978: Historic and Architectural Resources of Coventry, Rhode Island: A Preliminary Report. Providence.

Richman, Irving, 1905: Rhode Island: A Study in Separation. Houghton, Mifflin & Co., Boston.

Sande, Theodore A., 1972: "The Architecture of the Rhode Island Textile Industry: 1790-1860." Unpublished PhD. dissertation, University of Pennsylvania, Philadelphia.

Taft, H.S., 1941: Proprietors: Original Subdivisions of Old Warwick with Accompanying Plots. Rhode Island Historical Society Library, Providence.

Travelers Protective Association of America, Rhode Island Division, 1898: Commercial History of the State of Rhode Island. Snow & Farnum, Providence.

Tucker, Peter, 1966: Development of a Providence Centered

Transportation System: 1795-1835. Providence.

Walker, Cyrus, ND: "The History of Scituate, Rhode Island: From Acquisition of Territory in 1659 to the Close of the 19th Century." Unpublished manuscript in the Scituate, Rhode Island Town Hall, Scituate, Rhode Island.

Weedon, William B., 1890, (1963), 1910: Economic and Social History of New England: 1620-1789. Hillary House Publishers, Ltd., New York. Early Rhode Island. New York.

West Greenwich, Rhode Island, 1864-1962: Assessors of Taxes: Tax Book, Valuation of Property and Report of Town Treasurer. Centerville, Rhode Island.

Wilson, Harold Fisher, 1936: The Hill Country of Northern New England: Its Social and Economic History, 1790-1930. Columbia University Press, New York.

Wood, Frederic J., 1919: The Turnpikes of New England. Marshall Jones Co., Boston.

Wood, Squire G., 1936: A History of Greene and Vicinity: 1845-1929. Providence.

Works Progress Administration, Federal Writer's Project, 1937, 1938: W.P.A. Writer's Guide: Rhode Island. Houghton, Mifflin Co., Boston. Inventory of Federal Archives in the States. Oklahoma City.

Works Progress Administration, Historic Records Survey, 1941, 1942: Guide to Public Vital Statistics. Providence. Inventory of Town and City Archives of Rhode Island. Providence.

TABLE 1: SOIL DATA FOR KNOWN PREHISTORIC SITES

Key: Sites with WG, CV prefix located by RIHPC.
Sites with HB prefix located by Hudson brothers, (c. 1940's).

SITE	SITE DESCRIPTION	SOIL TYPE	SLOPE	DRAINAGE	EXPECTED TREECOVER	WILDLIFE HABITAT: hardwoods	conifers	wetland f/f	openland wildlife	herbs	grasses	grain/seed crops
RI WG-1 combination well-drained sands and swamp: varied environment	Prehistoric open site	17B Merrimack: sandy loam adjacent;	3-8%	well-drained	E. White pine, Nived Oak, sugar maple	F	F	P	G	G	G	F
		9 Palmsmuck; 17B Agawam fine sandy loam	-	very poor	-	P	P	G	P	P	P	P
W 6-18 similar to WG-1	Prehistoric open site	17A Merrimack; sandy loam, adjacent	0-3%	well-drained	"	F	F	P	G	G	G	F
		45-Deerfield	-	well-drained								
		17B loamy fine sand	3-8%	well-drained								
		40B-C-C very stony	3-8%	well-drained								
CV-7 balanced environment dry, well-drained soils and swampy areas	Prehistoric open site	17A Agawam fine sandy loam	0-3%	well-drained		G	G	P	G	G	G	G
		9 Palmsmuck	-	poorly-drained		P	P	P	P	P	P	P
		53 Raynham siltloam	-	poorly-drained	E. White pine	F	F	G	F	F	F	F

TABLE 1 (continued)

SITE	SITE DESCRIPTION	SOIL TYPE	SLOPE	DRAINAGE	EXPECTED TREECOVER	WILDLIFE HABITAT: hardwoods	conifers	wetlands f/f	openland wildlife	herbs	grasses	grain/seed crop	woodland wildlife
CV-6 very varied environments, 6 major soil types	Prehistoric open site	30 Walpole sandy loam	-	poor	E. White pine red maple	F	F	G	F	F	F	P	F
		50B-Enfield silt loam	3-8%	well-drained	E. White pine, N. red oak, red pine	G	G	P	G	G	G	F	P
		17B-Merrimack, sandy loam	3-8%	well-drained	E. White pine, N. red oak, sugar maple	F	F	P	G	G	G	G	F
		27 A/C Hinckley gravels sandy loam	A=0-3% C=3-15%	excessively drained	E. White pine, N. red oak, red pine, sugar maple	P	P	P	P	F	F	P	P
		45-Deerfield loamy fine sand	-	well-drained	E. White pine, N. red oak	P	P	P	F	F	F	F	P
		7M-W&R extremely stony soils	-	very poorly drained	E. White pine, red spruce, red maple, N. red oak	P	P	G	P	P	P	P	P

TABLE 1 (continued)

SITE	SITE DESCRIPTION	SOIL TYPE	SLOPE	DRAINAGE	EXPECTED TREECOVER	WILDLIFE HABITAT: hardwoods	conifers	wetlands f/f	openland wildlife	herbs	grasses	grain/seed crops	woodland wildlife
W6-11 side surrounding small pond to east of Nooseneck Hill Road	Prehistoric open site	7M-W&R extremely stony soils	-	very poor	E. white pine, red spruce, red maple, N. red oak	P	P	G	P	P	P	P	P
		64XB-woodbridge very stony fine sandy loam	0-8%	well-drained	E. white pine N. red oak red pine	G	G	P	P	G	P	F	G
		64BWB fine, sandy loam	3-8%	well-drained	E. white pine, N. red oak, red pine	G	G	P	G	G	G	F	G
		30-Walpole sandy loam	-	poor	E. white pine, red maple	F	F	G	F	F	F	P	F
		31-Scarboro sandy loam	-	very poor	E. white pine, red maple	P	P	G	P	P	P	F	P
		32-Sudbury sandy loam	-	poor	E. white pine, N. red oak	G	G	P	G	G	G	F	G
		27A-Hinckley generally sandy loam	0-3%	excessively drained	E. white pine, N. red oak, red pine, sugar maple	P	P	P	P	F	F	P	P

TABLE 1 (continued)

SITE	SITE DESCRIPTION	SOIL TYPE	SLOPE	DRAINAGE	EXPECTED TREECOVER	WOODLAND HABITAT hardwoods	conifers	wetlands f/f	openland wildlife	herbs	grasses	grain/seed crops	woodland wildlife
WG-12	Prehistoric rock shelter	47MB Wapping extremely strong, silt loam	0-8%	well-drained	E. white pine, N.red oak	G	G	P	P	G	P	P	F
W6-16 W6-13 W6-14	"	37MD Hollis rock, outcrop complex	15-25%	excessively drained	-	P	P	P	P	F	P	P	P
		7M - water very poorly drained	-	very poor	N. red oak E. white pine, white spruce	P	P	G	P	P	P	P	P
W6-15	"	37LC - Hollis Charlton complex	3-15%	well-drained	N. red oak E. white pine, sugar maple, red pine, white spruce	F	F	P	P	F	P	P	F

TABLE 1 (continued)

SITE	SITE DESCRIPTION	SOIL TYPE	SLOPE	DRAINAGE	EXPECTED TREECOVER	WOODLAND HABITAT hardwoods	conifers	wetlands f/f	openland wildlife	herbs	grasses	grain/seed crop	woodland wildlife
HB-1	Prehistoric open site	51A - Windsor loamy sand adjacent	0-3%	excessively drained	E. white pine, N. red oak, red pine	P	P	P	F	F	F	P	P
		17B - Merrimack sandy loam	3-8%	well-drained	E. white pine, N. red oak, sugar maple	F	F	P	G	G	G	G	F
4B-2	included on RICUG												
HB-3	Prehistoric	40xb - CCV, stony fine sandy loam	3-8%	well-drained	E. white pine, N. red oak	F	F	P	P	F	P	P	F
HB-4	Prehistoric	45 - Deerfield loamy fine sand	-	well-drained	E. white pine, N. red oak	P	P	P	F	F	F	P	P
HB-5	Prehistoric	7M - W&R extremely stony soils	-	very poorly drained	E. white pine, red spruce, red oak maple, N. red	P	P	G	P	P	P	P	P
		64xB - Woodbridge very stony fine sandy loam	0-8%	well-drained	E. white pine, N. red oak, red pine	G	G	P	P	G	P	F	G
HB-6	Prehistoric	64XB	"	"	"	G	G	P	P	G	P	F	G

G=good; F=fair; P=poor

TABLE 2: DATA ON KNOWN PREHISTORIC SITES, BIG RIVER PROJECT AREA AND VICINITY*

I. Sites Within Big River Project Area

No.	Site Name	RIHPC File No.	Town or Place	Components	Reference	Informant	Collections	Notes
1	Burnt Sawmill Road	WG-10	W. Greenwich	Late Archaic-Small Stem	RIHPC, 1978	N.A.	yes	in flood pool
2	Nooseneck River	WG-11	"	Unknown	"	"	no	in flood pool
3	Carr Pond Rock Shelters	WG-12	"	"	"	"	no	
4	Carr Pond Rock Shelters	WG-13	"	"	"	"	no	
5	Carrr Pond Rock Shelters	WG-14	"	"	"	"	no	
6	Carr Pond Rock Shelters	WG-15	"	"	"	"	no	
7	Carr Pond Rock Shelters	WG-16	"	"	"	"	no	
8	Big River-Burnt Sawmill Road	WG-18	"	Late Archaic-Small Stem(?)	"	RIHPC	no	in flood pool
9	Coventry Golf Club	CV-6	Coventry	Unknown	None	Roy Anderson	yes	in flood pool
10	Priscilla Farm	CV-7	"	"	"	Landowner	yes	in flood pool

*Based on RIHPC Study - June, 1978.

TABLE 2 continued; Part II. Sites in Vicinity of Big River Project continued)

No.	Site Name	RIHPC File No.	Town or Place	Components	Reference	Informant	Collections	Notes
13	Sheep Rock Shelter	-	Scituate	Late Archaic, Woodland	-	Armando Marini	yes	Hudson Collection, RI College
14	Ponagansett Rock Shelter	-	Foster	Late Archaic	-	Sue Letendre	yes	"
15	Misc. Unnamed Sites	-	Scituate, Glocester	Late Archaic, Woodland	-	-	yes	"
16	Misc. Unnamed Sites	-	Foster, Glocester, Scituate	Late Archaic, Woodland	-	Dr. Bowen B. Wood	yes	Roger Williams Museum
17	Lower Westconnaug Brook	-	Foster	Unknown	Gero, 1977	-	yes	Rt. 102 survey
18	Foster Country Club	FO-33	Foster	Late Archaic	"	M. Mattews	yes	"
19	Cherry Valley Pond	-	Glocester	Late Archaic	Talmage, 1977	-	yes	"
20	Ponagansett Reservoir	-	Glocester	Middle/Late Archaic	Talmage, 1977	Frank Place	yes	"
21	E.D. Prey	-	East Killingly, Connecticut	Unknown	Byers, 1958	H. Bennet	yes	
22	Charles Tyler	-	Moosup, Connecticut	Unknown	Pope, 1952	-	-	

(TABLE 2 continued)

II. Sites in Vicinity of Big River Project

No.	Site Name	RIHPC File No.	Town or Place	Components	Reference	Informant	Collections	Notes
1	Rattlesnake Rock Shelter	WG-1	W. Greenwich	Middle/Late Archaic, Woodland	Fowler, 1962a	Milton Hall	yes	
2	Flat River	-	Coventry	Late Paleo to Woodland	Fowler, 1968	-	yes	burials
3	Wilcox	-	"	Middle/Late Archaic, Woodland	Gero, 1977	Arthur Wilcox	yes	Rt. 102 survey
4	Sweet Meadow Brook	-	Apponaug	Late Archaic, Woodland	Fowler, 1956	Briger Anderson	yes	C_{14} 1156 ± 80
5	Locust Spring	-	Apponaug	Late Archaic, Woodland	Fowler, 1962b	-	yes	burials
6	Oaklawn Quarry	-	Cranston	Late Archaic, Woodland	Fowler, 1967	H. Johnson	yes	
7	Oaklawn Soapstone Quarry	-	"	Late Archaic	"	"	yes	
8	Church Brook Rock Shelter #1	-	"	Late Archaic	Waddicor, 1969	-	yes	
9	Furnace Hill Brook	-	"	Late Archaic, Woodland	Waddicor & Mitchell, 1969	Morris Mitchell	yes	
10	Arnold Spring Rock Shelter	-	Greene	Middle/Late Archaic, Woodland	Arnold, 1969	John Hudson	yes	
11	Furnace Hill Road	-	Hope	Late Archaic	-	Armando Marini	yes	Hudson Collection, RI College
12	Elmdale Rock Shelter	-	Scituate	Early Archaic to Woodland	-	"	yes	"

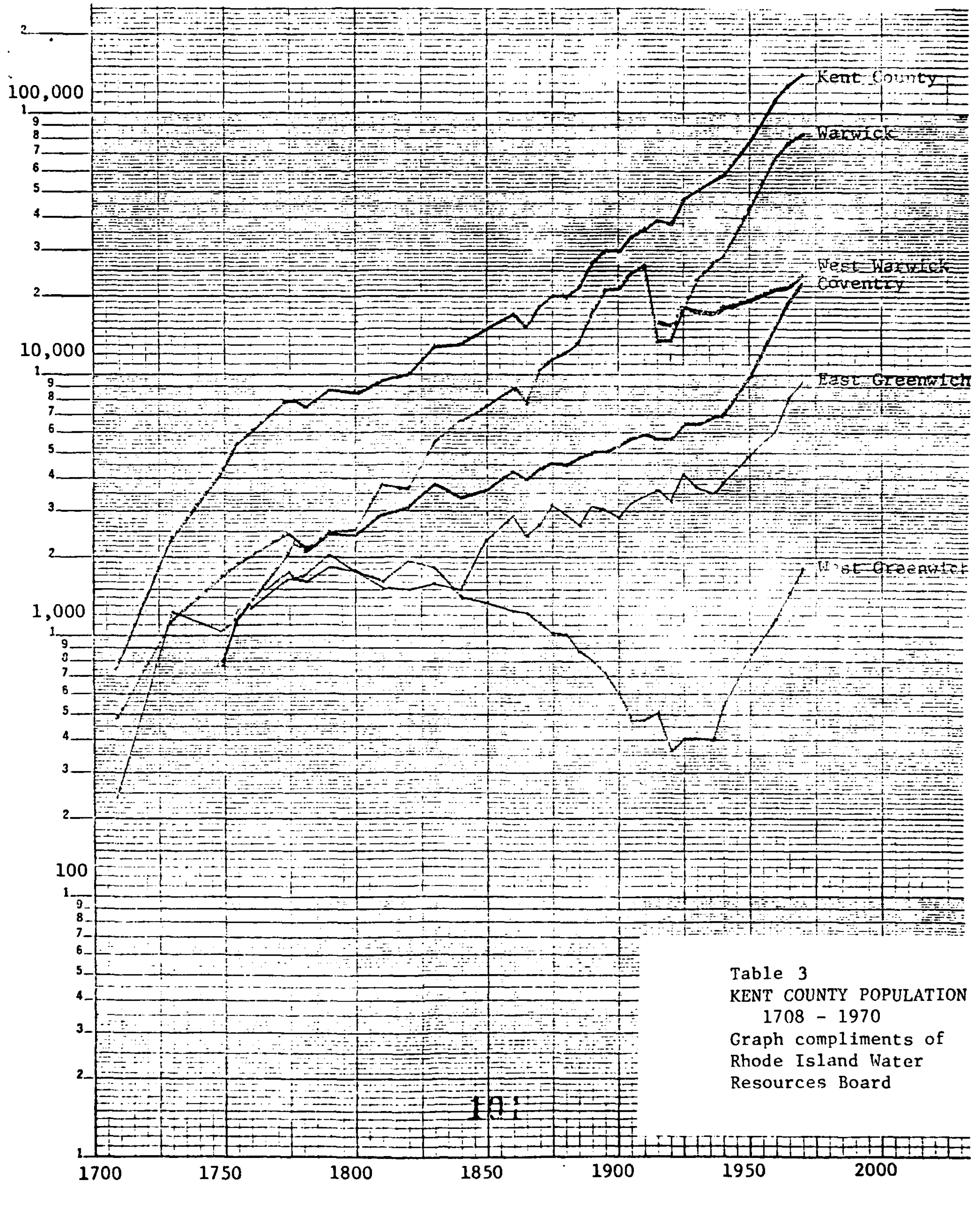


Table 3
KENT COUNTY POPULATION
1708 - 1970
Graph compliments of
Rhode Island Water
Resources Board

TABLE 4: POPULATION IN COVENTRY AND WEST GREENWICH, 1790-1860 (after Coleman)

	1790	1800	1810	1820	1830	1840	1850	1860
Coventry	2477	2423	2928	3139	3851	3433	3620	4247
West Greenwich	2054	1757	1619	1927	1817	1415	1350	1258
Rhode Island	62825	69122	76931	83059	97210	108330	147545	174620

TABLE 5: COTTON MILL EMPLOYEES IN COVENTRY AND WEST GREENWICH, 1809-1850 (after Coleman)

	1809	1812	1815	1832	1840	1850
Coventry	?	?	?	1035	710	599
West Greenwich	?	?	?	28	54	76
Rhode Island	?	?	?	9071	12086	12386

TALBE 6: COTTON MILLS IN COVENTRY AND WEST GREENWICH, 1809-1850 (after Coleman)

	1809	1812	1815	1832	1840	1850
Coventry	3	5	10	13	14	10
West Greenwich	-	-	4	5	3	5
Rhode Island	25	33	100	126	226	174

TABLE 7: KNOWN SITE INVENTORY* 15 September, 1978 HISTORIC ARCHAEOLOGICAL SITES

Map #	RI #	Area	Sites-Archaeological	In Bounds	In Pool	On Register	Recommend Register	New Entry
A 1	-	Big River	New London Turnpike	x	x		x	
A 2	WG-3	" "	Hopkins Hill Road tollgate complex		x		x	
A 3	WG-4	" "	Cleveland's Hotel Complex	x			x	
A 4	WG-2	" "	18th century foundation complex	x			x	
A 5	WG-6	" "	Congdon Mill complex		x			
A 6	WG-7	" "	Whitford's Mill complex	x				
A 7	WG-8	" "	Kittle's Mill complex	x				
A 8	WG-9	" "	Nooseneck Mill complex		x			
A 9	CV-8	" "	"Saw" Mill		x			
A 10	CV-9	" "	"Saw" Mill		x			
A 11**	-	" "	Grand Canyon quarry/canal cut	x				x
A 12**	-	" "	Carr Pond quarries	x				x
A 13**	-	" "	Carr Pond Road foundation complex	x				x
A 14**	-	" "	Town Hall site	x				x
A 15**	-	" "	Division Street desert site		x			x

* Based on RIHPC Study - June, 1978

** Based on PAL Survey - August, 1978

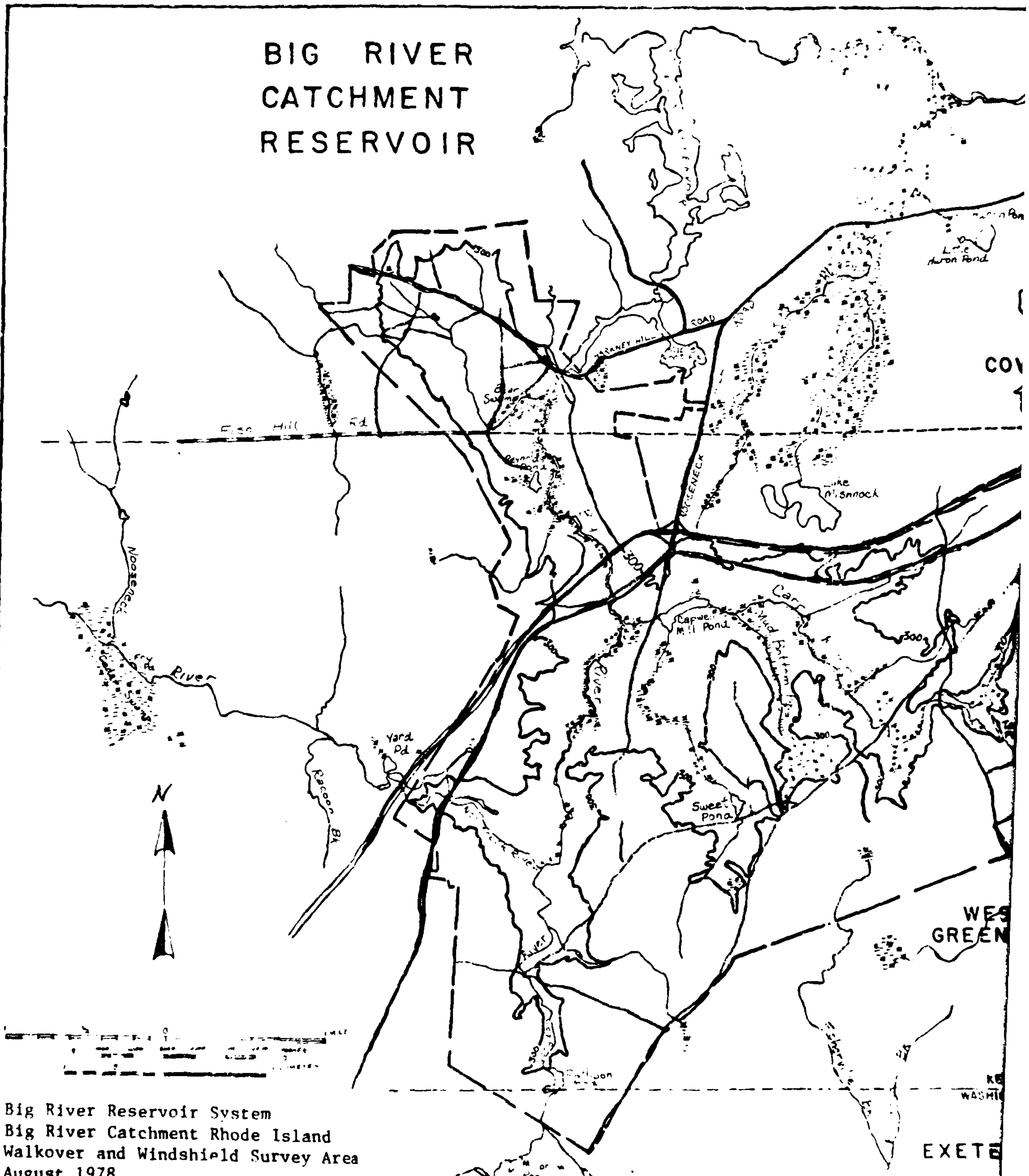
TABLE 8: KNOWN SITE INVENTORY 15 September, 1978 STANDING STRUCTURES

Map #	RI #	Area	Sites-Standing Structures	In Bound	In Pool	On Register	Recommend Register
S-1	C-49	Big River	Fish Hill Road 1-1/2 story Greek Revival House		x		
S-2	C-56	" "	Harkney Hill Road, Coventry Pines Golf Clubhouse		x		
S-3	C-56	" "	Harkney Hill Road 2-1/2 story Greek Revival houses		x		
S-4	-	" "	Bates Trail-Tarbox House (c.1745)	x			
S-5	-	" "	Burnt Sawmill Road - Matteson House (c. 1720)		x		
S-6	-	" "	Congdon Mill Road - Dawley House (1835)	x			
S-7	-	" "	Fish Hill Road - Fish House (1810)	x			
S-8	-	" "	New London Pike	x	x		x
S 9	-	" "	New London Pike - Greene Hotel (1821)		x		
S-10	-	" "	Nooseneck Hill Road - The Pines (1930)		x		
S-11	-	" "	Nooseneck Hill Road - Brown House (1835)		x		
S-12	-	" "	Nooseneck Hill Road - Hopkins House (1835)		x		
S-13	-	" "	Nooseneck Hill Road - Hopkins Mill (1867)		x	x	
S-14	-	" "	Nooseneck Hill Road - Federal house		x		

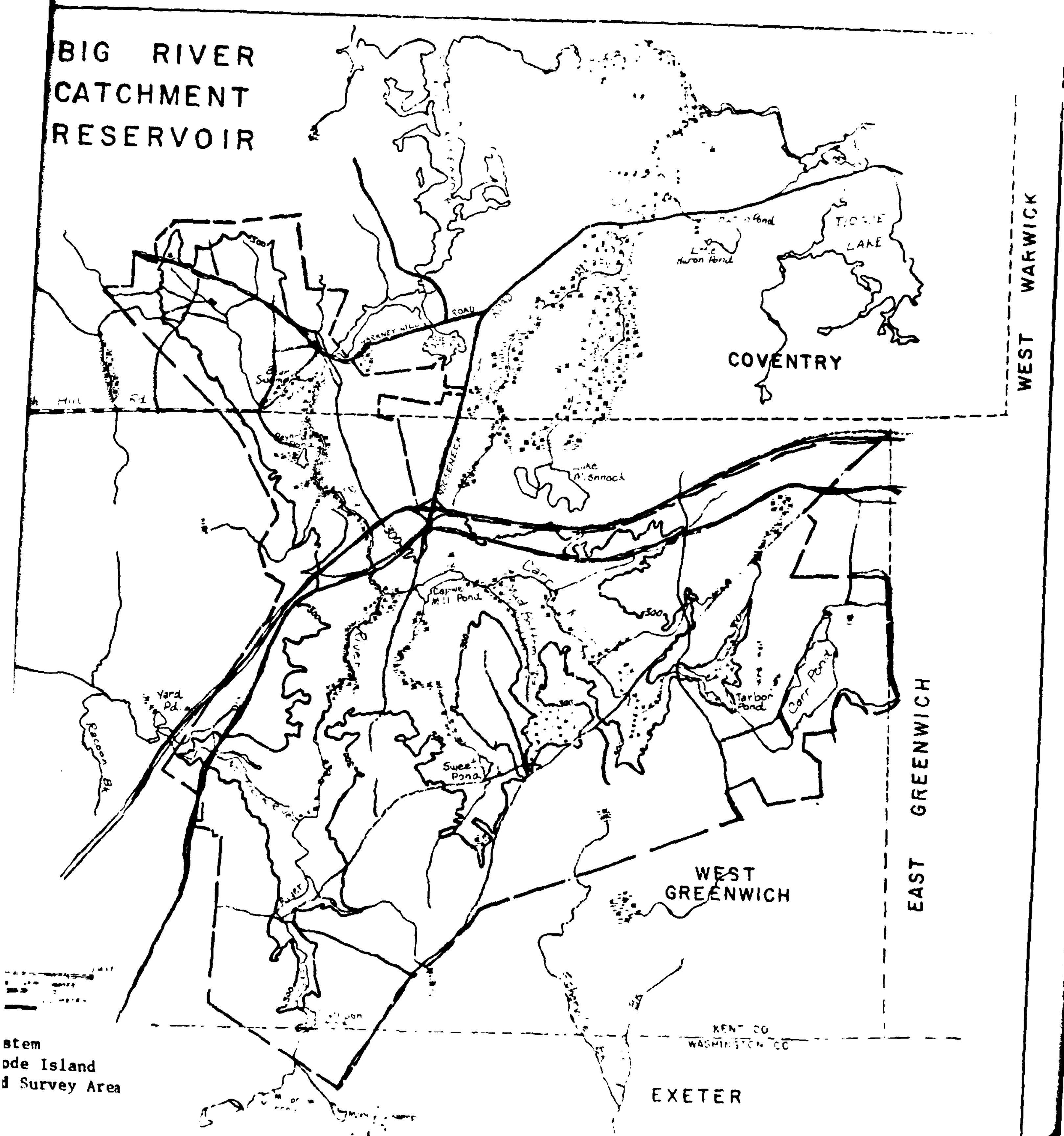
* Based on RIHPC Study - June, 1978

TABLE 9: EXTRAPOLATED HISTORIC SENSITIVITY RANKING FOR PROPOSED ALTERNATIVE FEEDER RESERVOIRS

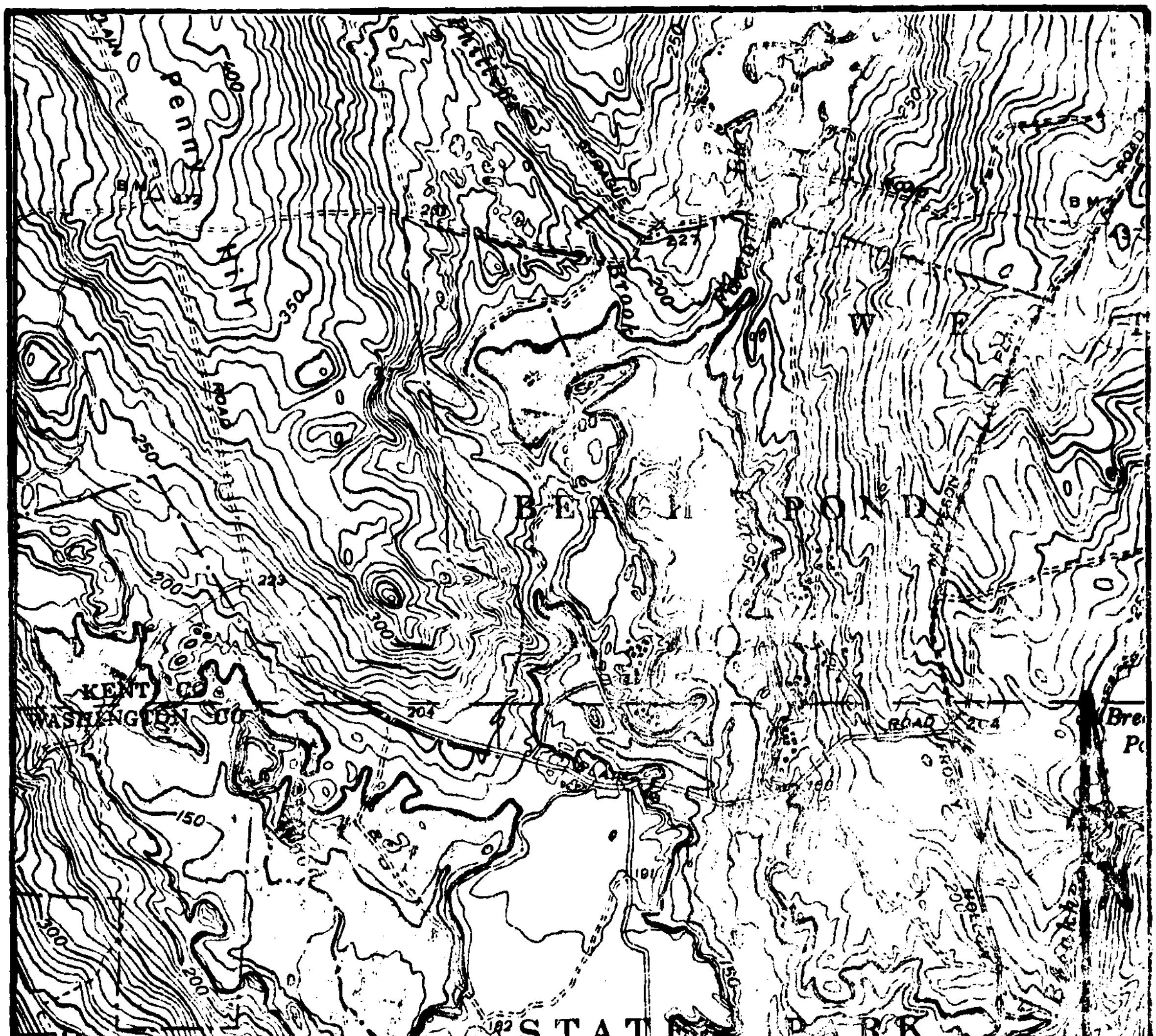
Area	Sensitivity	Comment
Wood River	low-medium	Lacks standing structures; lacks mill ponds; no cemeteries in evidence; probability good farm land; some road activity.
Bucks Horn Brook	high	Proximity to villages of Summit and Greene; presence of standing structures; existing cemeteries.
Moosup River	medium low	Thinness of project zone; wetlands; lacks standing structures; lacks mill ponds; lacks recorded cemeteries; proximity to Nicholas holdings.
Nooseneck River	high	Presence of defined roads; presence of several mill ponds; level uplands topography; known cemeteries.
Fisher-ville Brook	medium	Presence of mill pond: proximity to mill ponds; standing structures; good drainage/land.



Big River Reservoir System
Big River Catchment Rhode Island
Walkover and Windshield Survey Area
August 1978
Figure 1



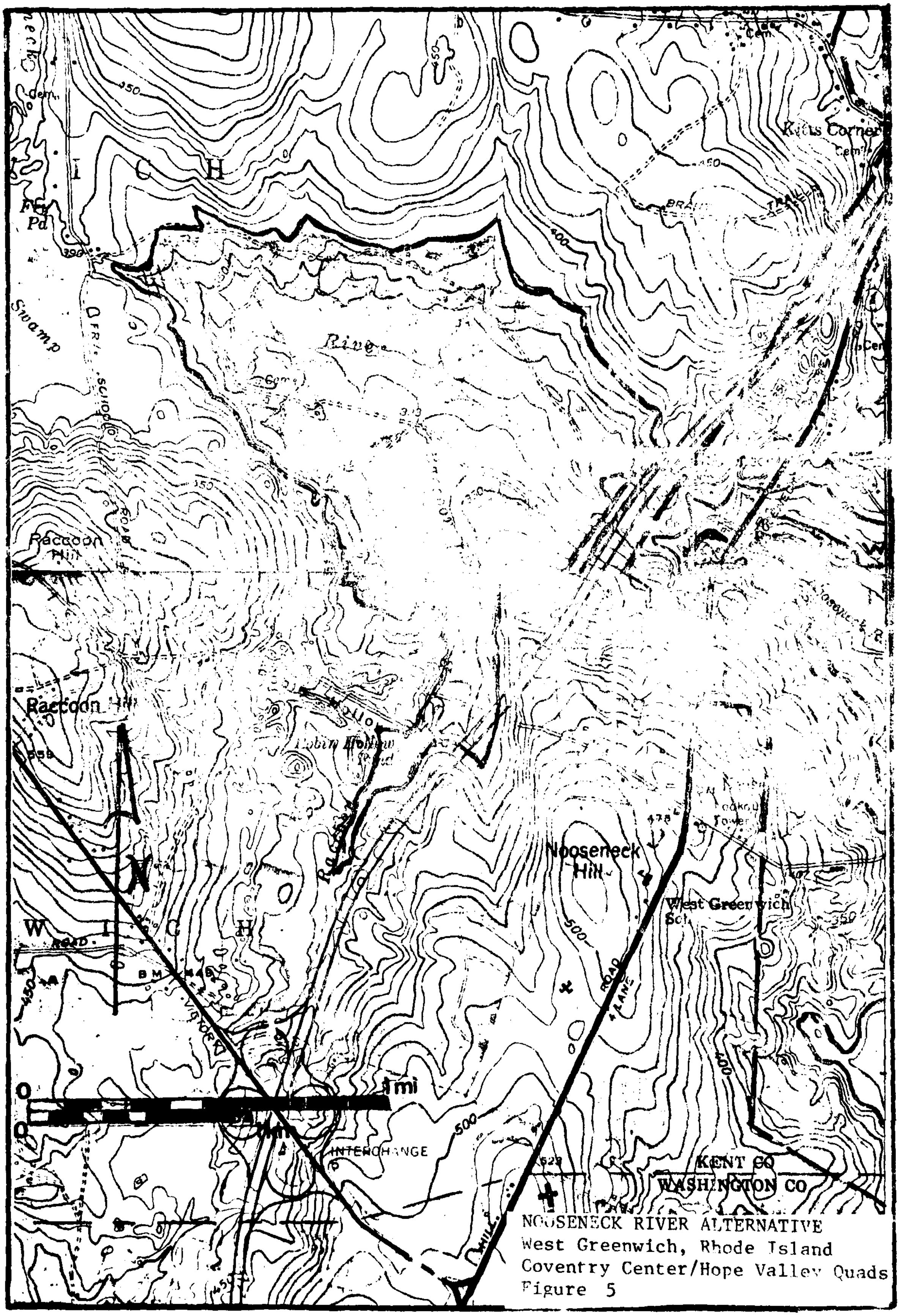
stem
ode Island
d Survey Area



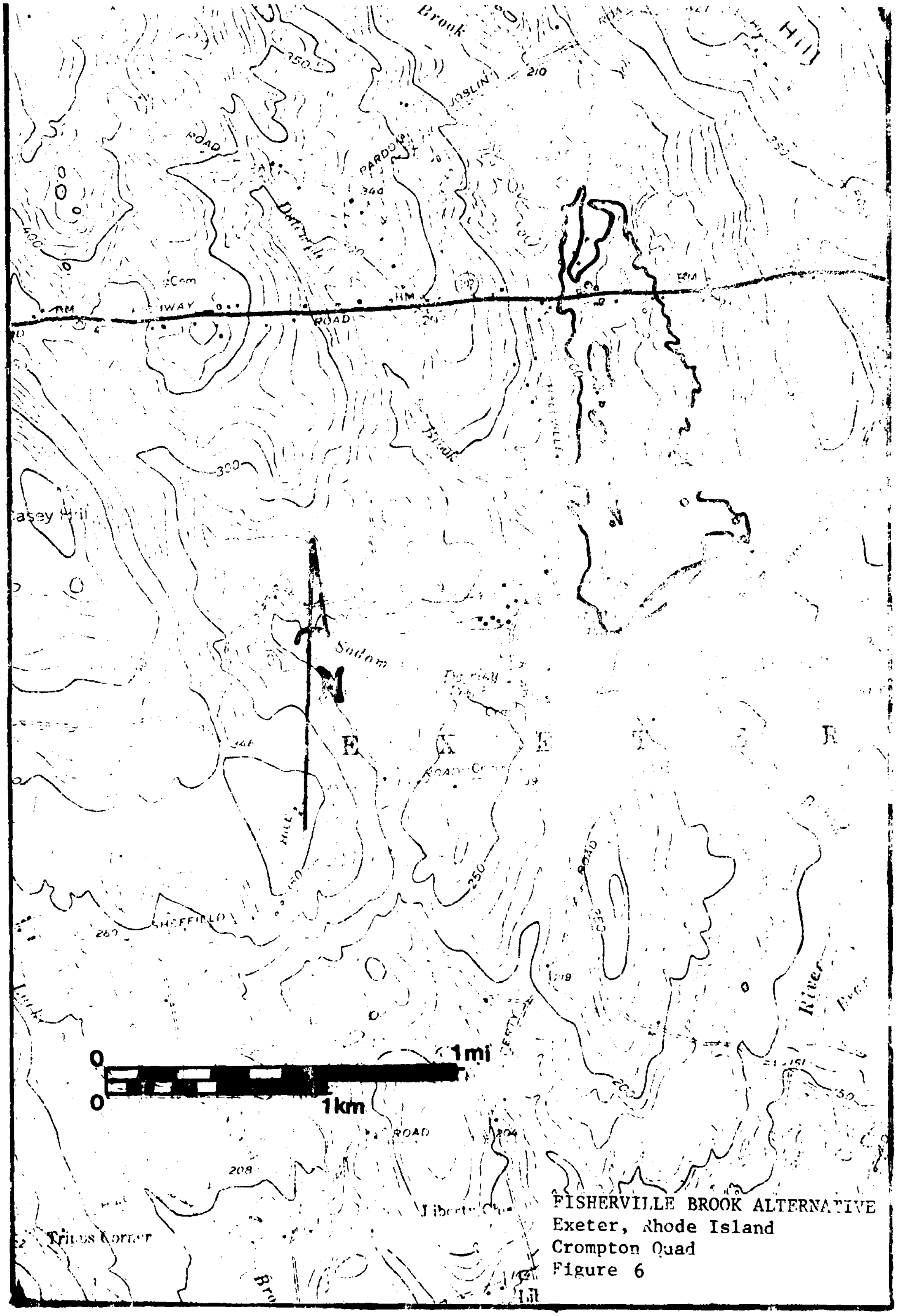
WOOD RIVER ALTERNATIVE
West Greenwich/Exeter, Rhode Island
Hope Valley Quad
Figure 2

BUCKS HORN BROOK ALTERNATIVE
Coventry, Rhode Island
Coventry Center Quad
Figure 3

MOOSUP RIVER ALTERNATIVE
Coventry, Rhode Island
Sterling, Connecticut
Oneco Quad
Figure 4



NOOSENECK RIVER ALTERNATIVE
West Greenwich, Rhode Island
Coventry Center/Hope Valley Quads
Figure 5



FISHERVILLE BROOK ALTERNATIVE
Exeter, Rhode Island
Crompton Quad
Figure 6

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX I

SOCIAL AND CULTURAL RESOURCES

Section 2b - Historical and Cultural Resources

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

A REPORT ON HISTORICAL AND CULTURAL RESOURCES WITHIN THE BIG RIVER RESERVOIR AREA OF COVENTRY, EXETER AND WEST GREENWICH, RHODE ISLAND

PREPARED FOR THE U.S. ARMY CORPS OF ENGINEERS

MARCH 1979

RHODE ISLAND HISTORICAL PRESERVATION COMMISSION

150 BENEFIT STREET

PROVIDENCE, R. I.   02903

TABLE OF CONTENTS

LIST OF FIGURES

MAPS

TABLES

I. INTRODUCTION

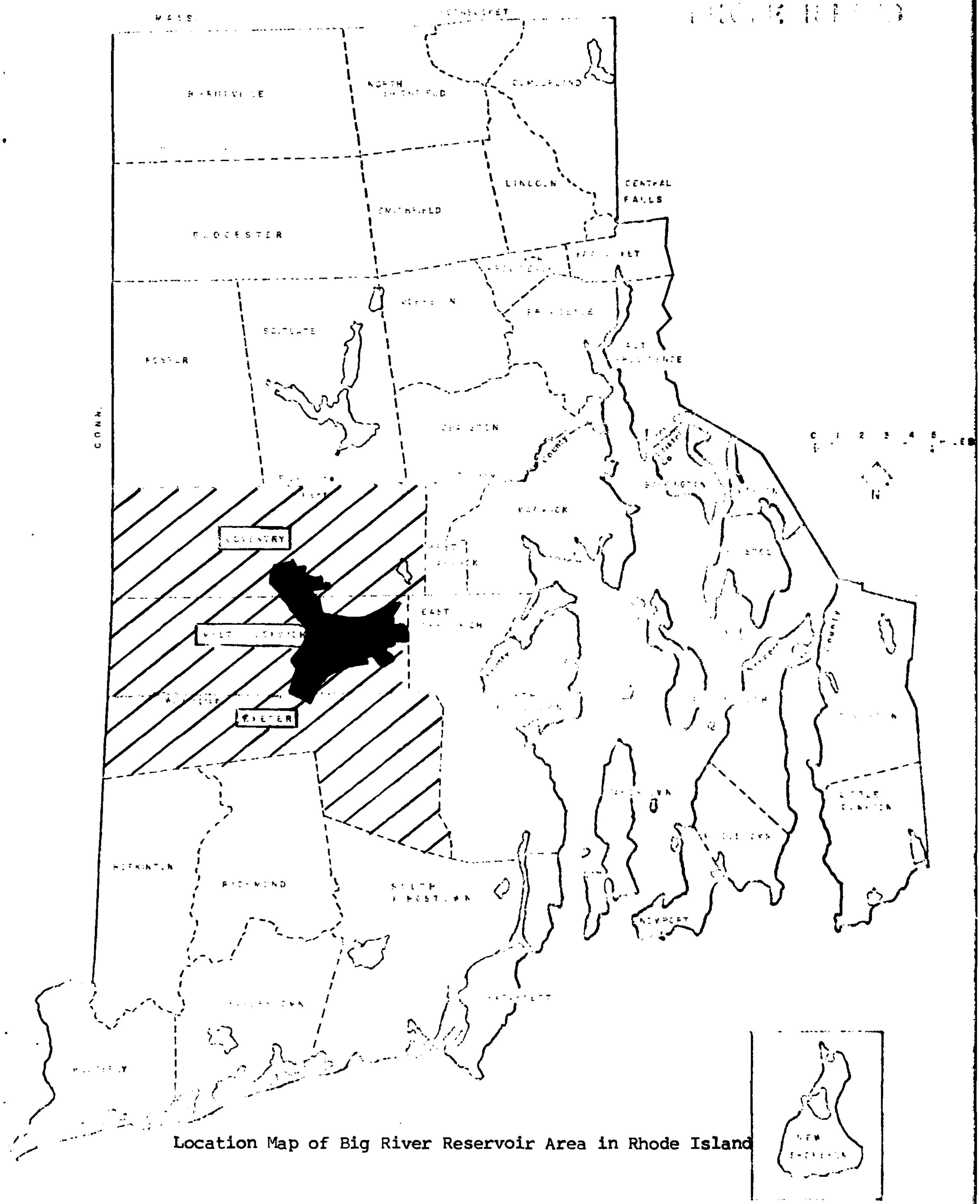
ENVIRONMENTAL REVIEW PROCESS

This analysis and review of cultural resources in the Big River area of Rhode Island, comprising parts of the towns of West Greenwich, Coventry, and Exeter has been prepared by the Rhode Island Historical Preservation Commission as part of an Environmental Impact Statement for the United States Army Corps of Engineers.

The Preservation Commission, through the State Historic Preservation Officer, is required by legal mandate to review all federally funded projects or activities to determine their effect on historical resources of the State of Rhode Island. The tone and direction of the present involvements in preservation programs and activities was set by the National Historical Preservation Act of 1966, which gave due recognition to the value of the historical and cultural foundations of the nation and provided encouragement to private individuals and agencies and to State and local governments. The National Environmental Protection Act, enacted in 1969 to establish a national poliicy for the environment, encourages private and public individuals, groups, and agencies to protect and enhance environmental quality. Initially recognizing the profound impact of man's activity on the interrelationship of all components of the natural environment, later revisions to the Act expanded the definition of environment. Today, under NEPA, all legislators and all other major actions significantly affecting the quality of the human environment as well as the national environment require consultation with the appropriate Federal, State, and local agencies and the public to assess in detail the potential environmental impact.

In 1977 the Preservation Commission was contracted by the Corps of Engineers to assess the impact of the proposed Big River Reservoir project on cultural resources in the area to be affected by the project. The limits of the survey area are defined by the property condemned and purchased by the State of Rhode Island in 1965 for the Big River Reservoir

Project. The area encompasses about 120 acres in Exeter, about 1000 acres in Coventry, and about 7623 acres in West Greenwich, including the Big River and most of its watershed (see map, p. 7). The irregularly shaped reservoir area has an east-west dimension of about five miles--from the East Greenwich town line on the east to Interstate Route 95 at Nooseneck, and just beyond the Coventry Pines Country Club on the west--and about five and a half miles in a north-south direction--from north of the Coventry Pines Country Club at the north to the New London Turnpike in Exeter just north of Victory Highway as its southernmost point.



Location Map of Big River Reservoir Area in Rhode Island

PURPOSE OF THE CULTURAL RESOURCES SURVEY

The purpose of this cultural resources survey was to identify and document districts, structures, sites, and objects significant in American history, architecture, and culture within the project area and possessing local, state, or national significance, and to make an evaluation of these properties. All entries in the inventory of cultural resources were divided into one of three levels of significance: those contributing to an understanding of local history; those of greater architectural and historical importance; and those of National Register status (see the Inventory of Cultural Resources, Section III, and Appendix A for a fuller explanation of terms and for an inventory of all properties).

The work conducted by the Preservation Commission is intended to identify, record, and evaluate the most important nonarcheological cultural resources in the Big River area only; at this level there is no recommendation for mitigation of impact.

This study conducted by the Preservation Commission included historical-architectural structures and surface sites, for the most part, essentially foundations on, or visible in or at, the surface of the earth. The Brown University Public Archeology Laboratory conduced a feasibility study of archeology sites within the reservoir area as part of the preliminary work which will lead to a more complete investigation and recording of archeological resources; it included historical and prehistorical archeological sites, some of which are also a part of the Preservation Commission's inventory of cultural resources.

SYNOPSIS OF THE REPORT

This report, the result of several months of field work, research and interviews, summarizes and encapsulates the work of the Preservation Commission. Material is presented in three major sections. Part I, the INTRODUCTION, provides the necessary background information for understanding the Preservation Commission's involvement in the area - the legislative mandates which outline the Commission's responsibility for safeguarding our cultural heritage; location of the area; purpose of the survey; and acknowledgement of assistance rendered during the study. The ANALYSIS, Part II of the report, reviews the background of the Big River Reservoir porject and discusses the history and geography of the area in order to place the recorded properties in a spatial-temporal context. Section III, the INVENTORY OF CULTURAL RESOURCES, is the most important part of the report; here, the 105 properties inventoried are listed and described, with an explanation and interpretation of the properties presented in a section preceding the listing. Supplementing the text is an appendix which provides explanatory and supporting data. Several types of tables in the report provide information in graphic and cartographic form.

The report is intended to serve as a planning tool in any decisions affecting the Big River Reservoir area and as a first step in avoiding or mitigating the impact of the reservoir project.

METHODOLOGY

A preliminary survey of historical and architectural resources in Coventry and West Greenwich, including the Big River Reservoir area, was conducted by the Preservation Commission in 1977, resulting in an inventorying, identifying, and initial documenting of historical districts, structures, and sites, and culminating in published preliminary reports for the two towns in 1978. These reports were the basis for a list of historical properties in the reservoir area submitted by the Preservation Commission to the Corps of Engineers in July, 1978, as a prelude to further work in the area. However, these surveys were not done in-depth and this intensive investigation was required as a basis for effecting mitigation of impact to cultural resources as part of a later phase of the environmental planning process.

This detailed study of cultural resources in the reservoir area was undertaken for the Corps of Engineers by the Preservation Commission in October, 1978, and was essentially completed by the end of November. All previously surveyed structures and sites were re-examined, re-evaluated, and rephotographed, and all roads in the reservoir area were redriven. A student intern and several local residents (see Acknowledgements) participated in the field work and helped identify and locate sites in the woods and obscure places. All visible significant cultural resources were recorded on standard survey sheets, which include photographs, physical descriptions, and an assessment of significance.* All known material relating to the area--in public and private libraries and collections, including state, county, and local histories; lists; inventories, scrapbooks, and newspapers--was examined. Several detailed nineteenth-century maps were extremely useful in locating and identifying cultural resources in the area; map histories on survey sheets and in the Inventory of Cultural Resources record the map entry for each property for each map consulted and provide a sketchy history of ownership. Information

* Survey sheets are on file at the Rhode Island Historical Preservation Commission office.

derived from field work, research, and interviews contributed to a final determination of significance for each structure and site.

ACKNOWLEDGEMENTS

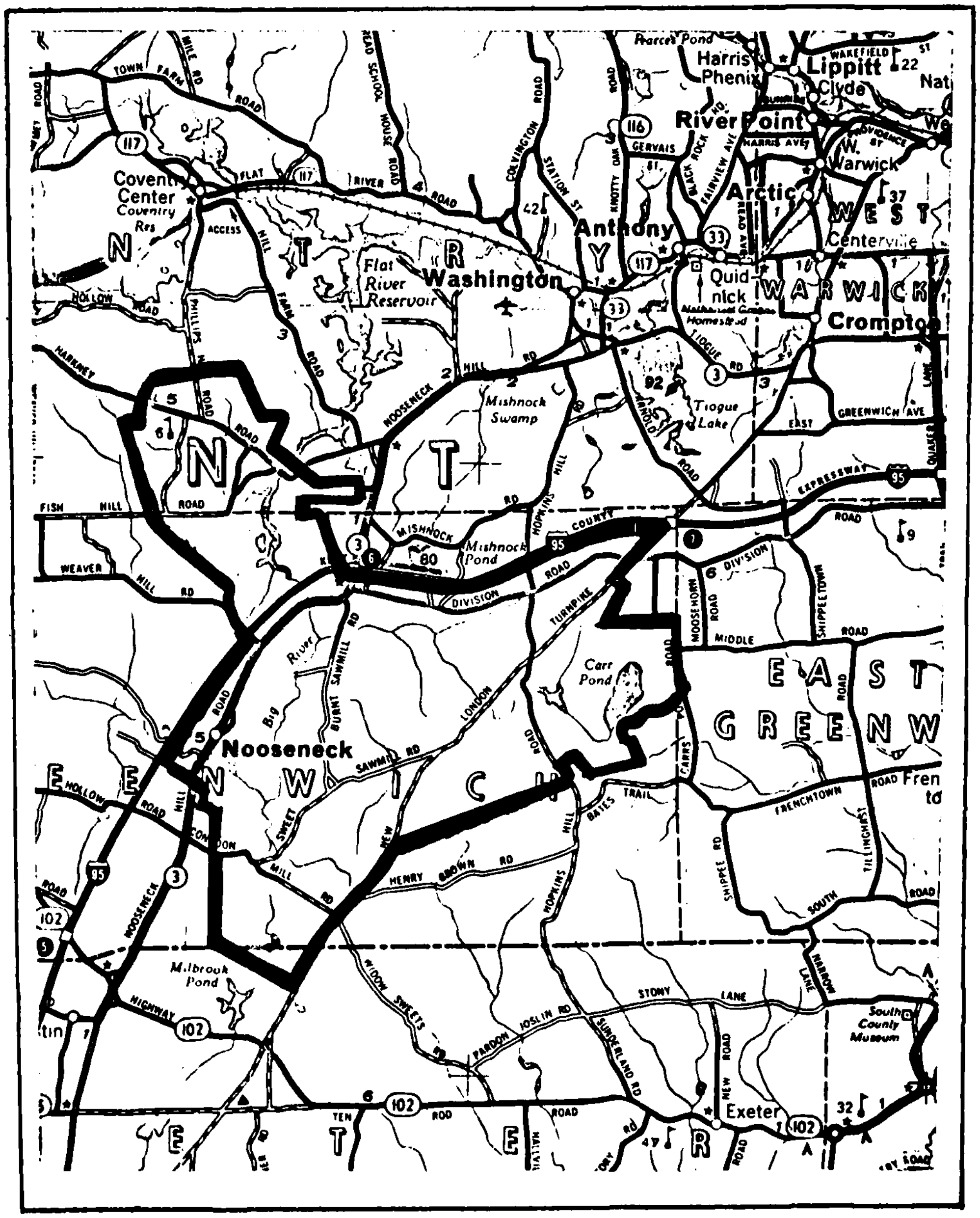
Marcia D. Erickson, a volunteer, assisted in field work in the initial phase of the survey. Lucinda Whitehill, a student intern from the University of Rhode Island, contributed to the report by interviewing several knowledgeable residents. Her work is summarized in an unpublished manuscript, "Before the Flooding Waters," which is included as Appendix E of this report. Several days were spent in the field by the author, Ms. Whitehill, Blanche Albro, and Howard Barbour. Blanche Albro's detailed cemetery inventory and knowledge of the locations of burying grounds was essential to locating old burying grounds in the area, most of which were previously unrecorded. Howard Barbour assisted in the location of several burying grounds, identified several sites, and provided information and photographs of people and places in the reservoir area. Ardis Barbour also supplied information based on her personal experience, scrapbooks, and research. Several scrapbooks located in the town hall which relate to West Greenwich history--the property of Town Clerk, Cora Lamoreux--also supplied information on area residents and cultural resources. The Rhode Island cemeteries program of the Office of Veteran's Affairs, under the direction of Edwin W. Connelly, recorded every cemetery in the reservoir area. This detailed inventory--which includes plat dimensions, locations of each gravemarker, and recording of inscriptions--is included as Appendix D of this report. Vivienne Lasky, former consultant to the Preservation Commission and author of the Coventry and West Greenwich reports, assisted in establishing an approach to the study of the Big River area; she also helped in setting up a format for this report and reviewed the preliminary draft. Commission staff members David Chase and Bernard Mendillo and Corps of Engineer representative John Wilson also were helpful in reviewing drafts of this report.

THE BIG RIVER RESERVOIR PROJECT: BACKGROUND

For the first century and a half of Rhode Island's history, when most of the state had an agriculturally oriented population widely dispersed over the land, wells or local water bodies were of sufficient quantity and quality to provide an adequate supply of drinking water. But, with the coming of the modern factory system and attendant growth of population and urbanization, available water supplies were no longer sufficient to supply drinking-water needs. Many of the rivers and streams were polluted by the mills, which had transformed Rhode Island into an industrial state.

The hilly topography of the upland section of Rhode Island had already lent itself to the development of a number of storage reservoirs, many of which were natural and most originally created to supply process or power water to textile mills. By the late nineteenth century, many cities and urban centers in Rhode Island had to purchase land outside their municipal boundaries to build reservoirs to meet their growing drinking-water needs. Some examples of early municipal water projects are the Diamond Hill Reservoir in Cumberland, which provided water for Pawtucket, and the Woonsocket Reservoir Number Three in North Smithfield, providing water for Woonsocket. Carr Pond, in the eastern part of West Greenwich in the present Big River reservoir area, was tapped as a water source for several communities in the lower Pawtuxet Valley.

Providence, the state's largest city, also supplied by local reservoir water, faced a possible water shortage in the early twentieth century. A Water Supply Board, created to search for a new resersite, found one on the North Branch of the Pawtuxet River in Scituate. The ensuing reservoir project was the largest ever undertaken in the state. When completed in 1925, it supplied not only the City of Providence, but parts of the metropolitan area as well. Today, the City of Providence Water Supply Board serves about one half the state's population. During the twentieth century other small reservoirs were built throughout the state and some existing systems enlarged, but continued growth of population,



Location Map of Big River Reservoir Area in Coventry,
Exeter and West Greenwich, Rhode Island

projected population growth statistics, and an anticipated increased demand for water led to the search for other large catchment areas that could provide good reservoir sites.

Following the Second World War, the first major step to studying the state's water needs came in 1951. The State Legislature, by H654 of the January session of that year, committed the State Water Resources Committee to the task of studying the water resources of Rhode Island and recommending a comprehensive state policy for the development of surface, subsurface, and percolating waters. Charles A. Maguire and Associates, consulting engineers, made recommendations on developing water resources in a report* in January, 1952. Among their findings, they concluded that the water-supply resources in Rhode Island were not sufficiently developed to meet the water-supply needs for all parts of the state. The engineering firm carefully investigated five dams sites in the Blackstone River basin and two on the Big River and Nooseneck River. The Big River Reservoir Area, as proposed, included the Big River south of Harkney Hill Road in Coventry and most of its tributaries--the Congdon River, the Nooseneck River, and the Carr River. With a dam at Harkney Hill Road at the south end of the Flat River Reservoir, the proposed Big River Reservoir would have a drainage area of 29.7 square miles including 8.4 square miles which would contribute to the proposed Nooseneck River project. It was determined that the thirty-eight million gallon safe yield could be held for use, in part at least, by cities and towns which may be supplied by the City of Providence or by a metropolitan water district.

Another study and investigation of the state's water resources, done in 1967 by the engineering firm of Metcalf and Eddy, resulted in an over-all plan formulated to meet the future water needs of the state through the year 2020. Under this fifty-year plan, the Big River Reservoir and auxiliary water facilities were to supplement the Scituate Reservoir supply for the Providence metropolitan area. The Big River Reservoir area, one of the best water-producing areas in Rhode Island, was judged the largest site and nucleus of the fifty-year plan for the Central system.

* "Report on the Water Resources of the State of Rhode Island"

Implementation of the plan to build a reservoir along the Big River actually began in 1960, with a request by the Water Supply Coordinating Board for legislation to acquire the Big River and Wood River sites. Plans for the project were killed by the Legislature in 1960 and 1961, and defeated in a referendum in 1962; but in 1964 the Big-Wood bill passed in a referendum.

In 1966 more than 8600 acres of land were condemned in the project area, and by 1972, acquisition was 99 percent complete. In Exeter, only about 120 acres, west of the New London Turnpike, were taken. Coventry landowners gave up about 1000 acres, less than 3 percent of the town's area, in the south-central part of town. West Greenwich suffered the greatest loss of land, about 7623 acres, or 23 percent of its total land area, in the eastern part of the town. A total of 444 parcels of land in the three towns were condemned by the state for the project, including the West Greenwich town hall and a town dump, 105 homes, 22 businesses, and 9 junkyards. The original plan was to allow people to rent their homes for a period of from three to five years during the design and engineering stage of the reservoir project. All residents were to have vacated the area, all structures destroyed, and a dam built across Harkney Hill Road by 1981. The state gave contracts to three construction firms for some seven million cubic yards of gravel; a large area along Division Street was subsequently transformed into a "barren waste."

Today, most of the state-owned properties in the Big River area are still occupied, perhaps about one third of them by persons living there when the area was condemned. The residents face an uncertain future. The result, in some cases, has been a marked deterioration of structures, and, in general, the quality of life and morale is at a low ebb. The ambivalent status of the project, with many structures deteriorating, decaying, or already in ruin, the enormous gravel excavations, and the use of the area as a dumping grounds, or junkyard, has produced what some people describe as a "no-man's-land"--blighted area.

II. ANALYSIS:OVERVIEW

Originally part of towns which were established along Narragansett Bay in the seventeenth century, this section of interior Rhode Island--the proposed Big River Reservoir site in Coventry and West Greenwich--was not settled until the eighteenth century and generally followed the course of progress and decline characteristic of the rest of inland Rhode Island. Initially occupied by Native Americans, under European settlers it was converted to an agricultural area, with farmhouses scattered about clearings in the woods; but as population grew and the area prospered, various amenities were provided. The history of the occupation of the land by Native Americans and white settlers is seen today in a variety of structures and sites--Indian encampments, colonial farms, local burying grounds, mill sites, taverns, churches, stores, bridges, a water-supply system, residential structures, old highways and byways, and a nineteenth-century mill village. Most of the area, once dominated by fields and pastures, has reverted to forest and presents an essentially sylvan appearance.

Of the 106 properties recorded in detail in the reservoir area, only one, the 1867 Hopkins Mill in Nooseneck, was entered in the National Register (in 1974), but was destroyed in September, 1978. Today, within the bounds of the reservoir area, there are no properties on or approved for the Register. Two old and historically important roads, the New London Turnpike and Sweet Sawmill Road, and the Nooseneck factory sites are recommended for the Register, but the only standing structure recommended for the Register--the Kit Matteson Tavern on Weaver Hill Road--is on the edge of the (and just outside) the reservoir area. Twenty-nine properties in a variety of categories are noteworthy for their contribution to the history of the local area.

AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED NL

PHYSICAL SETTING

This area of Rhode Island was formed millions of years ago as a part of the Appalachian Mountain system; formerly a high mountain area, it has been worn down to the level of low hills by endless centuries of erosion. In the recent geological past, the landscape was further modified by the passage of several continental glaciers, or ice sheets--the last one retreating only about 10,000 years ago. The result is a subdued landscape--low and flattened--with broad, round-topped summits.

The glacier deposited soil on the north slopes of hills and plucked soil from southern exposures which today are characterized by outcropping ledges and boulder fields. The best example of glacial-steepened topography in the reservoir area is found west of Carr Pond, where the ledges were quarried for their granite, beginning perhaps as early as the eighteenth century. In a sheltered valley a short distance west of the pond is a ledge utilized by Native Americans as a shelter before the beginning of European settlement.

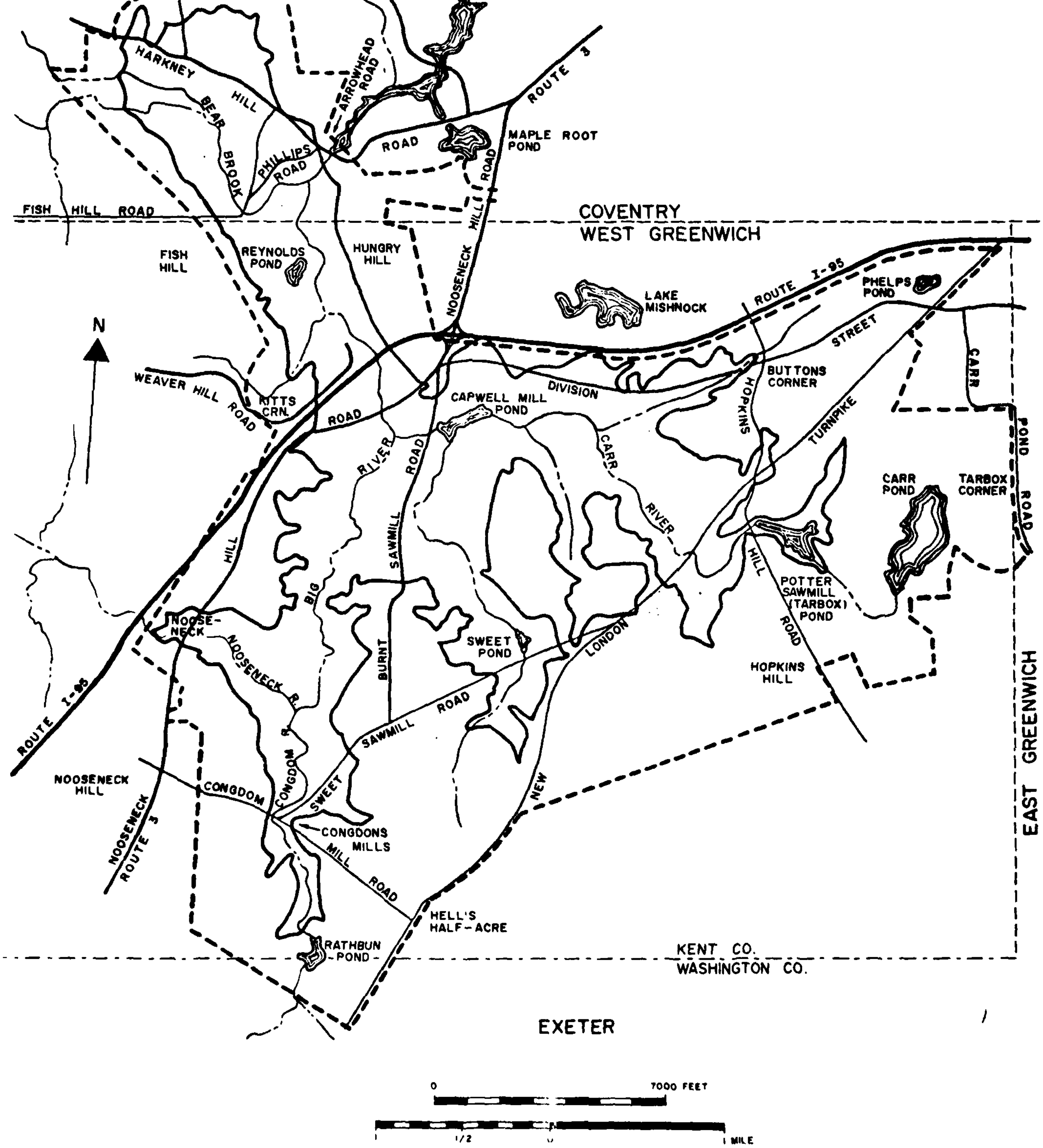
Much of the soil deposited by the glacier was an unsorted mixture of boulders, rock, sand, and clay known to geologists as till. It was spread over the land in great disorder. In places, it dammed preglacial stream valleys, creating the many swamps which are common to the Big River area. At the close of the ice age, when the glacier receded, meltwaters carried great quantities of material that was sorted out into gravel, sand, and clay, and deposited in beds, or layers. Some of the most extensive deposits of sand and gravel in Rhode Island occur along Division Street, including an area known as the Desert of Rhode Island (#LND-1).* In some instances large blocks of ice were covered by outwash deposits. When they melted, a very irregular, or knobby, topography was created. A good example of kame and kettle togography, as this feature is known to geologists, crosses Burnt Sawmill Road about one mile south of the Carr River.

Today the major land form features of the Big River area are broad hills separated by generally

* Numbers in parentheses refer to their location on maps in this report; see explanation of abbreviations

BIG RIVER RESERVOIR AREA

ROADS & CULTURAL PLACE NAMES



small, meandering, slowly flowing swampy waterways. The lowest elevation in the proposed reservoir area, just below 250 feet, lies along the Big River at Harkney Hill Road. Generally, elevations increase from north to south. Hungry Hill, along the Coventry-West Greenwich line, is 416 feet high. Hopkins Hill, in the southeast part of the reservoir area, and Nooseneck Hill, in the southwest part, rise to about 450 feet within the boundaries of the watershed.

Most of the land in the reservoir area is covered by second- or third-growth forest. The original virgin forest--dominated by oak, chestnut, and white pine--which greeted the first European settlers was cut down to make room for fields and pastures and to provide building materials and fuel for fireplaces and stoves. With a decline in agricultural pursuits in the nineteenth century, the land once again reverted to forest. Today the woods--dominated by oak and pine species--are generally in poor condition and, with the exception of a few scattered areas, are planted to groves of evergreen. Only a few clearings remain as vestiges of the agricultural era.

HISTORICAL BACKGROUND

NATIVE AMERICAN ETHNOHISTORY

In order to properly understand the history of the Big River reservoir area it is important to consider some specific aspects of the general history of the town and state. Indians occupied Rhode Island thousands of years before the arrival of European explorers and settlers, with the principal Indian settlements along and near the waters of Narraganset Bay and the Atlantic Ocean. Easy access to the interior of Rhode Island was provided by several rivers, including the Pawtuxet.

Members of the Narragansetts, who occupied this area, engaged in simple subsistence activities such as hunting, fishing, food gathering, and primitive farming. They made small clearings in the woods to grow their crops and set up small encampments or utilized natural formations for shelter from the elements.

Artifacts revealing the presence of Indians have been found scattered about the interior of the state. In the Big River area, an important site (Indians and their sites will be described in detail in the archeological phase of the Big River study) is a rock shelter in a granite ledge west of Carr Pond. More detailed archeological work is required in order to assess Native American life and interractions with their environment here.

THE SEVENTEENTH CENTURY

Coventry and West Greenwich, during the seventeenth century, remained unsettled wilderness tracts while the towns from which they evolved--Warwick and East Greenwich--were beginning their existence along Narragansett Bay.

The origin of Warwick dates from the coming of Samuel Gorton and eleven associates who purchased a tract south of Providence in January, 1643. The Shawomet Purchase, as it was known, took in all the land from Narragansett Bay westward for about twenty miles. Its north-south boundaries coincided with the present north-south boundaries of the town of Coventry and extended westward to the Connecticut line. Although there is no evidence of colonial settlement in what is now Coventry and none of that town passed into private ownership before 1700, tradition has it that several buildings which stood in the area of present-day Washington village were burned in King Philip's War in 1675-1676.

Samuel Gorton also helped to bring about the annexation of the Narragansett country lands. Under the Charter of 1644, land south of Warwick and west to the Connecticut line was included under the authority of Rhode Island, but there was no permanent settlement in the region until nearly twenty years later. Following King Philip's War, land could be settled without fear of Indian attack. In 1677, a year after the war ended, the Town of East Greenwich was founded by the Rhode Island General Assembly. As was true in Coventry, there is no record of settlement in what is now West Greenwich before 1700, although the Tarbox family settled at Tarbox Corner, on the present East Greenwich-West Greenwich town line, before the end of the seventeenth century, and there may have been settlers living here before there is any record of their presence.

THE EIGHTEENTH CENTURY

The history of West Greenwich and the rural sections of Coventry beyond the eastern mill villages follow a similar pattern. In both towns the land was laid out by groups of men, and the land was divided irregularly. Each share had a different geometric pattern and varied in size, but an attempt was made to equalize the lots with respect to quality.

In 1706 the Rhode Island General Assembly extended the boundaries of East Greenwich westward to the Connecticut line. A committee was appointed by the General Assembly to dispose of the "vacant lands" in the Narragansett Country, as most of southern Rhode Island was known at the time; on June 30, 1709, thirteen individuals, all inhabitants of Warwick and East Greenwich, were granted a deed for 30,000 acres, comprising the present town of West Greenwich. Soon after, the proprieters deeded land to other individuals and settlement was underway. Highways were laid out from the bay towns inland, allowing for a better exchange of goods between the shore communities and the rural hinterland. Division Street in East and West Greenwich was an early road in the area, and a tavern--the old Kit Matteson Tavern (#CMT-11)--(at the edge of, and just outside the reservoir area) was probably serving travellers along the road. Harkney Hill Road, which was laid out west to Zeke's Bridge by 1728, was then extended to the Connecticut line.

In 1741 Coventry and West Greenwich were set off as independent political entities. Coventry, formerly part of Warwick, was named for Coventry, England, a major city on Warwickshire, while West Greenwich was named for its obvious geographical relationship to its original town.

During an era when Rhode Island and rest of the nation was overwhelmingly agricultural, the early families judged the soils of the hilly interior of the state to be fertile and productive, and they cleared the forest for their cropland and pasture. The stones cleared from the land were used as boundary markers and to enclose and divide fields, pastures, and house lots; the endless miles of stone walls found throughout the area today are a legacy of the settler's enterprise and industriousness. Homes and outbuildings were built on relatively large holdings, so the farms were scattered about the landscape, connected by rough cart paths. Local industries--sawmills and gristmills--were built along waterways where power was available to harness energy to cut wood and grind grain. John Greene is known to have had a sawmill (#(S)-IND-1) along the Big River near Harkney Hill Road by 1728, and another Greene, said to be the brother of Nathaneal Greene, the Revolutionary War general, had a mill (#(S)-IND-6) along the Carr River just west of Hopkins Hill Road below Tarbox Pond. By 1790, a school was "kept" in a private residence at Kits Corner, the forerunner of a schoolhouse which was built nearby, and a blacksmith shop and a water-powered trip hammer were operating at Nooseneck, providing tools for local farmers and machinery, nails, and other ironwork used in the neighborhood. The year 1790 also marked a high-water mark of population for the area, as shown by census data. The population of West Greenwich was recorded at 2054, a level it would not attain again until the decade of the 1970s.

THE NINETEENTH CENTURY

Although population in West Greenwich declined through the nineteenth century, the eastern part of the town enjoyed its greatest period of prosperity. The industrial revolution in Rhode Island--which began in 1790 with the first successful cotton mill in America, the Slater Mill in Pawtucket--swept through all of Rhode Island in the following decades. The early years of the textile industry were characterized by a relatively low level of technology and the building of relatively small mills on relatively small waterways in comparison with mills built along the larger rivers. Small outlays of capital were required, which encouraged local residents in rural areas to become industrialists. The first mills usually utilized all or part of existing sawmills or gristmills with their attendant dams, mill ponds, and water-power supply. Later, larger mills were erected with the sole purpose of manufacturing textiles.

In the Nooseneck area, where a blacksmith shop and trip-hammer works and a sawmill and a gristmill were already operating by the end of the eighteenth century, attempts at textile manufacturing began early. During the nineteenth century about a half dozen mills (#(S)-IND-12) were built between Yard Pond, west of present-day Route 1-95 and the site of the 1867 Hopkins Mill east of Nooseneck Hill Road. The history of the mills is confusing and accounts of their locations and workings vague and imprecise, but it is recorded that a site occupied by a sawmill at Yard Pond manufactured cotton about 1810. Another mill, operated as a yarn mill by Hall Matteson Company Company around 1812, and later known as the Bumble Bee Mill, ran in connection with a sawmill in its early years. After the Bumble Bee Mill discontinued manufacturing, a company of men erected a larger mill known as the Stone Mill around 1840. A mill, known as the Old Red Mill, occupied the site of the former blacksmith ship, which was fitted up as a textile mill by David Hopkins about 1822. The Hoxsie Mill manufactured cotton yarn beginning about 1812. Later, it was purchased by Rhodes K. Edwards, who built a new mill in 1866 which became the most extensive manufactory in town. Several mills were also built near Nooseneck Hill Road, including the 1867 Hopkins Mill

(#(S)-IND-10) built by David Hopkins. It is interesting to note that all of the mills were built of wood or stone, the construction material used universally during the early years of the industry. The 1867 Hopkins Mill, constructed of wood, was built at a time when brick was coming into use as the most common material for new mill construction.

The development of mills at Nooseneck led to the building of mill housing and other support buildings. By the mid-nineteenth century, Nooseneck had evolved into a typical Rhode Island mill village, complete with its compact cluster of structures--mills, mill and non-mill houses, and a store and post office--in the hollow. South of the hollow (and outside of the reservoir area) a linear band of settlement extended to the top of Nooseneck Hill, where a hotel, post office, church, and another store were in existence by 1855 at or near the crossroads of Nooseneck Hill Road and Congdon Mill Road-Robin Hollow Road. Soon after, a schoolhouse was erected on the hill. Nooseneck was the largest and most important settlement in West Greenwich. Willis Carr's store on the hill served as the place of annual town meetings and other gatherings, and the Nooseneck area in general dominated the town's political life by supplying many of the town clerks and representatives to the state legislature.

In the nineteenth century, other scattered hamlets in the Big River area also supported mills. The Robin Hollow Cotton Mill, built around 1846 on Raccoon Brook, a tributary of the Nooseneck River and just outside the reservoir area, operated as a textile factory for about three decades in mid-century; but most of the other nineteenth-century mills in or near the reservoir area were sawmills or gristmills, providing manufactured goods for local consumption--shingles, boards, and barrel staves--and grinding corn for meal.

A small settlement evolved at the intersection of Congdon Mill Road and Sweet Sawmill Road along the Congdon River. Known first as Nichols' Mills, it later became Congdon Mills (#(S)-IND-4). Upstream from Congdon's Mills, another mill (#(S)-IND-8) probably stood at the north end of Rathbun Pond, along the West Greenwich-Exeter town line. Further upstream was Hopkins Factory, or Hopkins Mills. On a small tributary of the Congdon River, along the east side of the New London Turnpike, was a sawmill operated by the Money family. Hopkins Mills and the Money sawmill are in Exeter, at the outside edge of the reservoir area boundaries. Along the Carr River, a major branch of the Big River, a mill, known late in the century as Hopkins and Tarbox Sawmill (#(S)-IND-5), operated near Hopkins Hill Road. Downstream, at Burnt Sawmill Road, was Whitford's Mill, later known as Capwell's Mill (#(S)-IND-2), and a small cluster of houses near the mill. The old Greene Sawmill in Coventry, near Harkney Hill Road, continued to operate until the mid-nineteenth century as S. Andrews Sawmill.

While the sawmills and gristmills supplied the local needs, the exploitation of the immense granite ledges near the shore of Carr Pond were related to the growth of mill villages in the Pawtuxet Valley and to the growth of local urban centers, notably East Greenwich. A relatively large industry developed to supply curbstones, stone for mill construction, for window and door caps and sills, and other uses.

Simultaneous with the growth of Nooseneck into the town's major village, other developments were taking place in the area, including the construction of the New London Turnpike (#TRN-6) in the early nineteenth century. Conceived by a group of prominent Providence merchants as a more direct route between Providence and New London, Connecticut, where steamers to New York City were available, the highway was started in 1816 and completed by 1821. In West Greenwich it created a number of highway-related activities--a blacksmith shop, a toll gate and tool house and a string of hotels and taverns--which flourished in the first few decades of the turnpike's existence. The road was heralded as "the greatest improvement that ever was made in this state" by the Rhode Island American and General Advertiser, in June, 1815, and offered promise to the rural areas of the state by opening up the urban market to a new country with land capable of producing varied foodstuffs containing inexhaustible forests of excellent wood and providing easy access for manufacturers. However, it proved a financial failure. By the 1840s, traffic was reduced to a trickle, largely due to competition from steamboats, railroads, and improved roads; and in 1864 the turnpike went into public ownership. The turnpike's contribution to the growth or opening up of West Greenwich was minimal.

During the nineteenth century a number of community services became available to the public. Within the proposed reservoir area, a church is said to have stood on Hopkins Hill Road, just south of Division Street, at an early date. Several meeting-houses just outside the present reservoir boundaries served residents in the area, including the Union Meeting House built at Nooseneck Hill in 1811; a meetinghouse built near Tarbox Corners, in East Greenwich; and the Maple Root Church, in Coventry, which dates from the eighteenth century. In 1890, the Union Meeting House burned, and about that time the Nooseneck Baptist Church (#(S)-REL-1) was erected in the hollow.

Following the passage of the Free School Law in 1828, which appropriated money for the aid of public schools, West Greenwich was divided into twelve school districts. The first of the town's one-room school houses was reportedly the Kit's Corner School (#(S)-EDU-2). Other schools in the reservoir area were the Burton's (Button's) Corner School (#(S)-EDU-3) at Division Street and Hopkins Hill Road; the Niles Wood School (#(S)-EDU-4) on the New London Turnpike; and a school house on Harkney Hill Road in Coventry (#(S)-EDU-1). The Nooseneck Hill School, outside the area, was built in the 1860s on the hill south of Nooseneck Hollow.

Most of the area's residents throughout the nineteenth century remained on the family farm and continued their existence as subsistence farmers, growing enough food for their own needs. Their relatively isolated existence and largely self-supporting life style required few excursions away from home. This, along with the lack of a community church or cemetery, and poverty contributed to the custom of burying members of the family on the property in a private burial ground; today the many local family burying grounds scattered about are a typical and common Rhode Island landscape feature. At first, the material used for gravestones was that found nearest at hand--granite. It is possible that most of the early stones were not inscribed. Even if they were inscribed, the lettering would have worn off over the centuries because granite wears away rapidly under the effects of rain and frost. Almost all of the stones from the earliest period--plain stones, roughly square or round-shaped--therefore, bear no inscriptions. According to local residents, there are several burying grounds in the reservoir area containing only these crude markers. Unbounded and unidentified, they have become assimilated into the woods which enveloped them many years ago. Later headstones were inscribed, usually only with initials and dates. Several old burying grounds in the area, notably the Matteson burying ground (CEM-27) off Nooseneck Hill Road and the Sweet Burying Ground (CEM-32) off Sweet Sawmill Road contain many stones of this period of cemetery evolution. Beginning in the late eighteenth century, weather-resistant slate headstones were imported; these stones included a more complete recording of names and dates, as well as poetic passages; some stones have the typical decorative carvings, such as angel or death's heads, urns, weeping willows, and so on. The smaller burying grounds were never bounded, but the larger ones are delineated by a stone wall around most or part of the plot, or an iron rail fence set into granite posts; the latter type representing a middle-to-late nineteenth-century evolution. Some of the best cemeteries in the reservoir area are two Tarbox cemeteries off Carr Pond Road (CEM-6 and CEM-7), the King-Howard Cemetery (CEM-15) off Division Street, the Matteson-Shippee Cemetery (CEM-26) off Nooseneck Hill Road, and the Cleaveland-Congdon-Nichols Cemetery (CEM-34) off Sweet Sawmill Road.

Many of the burying grounds witnessed their last burial before the end of the nineteenth century, by which time the area was in great decline. According to the 1890 Annual Report of the Commissioner of Industrial Statistics, West Greenwich was the poorest and most desolate town in the state. The 1890 census recorded a population of 766 people, less than half of what it was a century earlier and only thirty more than the 1748 census, taken shortly after the town was incorporated. Farms were being continuously deserted as the out-migration of young people seeking better opportunities elsewhere continued, generally leaving the older people behind. In 1890 sixty-five formerly cultivated farms, covering an area equal to one quarter of the town's total area, were abandoned. When the old Sweet place burned in 1895, it was never rebuilt. On some farms the fields were still being cut, but for the most part the land was left unproductive and wild, with the remaining buildings rapidly losing their paint to poverty and former fields and pastures reverting to forest. The forest--mostly white pine, oak, chestnut, and birch--was a source of considerable revenue to the owners of several sawmills and shingle mills, several of which--Capwell's Mill and the Hopkins-Tarbox Sawmill--were still working, their old, wooden water wheels replaced by iron turbines. The granite ledges at Carr Pond continued to be quarried, and the small schools and churches persisted, but the general level of life was slow-paced. When many of the mills burned in Nooseneck and elsewhere they were not replaced; others deteriorated. The 1867 Hopkins Mill, the last mill to survive in Nooseneck, ceased to function as a factory around 1900.

A newspaper account of 1893 described West Greenwich as "an area of curiosity." "West Greenwich in these days is a synonym for backwoods" was a headline in an 1899 newspaper account, which went on to say, "In common with other out-of-the way manufactories, Noose Neck is slowly dying. In its death struggles it occasionally arouses, and seems to make an attempt to shake off the on-coming stupor. But the time between the awakenings gradually increases, and the time is fast approaching when it must finally sink into its inocuous desuesitude."*

* "Noose Neck Hill," Providence Journal, June 25, 1899

THE TWENTIETH CENTURY

The decline of West Greenwich continued into the twentieth century. A 1900 descriptive catalogue, "Rhode Island Farms for Sale," listed several properties in the reservoir area. West Greenwich, according to a 1907 newspaper account, was the "poorest of the Rhode Island sisterhood" in valuation of real and personal property and in population. The seat of government in 1915 was in a "deserted factory village," according to yet another reporter. Population continued to decline in the first two decades of the twentieth century; a low of 367 people for the entire town of West Greenwich was recorded in the 1920 census.

The beginning of the twentieth century ushered in the "modern highway" era. In 1902, the State Board of the original state highway system was adopted. Although large parts of the New London Turnpike appeared on maps to be the shorter and more preferable route across the state, it was judged too hilly, so another route--Nooseneck Hill Road (Route 3)--was chosen because it was less expensive to build. The new route, which was also hilly, was selected largely because it would run through more towns and villages and be of more value to people. The first in a continuous series of highway improvements were made in 1904, consisting primarily of adding a better surface over the dirt roadway. In the mid 1920s the highway was reconstructed to eliminate poor alignments and combinations of faulty alignments and steep grades, and the road received a seven-inch reinforced-cement surface. The road was further reconstructed and modernized in the late 1930s; a new surface was added and the pavement widened to four lanes. The road widening resulted in the closing of Fish's Store in Nooseneck, the moving of several houses, and the rebuilding of bridges over the Big River and the Nooseneck River. The improved highway, which was a major state highway throughout the first half century, increased motor traffic and also generated the growth of highway-oriented business establishments--motels, gasoline stations, and restaurants.

The 1930 census figures showed an increase in population, a trend which continued in the following decades, but, aside from the development of the highway strip, the area remained essentially static. At the 1867 Hopkins Mill in Nooseneck, now converted to a dairy barn (shortly after the turn of the century), an attempt was made to revive the mill in 1926. Electricity was brought into Nooseneck to power the new machinery, but the project was evidently unsuccessful and the former mill became vacant. Fish's Store went on serving the public, in the hollow, not far from the Nooseneck Church, and Carr's Store continued to be a gathering place and the town's "political center" until 1937, when a town hall, the first in West Greenwich, was built in Nooseneck on Town Hall Road.

In the rural area life continued at a relatively slow pace. Some homes were built and a number of people--part-time farmers--raised turkeys and a few animals and crops on small "farms." The Capwell Saw Mill succumbed to old age in the early twentieth century, and the Tarbox and Hopkins Saw Mill, which in addition to producing various kinds of lumber, also ground corn into meal (at least as late as 1910), was destroyed by fire in 1935. But, even before that, the old stationary, water-powered mills had been rendered obsolete by more efficient, steam-powered, portable sawmills which continued to be a profitable venture in the West Greenwich woods. These portable mills were particularly active after the 1938 hurricane, which destroyed many trees in the area.

After World War II, West Greenwich shared in the American suburban growth phenomenon, albeit to a more limited degree than towns nearer urban centers. Population increased, more than tripling in the three decades from 1940 to 1970. John Potter built a lace mill in Nooseneck, across from the town hall; people began building summer cottages and cabins along the Big River, mostly near the Flat River Reservoir in Coventry, and a golf course was laid out in Coventry. But, two events of the 1960s had a serious social and economic impact on an already depressed area. In 1966 the land and property within the Big River Reservoir area was condemned and in 1969 Route I-95 was completed through West Greenwich. The former large volume of traffic on Nooseneck Hill Road, which had served as an important route between Providence and New York for more than a half century and which had generated some revenue in the area, was reduced to a trickle. Since the condemnation of the area and construction of Route I-95, most commercial establishments along Nooseneck Hill Road have gone out of business. However, new businesses have been built along Route 3 north of the Nooseneck Hill Road--Route I-93 interchange, including the large Congress Inn, perched on a ledge above the highway, beckoning and serving hungry and weary travelers as did its predecessors, the old nineteenth-century turnpike taverns and the motels of the pre-World War II era.

In Nooseneck, Fish's Store, the 1867 Hopkins Mill, and a fine Greek Revival style house nearby were destroyed, and the former town hall and the church were moved to new sites outside the reservoir area in the 1970s. Earlier, Carr's Store was destroyed and the former Nooseneck School converted to a residence. In January, 1979, the Nooseneck Inn of the pre-World War II highway era burned after being vacant for many years. Nooseneck today contains a local combination grocery-store-and-gasoline-station, another small business, a fire station atop the hill, and a generally nondescript and unrelated line of houses stretched out along both sides of the highway. The former cluster of buildings that comprised a "neat" mill village is no more, and Nooseneck now has scarcely more identity than any other amorphous string of houses along any other rural highway in the state.

The rural parts of the reservoir area have literally "gone to seed." Houses are still scattered about, some neglected for more than a dozen years because they are rented and the future is uncertain, and some are in ruins. Cellar holes liberally sprinkled through the area mark the sites of homes and structures which vanished decades ago. Along Division Street, perhaps the largest gravel works in Rhode Island has created a blighted landscape. Litter and junk are plentiful, particularly along the shores of once-pristine Carr Pond.

SUMMARY

The survey of cultural resources in the Big River Reservoir Area, and the inventory which follows, reflect the character of the area during its geological, prehistoric, and historic evolution. The land, as always, is the basic framework--its contours, waterways, plant and animal life, and the changing seasons offered opportunities and provided handicaps to its inhabitants who judged it differently as time and perceptions changed. To the first white settlers, the opening up of a new land--a virgin wilderness--produced visions of a new life of independence where rewards would be based on one's own hard work and enterprise. Farm families were large and rapidly spread over the land, providing geographical and family links in different sections of the rural areas. Local family history is still important in understanding the area; this link is most dearly preserved in many old family burying grounds. It is easy to understand why the area grew rapidly in the eighteenth century. Rhode Island, and the rest of the nation, was centered on agricultural economy, and the rural areas were the hub around which the colonies and the young nation revolved and evolved.

The opening of the New London Turnpike and the development of mills, particularly at Nooseneck, in the early nineteenth century offered promise of continued growth and prosperity. However, improved transportation and the development of the textile industry sparked the growth of other areas, notably along the larger rivers of the state. The rural parts of western Rhode Island, distant from major urban centers, lapsed into a decline from which some places, including the Big River area, never fully recovered. Economic opportunities--better land in the west or better jobs in the cities--lured many people out of the area. Most of the older generation remained on the family farm to live out their years; their former fields and cropland yielded to the encroaching forests while their homes and outbuildings fell victim to lack of attention and the elements. The turnpike had a short-lived existence as a viable economic force, and its attendant taverns were all deserted, if not gone, by the end of the nineteenth century. The mills, small and local affairs, based on small water-power sources, were also rendered obsolete by larger, more efficient, modern factories which were closer to markets and sources of energy and raw materials.

This part of West Greenwich and Coventry in the reservoir area, after the early nineteenth century, drifted out of the mainstream of life in Rhode Island and existed as a "backwoods" area, a source of curiosity for those seeking the picturesque, quaint, or antique in Rhode Island. Although it once kept pace with the rest of the state, by the early nineteenth century it had stopped in its progress through time. It's level of prosperity was low, and has remained such for the last century and a half.

The cultural resources recorded by Rhode Island Historical Preservation Commission in the Big River reservoir area reflect its history. It is a place of the past, a place where little of importance has occurred for more than a century. The lack of progress, of modern "intrusions" into the area beyond the main roads, reinforces the feeling for the past, for the sense of a bygone time, and at places such as Sweet Sawmill Road, one can easily slip back in time several centuries. Most of the surviving structures are simple "vernacular" buildings, constructed without attention to architectural style by local people to serve local needs. The simplicity of building and the many ruins of bygone structure is the legacy of the area; collectively, they represent its material history and are important, if not essential, to an understanding of the cultural evolution of the Big River Reservoir area.

III. INVENTORY OF CULTURAL RESOURCES

EXPLANATION OF INVENTORY ENTRIES

In, or at the edge of, the Big River Reservoir area, 105 properties were recorded and mapped by the Rhode Island Historical Preservation Commission.* For each property, as recorded in the inventory, a standard format was used. An explanation of some of the entries in the inventory follows. Some of them are self-explanatory and require no further elaboration.

- Name of Town
- Name of Street
- Name of Property
- Map #. A three letter code and number refer to the location of each inventoried property on maps included in this report. Locations are approximate. The maps locating each property precede the listing for each thematic section--such as industry, cemeteries. The letter "S" in parentheses before the number designates sites.
- Previous Map #. This refers to a preliminary list of cultural resources submitted to the Corps of Engineers by the Rhode Island Historical Preservation Commission in June, 1978.
- Level of Significance. Each property included in the survey of cultural resources was evaluated on the basis of its architectural and historical significance--its importance as a standing structure(s) or for its role in contributing to the historical development of the town, state, or nation. The three categories of significance are:

  National Register (NR/RNR):** Properties included at level of significance are either on the National Register (NR), have been approved for entry into the Register, or are considered at this level of inquiry to be worthy of National Register inclusion. All properties recommended

* Four of these properties included more than one use; therefore, in the tables, a total of 109 is shown.

** See Appendix A for an explanation of the National Register of Historic Places.

for the Register (RNR) will require determinations of National Register eligibility during the next phase of study.

Important (I): Properties in this category have high potential, based on architectural-historical values, for inclusion in the National Register, but require further investigation and study to determine their eligibility.

Contributing (C): Properties in this category are not considered to have sufficient architectural-historical value to be included in the Register. Individually, they are not as significant as properties in the previous two categories but make an important contribution to an understanding of local cultural history in the context of the area and are also important as part of a group, or category of cultural features represented in the area. Although it is highly unlikely that these properties would be eligible for the Register, they require further investigation and documentation in the next phase of study.

- Description. Essentially a physical description of what can be seen.
- Significance. A rational for the inclusion of the property as a cultural resource; its association with general or local history, family, events, commercial and transportation developments, and so on.
- Map History. A history of the property as it was identified on nineteenth- and twentieth-century maps with a scale large enough to show individual properties or owners. Entries are recorded exactly as they appear on the map, including errors. The series of maps consulted for this study (see Bibliography for a complete listing) begins with Benoni Lockwood's map of 1819 and ends with the series of U.S.G.S. quadrangles published in the 1950s and revised in 1970.
- Present Status. The physical condition of the property.
- Relation to Proposed Reservoir. In this category there are are three divisions:

In Pool: Properties that will be covered by the reservoir's waters, or those that are at the very edge.

In Watershed: Those that are above the high-water mark but within the reservoir boundaries.

On Fringe of Watershed: Those that are on the outside edge of the watershed area, within 100 feet or so of the boundary line. They are included because they are noteworthy in the historical evolution of the area and because their proximity to the area may result in a possible impact.

INTERPRETATION OF INVENTORY

TABLE 1

The 105 recorded properties in the Big River Reservoir area are shown in Tables 1 and 2. Table 1 relates the thematic categories to levels of historical-architectural significance. About two thirds of the properties contribute to an understanding of the area, slightly more than one fourth are important and less than five percent--five properties-- are considered, at this level of study, to be eligible for the National Register. All properties must be researched and investigated further in the next phase of the reservoir area study, particularly those in the two highest categories. Of the total number of properties recorded, eleven were in the town of Coventry, the rest in West Greenwich. Thirty-three properties which were formerly standing structures exist today only as sites. They are important in understanding the area; many offer potential for archeological investigation.

Cemeteries (CEM): Thirty-four cemeteries were recorded in the area--almost one third of all the properties recorded--all but one in West Greenwich. Cemeteries vary in age, size (dimensions), number of and type of stone and in their manner, or lack of, enclosure. Several, such as the Tarbox-Whitford Cemetery off Carr Pond Road, contain early stones and an unusual triangular, roughly trimmed granite stone. The Sweet Burying Ground off Sweet Sawmill Road and several Matteson cemeteries off Nooseneck Road also contain old stones. The cemeteries provide an invaluable record of area families as well as providing information on the evolution of gravestone architecture and local family burying grounds, a feature better exemplified in Rhode Island than anywhere else.

Commercial, Local (CML): The only locally oriented commercial establishment, Fish's Store in Nooseneck, was destroyed in the 1970s. Originally a gristmill, it is also included in the industry category.

Commercial, Transportation-Oriented (CMT): Of the eleven properties in this category, seven are sites--a former toll house, a former blacksmith shop, and several taverns along the New London Turnpike. The sole surviving tavern, the Kit Matteson Tavern, recommended for the National Register, is at the edge of the reservoir property, across the road from the reservoir boundary. The other three standing structures in this category are twentieth-century structures along Nooseneck Hill Road and Route I-95 and are evaluated as contributing. The former blacksmith shop is also included in the industry category and the toll gate house-hotel is also in the transportation category.

Education (EDU): The four one-room schoolhouses which once were in the area are all gone and are indicated as sites.

Industry (IND): Only one of the thirteen properties in this category remains standing, and that is a now discontinued mid-twentieth-century cinder-block structures. There are no surviving early sawmills, gristmills, or cotton mills. Six of the sites were evaluated as important. The 1867 Hopkins Mill, formerly entered in the National Register, was destroyed in 1978 and is now indicated as a site. The former Nooseneck Factories, whose sites are strung out along the Nooseneck River, and a nearby mill trench-raceway, are recommended for the National Register because of their importance to the town's development and their relationship to the growth of early industry.

Landscape (LND): Although there are a number of interesting natural landscape features in the reservoir area--including the waterways, ponds, rock ledges, and forests--the only entry is the Desert of Rhode Island because this apparently natural phynomena is essentially a culturally induced feature.

Public Welfare (PWL): Included is the recently moved town hall (now a site), the first in West Greenwich, and two buildings and a trench associated with the water-supply system from Carr Pond.

Recreation (REC): The only recreation category of note in the area is a recent golf course, the Coventry Pines Country Club of the mid-twentieth century.

Religion (REL): The Nooseneck Baptist Church, which stood in the hollow, was moved to another site in the 1970s.

Residential (RES): The second largest category includes twenty-seven houses and sites which range in date from the earliest period of settlement to the early twentieth century, including the John Matteson house of pre-1740 vintage. Twelve residences were listed as important and must be re-evaluated in a further study to determine whether or not they are of National Register status. Six house sites were included because of their early dates or historical interests, including the David Tarbox 2nd House near Carr Pond and Tarbox Farm near Hopkins Hill Road. These sites offer potential for archeological excavation.

Transportation (TRN): This category includes a variety of roads and highways, extending in time from the early eighteenth century Sweet Sawmill Road to the recently completed Route I-95. Also included are some bridges and several transportation-oriented activities. Two roads, Sweet Sawmill Road, a well-preserved colonial artery, and the New London Turnpike, are recommended for the National Register.

	Thematic Category	Historical-Architectural Significance: Contributing	Important	National Register	Total*	# of Sites
Cemeteries	(CEM)	23	11	-	34	-
Commercial, Local	(CML)	1	-	-	1	1
Commercial, Transportation oriented	(CMT)	10	-	1	11	7
Education	(EDU)	4	-	-	4	-
Industry	(IND)	6	6	1	13	12
Landscape	(LND)	1	-	-	1	-
Public Welfare	(PWL)	4	-	-	4	1
Recreation	(REC)	1	-	-	1	-
Religion	(REL)	1	-	-	1	1
Residential	(RES)	14	12	1	27	6
Transportation	(TRN)	9	1	2	12	1
Total		74	30	5	109	33
Percentages		(67.9%)	(27.5%)	(4.6%)		(30.5%)

Table 1. Cultural Resources by Thematic Category and Level of Historical-Architectural Significance. Big River Reservoir Area, Coventry, and West Greenwich, Rhode Island.

* There are four surveyed structures and sites in two thematic categories; i.e., they served more than one use during their existence. They are: (S)-CML-1 and (S)-IND-11; (S)-CMT-2 and (S)-TRN-6; (S)-CMT-4 and (S)-IND-7; CMT-11 and RES-27.

TABLE 2

This table shows the relationship of properties recorded to the proposed reservoir. Sixty properties, or 55.5 percent of the total, will be submerged or close enough to the edge of the pool to be affected, including four of the five National Register properties recorded and twenty of the twenty-nine important properties; forty-five, or about 42 percent of the properties are above pool, most of them evaluated as contributing, and are located in the watershed area; three properties are just outside the edge of the reservoir boundaries.

Cemeteries (CEM): Fourteen of thirty-four historical cemeteries will be covered by the reservoir's waters, including five important ones.

Commercial, Local (CML): The site of Fish's Store will be covered with water.

Commercial, Transportation-Oriented (CMT): Two of the eleven properties will be flooded, a hotel site along the New London Turnpike and The Pines Motel on Nooseneck Hill Road; both are of contributing significance.

Education (EDU): Two of the four school sites will be under water.

Industry (IND): Most of the former industrial sites will be flooded, including one of National Register status--the site(s) of the Nooseneck Factories. Four important industrial sites will be in the reservoir, including the site of Potter's Saw Mill, Capwell's Mills, a mill site at the end of Rathbun Pond, and Congdon's Mills.

Landscape (LND): The Desert of Rhode Island will be mostly water covered.

Public Welfare (PWL): All of the four properties in this category are above the proposed water level.

Recreation (REC): The Coventry Pines Country Club will be covered by water.

Religion (REL): The church site in Nooseneck will be under water.

Residential (RES): Nineteen of twenty-six residential properties will be covered by the reservoir, including ten important properties.

Transportation (TRN): Of the twelve transportation properties, nine will be covered by water in whole or part, including Sweet Sawmill Road and the New London Turnpike, recommended for the National Register and the four bridges in the area.

		POOL				WATERSHED				AT EDGE (OUTSIDE)			
	Thematic Category	C	I	NR	Total	C	I	NR	Total	C	I	NR	Total
Cemeteries	(CEM)	9	5	-	14	14	6	-	20	-	-	-	-
Commercial, Local	(CML)	-	-	-	1	-	-	-	-	-	-	-	-
Commercial, Transportation-Oriented	(CMT)	2	-	-	2	6	-	-	6	2	-	1	3
Education	(EDU)	2	-	-	2	2	-	-	2	-	-	-	-
Industry	(IND)	3	5	2	10	2	1	-	3	-	-	-	-
Landscape	(LND)	1	-	-	1	-	-	-	-	-	-	-	-
Public Welfare	(PWL)	-	-	-	-	4	-	-	4	-	-	-	-
Recreation	(REC)	1	-	-	1	-	-	-	-	-	-	-	-
Religion	(REL)	1	-	-	1	-	-	-	-	-	-	-	-
Residential	(RES)	9	10	-	19	5	2	-	7	-	-	-	-
Transportation	(TRN)	6	1	2	9	3	-	-	3	-	-	-	-
Totals		34	21	4	60	36	9	-	45	2	-	1	3
					(55.5%)				(41.7%)				(2.8%)

Table 2. Cultural Resources, by Thematic Category, Level of Historical Significance and Relation to Reservoir (Pool). Big River Area, Coventry, and West Greenwich, Rhode Island.

INVENTORY OF CULTURAL RESOURCES

MASTER LIST

COVENTRY

Arrowhead Road

. Historical Cemetery Number Fifty-one (Greene)	CEM-1
. Summer Community	RES-1

Harkney Hill Road

. Harkney Hill Road	TRN-1
. Theodore Andrews Place	RES-2
. John Greene's-Zeke's Bridge	TRN-2
. Site of John Greene's Saw Mill and Dam	(S)-IND-1
. House	RES-3
. Coventry Pines Country Club	REC-1
. Site of Andrew School	(S)-EDU-1
. Stephen Johnson House-Judge Rathbun Farm	RES-4
. G. W. Greene House	RES-5

WEST GREENWICH

Big River Road

. Big River Road	TRN-3
. Historical Cemetery Number Twenty-six (Matteson)	CEM-2

. Site of Kit's Corner School	(S)-EDU-2
. Summer Cabins	RES-6

Burnt Sawmill Road

. Historical Cemetery Number Fifty-three (Matteson)	CEM-3
. Matteson House	RES-7
. Carr River Bridge	TRN-4
. Site of Whitford's-Capwell's Mill and Dam	(S)-IND-2
. Historical Cemetery Number Twenty-seven (Whitford)	CEM-4
. Historical Cemetery, unnumbered (Kettle)	CEM-5

Carr Pond Road

. Site of Captain David Tarbox II's House	(S)-RES-8
. Historical Cemetery, unnumbered (Tarbox, Jackson)	CEM-6
. Historical Cemetery Number Twenty-nine (Tarbox, Whitford)	CEM-7
. Historical Cemetery, unnumbered (Kettle)	CEM-8

Carr Pond Area

. Former Granite Quarrries	(S)-IND-3
. Former Gatehouse	PWL-1
. Trench (for water supply system)	PWL-2

Congdon Mill Road

. Historical Cemetery, unnumbered (Whitford)	CEM-9
. Joseph Lemaire House	RES-9
. Site of Nichols-Congdons Mills	(S)-IND-4
. House	RES-10

Division Street

. Historical Cemetery Number Twenty-five (Andrews)	CEM-10
. Historical Cemetery, unnumbered (Matteson)	CEM-11
. Historical Cemetery, Number Forty-six (Whitman, Woodward)	CEM-12
. The Desert of Rhode Island	LND-1
. Historical Cemetery Number Forty-seven (Harrington)	CEM-13
. Historical Cemetery, unnumbered	CEM-14
. Site of Burton's (Button's) Corner School	(S)-EDU-3
. Historical Cemetery Number Thirty-seven (King, Howard)	CEM-15
. Historical Cemetery Number Thirty-eight (Matteson, Shippee)	CEM-16
. Historical Cemetery, unnumbered	CEM-17

Hopkins Hill Road

. Historical Cemetery Number Thirty-six (Greene)	CEM-18

. Historical Cemetery Number Thirty (Barbour, Hopkins, Potter)	CEM-19
. Historical Cemetery, unnumbered (Spink)	CEM-20
. Site of Tarbox Farm-Potter House	(S)-RES-11
. Site of Potter's Saw Mill-Hopkins and Tarbox Saw and Grist Mill	(S)-IND-5
. Site of Greene's Mill	(S)-IND-6
. Historical Cemetery, unnumbered (Potter)	CEM-21

<u>Interstate Route 95</u>

. Interstate Highway 95	TRN-5

<u>New London Turnpike</u>

. New London Turnpike	TRN-6
. Site of Watson's Hotel	(S)-CMT-1
. Former Water Gauging Station	PWL-3
. Site of Greene's Hotel-Site of Webster Gate	(S)-CMT-2 (S)-TRN-7
. Historical Cemetery, unnumbered (Carr)	CEM-22
. Historical Cemetery, unnumbered (Case)	CEM-23
. House	RES-12
. Site of Perry Hopkins House	(S)-RES-13
. Site of Blake's Hotel	(S)-CMT-3
. Site of Calvin Hopkins Blacksmith Shop	(S)-CMT-4 (S)-IND-7
. Historical Cemetery, unnumbered (Hopkins)	CEM-24

. Historical Cemetery Number Twenty-eight (Hopkins)	CEM-25
. Site of Niles Woods School	(S)-EDU-4
. Site of Cleveland's Hotel	(S)-CMT-5
. Site of Tavern	(S)-CMT-6
. Site of Oven Bird Tavern	(S)-CMT-7
. Site of Mill	(S)-IND-8

Nooseneck Hill Road

. Nooseneck Hill Road	TRN-8
. Congress Inn	CMT-8
. The Pines Motel	CMT-9
. William Matteson House	RES-14
. Big River Bridge	TRN-9
. Leon D. Andrews House	RES-15
. The Former Wayside-Big River Restaurant	CMT-10
. Historical Cemetery, unnumbered (Matteson, Shippee)	CEM-26
. John Matteson House	RES-16
. Former Lace Mill	IND-9
. Site of Former West Greenwich Town Hall	(S)-PWL-4
. Historical Cemetery, unnumbered (Matteson)	CEM-27
. Historical Cemetery, unnumbered (Johnson)	CEM-28
. Site of House	(S)-RES-17

. Site of Nooseneck Baptist Church	(S)-REL-1
. David Hopkins House	RES-18
. Site of Hopkins Mill	(S)-IND-10
. Site of Andrews' and Fish's Store- Site of Grist Mill	(S)-CML-1 (S)-IND-11
. Hopkins-Sweet House	RES-19
. Historical Cemetery Number Twenty-three (Hall)	CEM-29
. Site of Nooseneck Factories	(S)-IND-12
. Nooseneck River Bridge	TRN-10
. Historical Cemetery, unnumbered (Hall)	CEM-30
. House	RES-20
. House	RES-21
. Historical Cemetery, unnumbered (Andrews, Edwards, Gardner)	CEM-31

Sweet Sawmill Road

. House	RES-22
. Sweet Sawmill Road	TRN-11
. House	RES-22
. Historical Cemetery Number Fifty-two (Sweet Burying Ground)	CEM-32
. Site of Sweet Farm	(S)-RES-23
. Site of Sweet Sawmill	(S)-IND-13
. Historical Cemetery, unnumbered (Briggs)	CEM-33
. T. W. Whitman Farm	RES-24

. Historical Cemetery Number Fifty-four (Cleaveland, Congdon, Nichols)	CEM-34
. Site of Brown Farm	(S)-RES-25

Two-Rod Road

. Two Rod Road	TRN-12

Weaver Hill Road

. Old Kit Matteson Tavern	CMT-11 RES-27
. Amos Sweet House	RES-26

CEMETERIES

COVENTRY

ARROW HEAD ROAD

HISTORICAL CEMETERY #51 (GREENE)

CEM-1

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded and overgrown. Contains members of the Greene family. Stones date from 1799 and early 19th century.

Significance: The Greene family was a pioneer family. John Greene (d. 1723) settled here; he built an early mill (see (S)-IND-1) and Zeke's Bridge over the river nearby, was originally known as John Greene's Bridge (see TRN-2).

Map History: 1831-1895 - not shown.
1962-Cem.

Present Status: Neglected, with some broken stones and some letter. Mid-20th century summer cottages are nearby.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

BIG RIVER ROAD

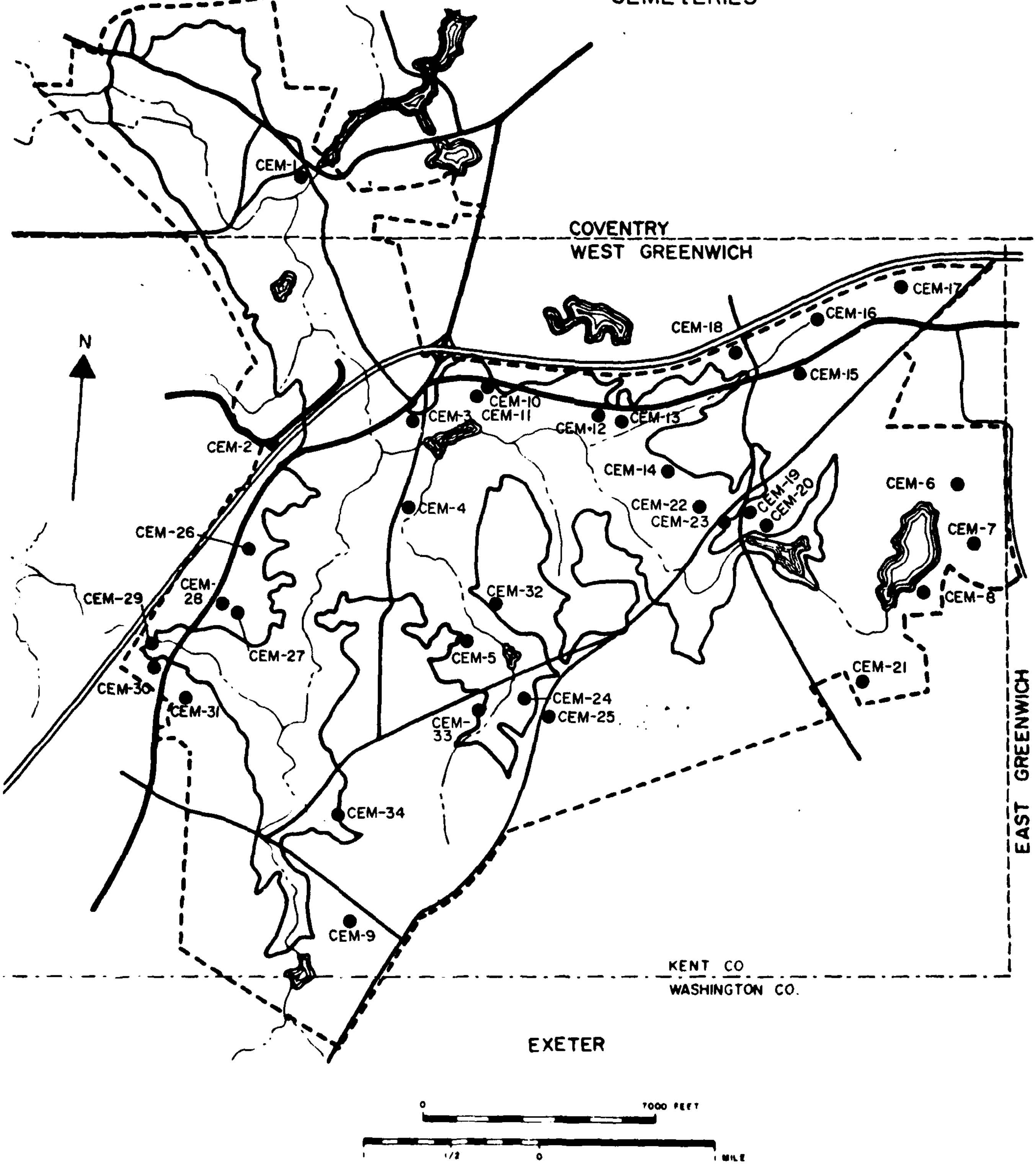
HISTORICAL CEMETERY #26 (Matteson)

CEM-2

Previous Map #: None

Level of Significance: Contributing

BIG RIVER RESERVOIR AREA
CEMETERIES



Description: Unbounded and overgrown. Three inscribed stones of Matteson family, dating from early to mid 19th century.

Significance: The Matteson family was an important family in this section of West Greenwich.

Map History: 1966-Matteson Cem.

Present Status: Neglected, heavily overgrown with vegetation, mostly scrub oak, and in very poor condition. This burying ground was located in a gravel area; when the surrounding gravel was removed for the construction of Route I-95, which passes about 300 feet east of the cemetery, the burying ground was left as an isolated mound of earth about twenty feet above the surrounding area. The few remaining gravestones are in poor condition.

Notes:* Before the construction of I-95 and the surrounding area was bulldozed and stripped, there were about thirty graves here.

Relation of Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

BURNT SAWMILL ROAD

HISTORICAL CEMETERY #53 (Matteson)

CEM-3

Previous Map#: None

Level of Significance: Contributing

---

* Unless otherwise noted, these note entries are taken from Blanche Albra's detailed cemetery records.

Description: Unbounded and overgrown. Five inscribed stones of the Matteson family, dating from 1805 (an initialed stone) to 1884, and about 10-15 more heavily weatherworn stones.

Significance: The Matteson family was locally important. This burying ground is associated with a nearby 18th-century Matteson house (see RES-7). The most recent stone is that of Sarah Matteson (d. 1884); it is possible that after her death the Mattesons no longer resided here.

Map History: 1948 - Matteson Cem.
1966 - Matteson Cem., 26 (This number an error.)

Present Status: Although untended, the cemetery's location in a pine forest has given it a relatively open floor clear of undergrowth.

Notes: At one time there were at least four more stones here, including two members of the Whipple family (Rachael Whipple was a Matteson.)

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

BURNT SAWMILL ROAD

HISTORICAL CEMETERY #27 (WHITFORD)

CEM-4

Previous Map#: None

Level of Significance: Important

Description: Bounded by a cemented stone wall about three feet high along the road and by a three-rail iron fence set in granite posts on the other three sides. Contains eight inscribed stones of the Whitford family, dating from 1831 to 1883.

Significance: The Whitfords were an early family on Burnt Sawmill Road and are associated with a local industry--Whitford's Mills--of the mid 19th-century (see (S)-IND-2). The mill and the residence of William Whitford were along the Carr River.

Map History: 1948 - Old Whitford Cemetery
1966 - 27, Old Whitford Cemetery

Present Status: Stones in good condition and the grounds are relatively open and free of vegetation.

Relation of Proposed Reservoir: In pool.

WEST GREENWICH

BURNT SAWMILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (KETTLE)

CEM-5

Previous Map#: None

Level of Significance: Contributing

Description: Unbounded and overgrown. Contains ten inscribed stones of the Kettle family dating from 1830 to 1889, and about six fieldstone markers.

Significance: A local burying ground containing typical plainly inscribed headstones, some of slate.

Map History: Not shown on any maps.

Present Status: Overgrown with scrubby vegetation in white pine and pitch pine forest.

Relation of Proposed Reservoir: In or near edge of pool.

WEST GREENWICH

CARR POND ROAD

HISTORICAL CEMETERY, UNNUMBERED (TARBOX, JACKSON, PECK)

CEM-6

Previous Map#: None

Level of Significance: Important

Description: Bounded by a 3-rail iron fence and iron gate set in granite posts, this is a well maintained plot containing about a dozen stones of the Tarbox, Jackson, and Peck families dating from 1853 to 1950, and several fieldstone markers.

Significance: The Tarbox family was an early and important family here, along the East Greenwich-West Greenwich town line. Captain David Tarbox, II, whose home was nearby, played a role in Rhode Island's Door War in the 1840s.

Map History: Not shown on any maps.

Present Status: In very good condition and well-maintained.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CARR POND ROAD

HISTORICAL CEMETERY #29 (TARBOX, WHITFORD, SHIPPEE)

CEM-7

Previous Map#: None

Level of Significance: Important

Description: Unbounded and overgrown. It contains about nineteen marked stones of the Tarbox, Whitford, and Shippee families dating from about 1800 to 1937; one 17th-century and eight 18th-century stones of the Whitford family inscribed only with initials, including "P.W.", 1690 (Pasco Whitford); and about 30 uninscribed fieldstone markers.

Significance: This is one of the oldest burying grounds in the area, with several early stones. It is important because of its association with several pioneer and later important families and because of the stone architecture which includes an unusual massive and triangular rough-hewn granite stone. The extensive Carr Pond granite quarries, which were operated by the Tarbox family in the 19th and 20th centuries, were a short distance away (see (S)-IND-3).

Map History: 1831-1966 - Not shown on maps.
1966 - Cam.

Present Status: Overgrown with a dense cover of shrubs and briars; not maintained.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CARR POND ROAD

HISTORICAL CEMETERY #31 (KETTELLE)

CEM-8

Previous Map#: None

Level of Significance: Contributing

Description: Bounded by a 3-rail iron fence and an iron gate set in granite posts, and covered with leaves and young pine trees, the plot contains five marked stones of the Kettelle family dating from 1870 to 1949 and three graves marked with fieldstones.

Significance: The Kettelles were a local family. Samuel and Benjamin Kettelle, buried here, lived in a nearby house not far from the granite quarries.

Map History: 1831-1948 - Not shown.
1966-31.

Present Status: Overgrown, not maintained.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CONGDON MILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (WHITFORD)

CEM-9

Previous Map#: None

Level of Significance: Contributing

Description: A small burying ground in the woods bounded by a 4-rail iron fence with supporting iron posts, containing one gravestone, that of Deborah Whitford, who died in 1884.

Significance: A local burying ground, this is unusual because it is the only one in the entire reservoir area bounded completely with iron posts and rails.

Map History: 1831-1895 - Not shown.
1948, 1966 - Shown on map.

Present Status: Several pine trees are inside the plot, which is covered with a thick layer of pine needles and branches.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY #25 (ANDREWS)

CEM-10

Previous Map#: None

Level of Significance: Contributing

Description: The rectangular, tree-covered, burying ground is set on a platform bounded by large granite stones, with granite steps along the west side. There are no grave markers.

Significance: The burying ground was one of the many 19th-century cemeteries common to rural Rhode Island, and although the stone markers are gone, the stone walls comprising the cemetery contain the largest stones of any in the reservoir area, with some capstones as long as six feet.

Map History: 1831-1862 - Not shown.
1870 - Cemetery
1895 - Cemetery
1948 - Very Old Matteson Cemetery
1966 - Very Old Matteson Cemetery, 25.

Present Status: Overgrown; part of surrounding woods.

Notes: This is not a Matteson cemetery, as indicated on the 1948 and 1966 maps, but contained members of the Andrews family (John Andrews lived nearby and is shown on the 1855 and 1862 maps) whose remains were removed to the Knotty Oak Cemetery in Anthony (Coventry) many years ago.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY, UNNUMBERED (MATTESON)

CEM-11

Previous Map#: None

Level of Significance: Contributing

Description: Unbounded and overgrown, this burying ground contains three inscribed stones of the Matteson family dating from 1838 to 1845 and about a dozen graves marked with fieldstones.

Significance: A local burying ground common to rural Rhode Island.

Map History: Not shown on any maps.

Present Status: Overgrown and neglected.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY #46 (WHITMAN, WOODWARD, MATTESON, SMITH)

CEM-12

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded and overgrown, it contains at least nine stones of several families, dating from 1831 to 1867.

Significance: A typical local burying ground.

Map History: 1831-1948 - Not shown
1966 - ".F. Whitman, Co. 1, 7th R. I. Inf. Buried Here", No. 25.

Present Status: Overgrown and part of the surrounding forest. Sand and gravel piled up along the west side of the burying ground may have covered more graves.

Relation to Proposed Reservoir: *In pool.*

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY #47 (HARRINGTON)

CEM-13

Previous Map #: None

Level of Significance: Important

Description: Granite entry posts and some iron posts are present, but most of the burying ground is unbounded and overgrown. There are at least a dozen inscribed stones of the Harrington family, dating from 1816 to 1872, and about six whose lettering is weatherworn and illegible.

Significance: The Harringtons lived in the local area. The stones, generally plain in form and inscription, are typical of the area.

Map History: 1855, 1862 - Grave Yard
1870, 1895 - Cemetery
1948 - Not shown
1966 - Job Harrington Cemeter, no number

Present Status: Overgrown and part of the surrounding forest.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY, UNNUMBERED (HARRINGTON)

CEM-14

Previous Map#: None

Level of Significance: Contributing

Description: Unbounded and overgrown, it contains seven marked stones of the Harrington family who were buried here between 1808 and 1859, and about 20 uninscribed field stone markers.

Significance: A typical local family burying ground of the unbounded variety.

Map History: Not shown on any maps.

Present Status: Overgrown and part of the surrounding woods.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY #37 (KING, HOWARD)

CEM-15

Previous Map #: None

Level of Significance: Important

Description: Bounded by low stone walls, with an iron gate entry set in granite posts. It contains about fourteen inscribed stones of the King and Howard families, dating from about 1818 to 1870, several initialed 18th-century stones and about two dozen graves marked with fieldstones.

Significance: A neat, relatively well maintained burying ground with members of a local family. David King (who died in 1870) lived on the nearby New London Turnpike. Samuel King was a private in the Rhode Island Militia during the Revolutionary War.

Map History: 1831-1948 - Not shown.
1966 - No. 37 (and listing of some names).

Present Status: In good condition, one of the finest and best preserved in the reservoir area.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY #38 (MATTESON, SHIPPEE)

CEM-16

Previous Map#: None

Level of Significance: Contributing

Description: Unbounded, on a wooded knoll next to a large open area, it contains the graves of Matteson and Shippee families who died between 1831 and 1899.

Significance: The farm on which the burying ground is located was called the Stukley Matteson Place (there was a stone initialed S.M., 1822). Sally Anne Matteson (d. 1879) married a Shippee; the Shippee family occupied the area in the late nineteenth century.

Map History: 1831-1948 - Not shown
1966 - Old Cemetery 38.

Present Status: Overgrown; in poor condition; badly vandalized.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

DIVISION STREET

HISTORICAL CEMETERY, UNNUMBERED (NICHOLS)

CEM-17

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded, this small burying ground in a small grove of scrub pine and oak contains two flat stones in memory of Rachel Nichols (d. 1778) and her child.

Significance: Each stone is covered with a large, flat, slate stone. It is legend that during an argument, the husband said to his wife Rachel, "I'll live to eat the goose that eats the grass that grows on your grave." When she and their child died a short time later, he had the graves covered with large stones so that no grass could grow on the graves. (Source: Blanche Albro).

Map History: Not shown on any maps.

Present Status: Overgrown

Relation to Present Reservoir: In watershed, above pool.

WEST GREENWICH

HOPKINS HILL ROAD

HISTORICAL CEMETERY #36 (GREENE)

CEM-18

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded and overgrown, this small burying ground contains inscribed markers of two members of the Greene family who died in 1828 and 1841.

Significance: The Greenes were a local family.

Map History: 1831-1895 - Not shown.
1948 - Shown on map.
1966 - Cem. 36.

Present Status: Heavily overgrown and badly vandalized. All stones are broken or lying on the ground. This burying ground is in the poorest condition of any in the reservoir area.

Notes: A local resident said that there were once about 10 stones here, but they have been removed by someone.

Relation to Present Reservoir: In watershed, above pool.

WEST GREENWICH

HOPKINS HILL ROAD

HISTORICAL CEMETERY #30 (BARBOUR, HOPKINS, POTTER, ET. AL.)

CEM-19

Previous Map #: None

Level of Significance: Important

Description: Relatively large and well maintained and bounded by a 3-rail iron fence set in granite posts, this cemetery contains more than two dozen gravestones of the Barbour, Hopkins, Potter, and several other families, the first stone dating from 1831.

Significance: The cemetery, which is divided into two parts by an inside rail fence, has been used since its establishment in the early nineteenth century to the present and includes grave markers for people still living. The Potter family, which lived close to nearby Potter Sawmill Pond, ran a sawmill and gristmill for many years and owned a large tract of land in this area.

Map History: 1831-1895 - Not shown.
1948 - Hopkins Cem.
1966 - Cem. No. 30. Potter, Hopkins, and Barbour

Present Status: In very good condition.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

HOPKINS HILL ROAD

HISTORICAL CEMETERY #55 (SPINK)

CEM-20

Previous Map #: None

Level of Significance: Contributing

Description: A pair of grave markers (a head and a foot stone), in a planted pine woods atop a knoll above the pond, marking the burying place of Thomas Spink (d. 1834), and about five fieldstone grave markers constitute a small burying ground.

Significance: Several early families settled here, including Thomas Spink.

Map History: Not shown on any maps.

Present Status: The gravestones are relatively well preserved, the heavy growth of pine providing a dense canopy of shade and a carpet of needles which discourages the growth of other vegetation and provides a pleasant setting for the stones.

Notes: The trees in this area were leveled by the 1938 hurricane. A photograph by Howard Barbour shows the Spink gravestone amidst a mass of tangled trunks, limbs, and branches. Soon after, the forest was replanted by Howard Barbour (W. Nebiker).

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

HOPKINS HILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (POTTER)

CEM-21

Previous Map #: None

Level of Significance: Contributing

Description: Overgrown and bounded by a low, crude stone wall, it contains several inscribed stones of the Potter family, dated 1833, 1834, and 1837, and about twelve fieldstone markers.

Significance: A typical local burying ground of the area.

Map History: Not shown on any maps.

Present Status: Heavily overgrown with scrub vegetation. The stone walls which surround the cemetery are falling down.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NEW LONDON TURNPIKE

HISTORICAL CEMETERY, UNNUMBERED (CARR)

CEM-22

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded and overgrown, with inscribed gravestones of the Carr family dated 1794, 1820, and 1842, and about a dozen unmarked fieldstones.

Significance: A local family burying ground.

Map History: Not shown on any maps.

Present Status: Heavily overgrown with scrub vegetation.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NEW LONDON TURNPIKE

HISTORICAL CEMETERY, UNNUMBERED (CASE)

CEM-23

Previous Map #: None

Level of Significance: Contributing

Description: One solitary gravestone, of Thomas Case (d. 1825), located atop a hill in the middle of a pine woods.

Significance: Case was a local resident.

Map History: Not shown on any maps.

Present Status: Site littered with forest debris.

Relation to Proposed Reservoir: In watershed, close to pool.

WEST GREENWICH

NEW LONDON TURNPIKE

HISTORICAL CEMETERY, UNNUMBERED (HOPKINS)

CEM-24

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded and overgrown, containing several stones of the Hopkins family, dated 1834, 1839, 1862, and 1866, and about nine graves marked with fieldstones.

Significance: A small burying ground containing members of a locally important family.

Map History: Not shown on any maps.

Present Status: Overgrown and covered with forest litter. Most stones are down or hidden from view.

Relation to Proposed Reservoir: Above watershed, near pool.

WEST GREENWICH

NEW LONDON TURNPIKE

HISTORICAL CEMETERY #28 (Hopkins)

CEM-25

Previous Map #: None

Level of Significance: Contributing

Description: A burying ground containing members of the Hopkins family, in a wooded area, on a slight rise above the turnpike and fronted by a stone retaining wall.

There are about eighteen inscribed stones, dated from about 1800 to 1891.

Significance: The Hopkins family was an important local family, dominating the southeast part of the town of West Greenwich. Through most of the 19th century they were part of a small settlement at the intersection of the turnpike with Sweet Sawmill Road, where Blake's Hotel was located. A Hopkins ran a blacksmith ship just north of the cemetery (S-CMT-5).

Map History: 1831-1948 - Not shown.
1966-28. Old Hopkins Cemtery

Present Status: It receives minimal attention, if any, and is slightly overgrown.

Notes: According to Howard Barbour, the Hopkins family found a baby left on their doorstep. They kept him and gave him the name, Wilson Hattan, and he is buried here (from Blanche Albro's notes).

Relation to Proposed Reservoir: In watershed, near pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (MATTESON, SHIPPEE)

CEM-26

Previous Map #: None

Level of Significance: Important

Description: Bounded by well laid dry stone walls with capstones and an iron gate with granite posts. The relatively well maintained burying ground contains about two dozen inscribed stones of the

Matteson and Shippee families, dating from about 1776 to 1946.

Significance: The Matteson family was locally an important family. John Matteson (d. 1784) was one of the first settlers in the area; Hall Matteson was an early industrialist in Nooseneck. Many of the people buried here lived in the nearby John Matteson House (RES-16).

Map History: 1831-1870 - Not shown.
1895 - Cem.
1948 - Shown on map.
1966 - Matteson Cem.

Present Status: In very good condition.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (MATTESON)

CEM-27

Previous Map #: None

Level of Significance: Important

Description: Unbounded and overgrown, in a pine forest on the slope of a hill. A relatively large burying ground, with about seventy-five gravestones, some of which are crude and old, including many of the Matteson family, dating from about 1749 to 1807. All the inscribed stones bear initials and dates only.

Significance: It is important because of its many early stones containing members of a locally important family. It is perhaps the largest burying ground in the Big River Reservoir area.

Map History: 1831-1948 - Not shown.
1966 - Shown on map.

Present Status: Overgrown and neglected.

Relation to Proposed Reservoir: In watershed, close to or in pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (JOHNSON)

CEM-28

Previous Map #: None

Level of Significance: Contributing

Description: A small burying ground in a pine woods, bounded by a 3-rail iron fence set in granite posts, containing four inscribed stones of the Johnson family, dated 1847, 1863, 1865, and 1876, and some unmarked gravestones.

Significance: A typical local family burying ground.

Map History: Not shown on any maps.

Present Status: Neglected. The fence has been damaged by the fallen tree limbs. It has been badly vandalized--all of the stones are down and one grave was dug open.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HISTORICAL CEMETERY #23 (HALL)

CEM-29

Previous Map #: None

Level of Significance: Important

Description: A mostly grassy plot set on a slight rise, or platform, bounded by flat-topped stone walls and with an iron gate on the east side. It contains more than two dozen inscribed stones of the Hall family, and several other families, dating from about 1778 to 1882.

Significance: An important local burying ground, with well preserved stones of members of a locally-significant family. The Halls were one of the early families in this area. Caleb Hall, buried here (d. 1801) and his brother, John, had a blacksmith shop and a water-powered trip hammer shop along the Nooseneck River about 1789; it is the first recorded industial activity in the Nooseneck area.

Map History: 1831-1895 - Not shown.
1948 - Shown on map.
1966 - Cem. 23.

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (HALL)

CEM-30

Previous Map #: None

Level of Significance: Contributing

Description: Unbounded and overgrown, a small burying ground, with one inscribed marker--Amy Hall, d. 1820--and two initialed markers--L. H., d. 1776 and M. H., d. 1790--and about ten graves marked with fieldstones.

Significance: A local family burying ground with old, crude markers.

Map History: Not shown on any maps.

Present Status: In poor condition, overgrown, some stones down.

Relation to Proposed Reservoir: In watershed, near pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (ANDREWS, EDWARDS, GARDNER)

CEM-31

Previous Map #: None

Level of Significance: Contributing

Description: Overgrown; bounded by a stone wall along the south side (next to the cart path) and an iron fence set into granite posts on the other three sides. It contains about seven inscribed stones of the Andrews, Edwards, and Gardner families dating from 1828 to 1863, and several graves marked with fieldstones.

Significance: A local burying ground containing members of locally important families.

Charles Andrews, buried here (d. 1846) is said to have kept a hotel at Nooseneck.

Map History: 1831-1895 - Not shown.
1948 - Shown on map.
1966 - Cem.

Present Status: Neglected, heavily overgrown.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

SWEET SAWMILL ROAD

HISTORICAL CEMETERY #52 (SWEET BURYING GROUND)

CEM-32

Previous Map #: None

Level of Significance: Important

Description: Slightly overgrown with shrubs, and bounded by a 3-rail iron fence set in granite posts, this plot contains inscribed stones, stones with initials and dates, and uninscribed stones of the Sweet family, dating from about 1759 to 1843.

Significance: The Sweet family was one of the earliest to settle this section of West Greenwich, and the family occupied the land here for several centuries. The Old Sweet Farm, on which the cemetery is located, is nearby. The road, pond, and former sawmill were named for this family. The stones are old, crudely inscribed, and interesting and significant in the history and evolution of gravestone architecture.

Map History: 1831-1895 - Not shown on maps.
1948 - Shown on map.
1966 - Cem.

Present Status: Overgrown, but the stones are in good condition.

Relation to Proposed Reservoir: In watershed, near pool.

WEST GREENWICH

SWEET SAWMILL ROAD

HISTORICAL CEMETERY, UNNUMBERED (BRIGGS)

CEM-33

Previous Map #: None

Level of Significance: Contributing

Description: A burying ground set above the surrounding ground on a low platform, containing several initialed and several fieldstone markers. Two initialed stones are dated 1805 and 1807.

Significance: One of several "platform" type burying grounds in the reservoir area, with stones of an early local family.

Map History: Not shown on any maps.

Present Status: Heavily overgrown.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

SWEET SAWMILL ROAD

HISTORICAL CEMETERY #54 (CLEAVELAND, CONGDON, NICHOLS, ET AL).

CEM-34

Previous Map #: None

Level of Significance: Important

Description: Overgrown and bounded by crude stone walls, roughly flat-topped, this relatively large burying ground contains several dozen inscribed stones and about fifteen graves marked with fieldstones, of the Cleaveland, Congdon, Nichols, and several other local families, dating from about 1763 to 1867.

Significance: This is an important burying ground because of the carved gravestones and because of the families buried here. The Nichols family ran the local mills, one of the town's early industrial-centered settlements. Later, the mills were run by the Congdons.

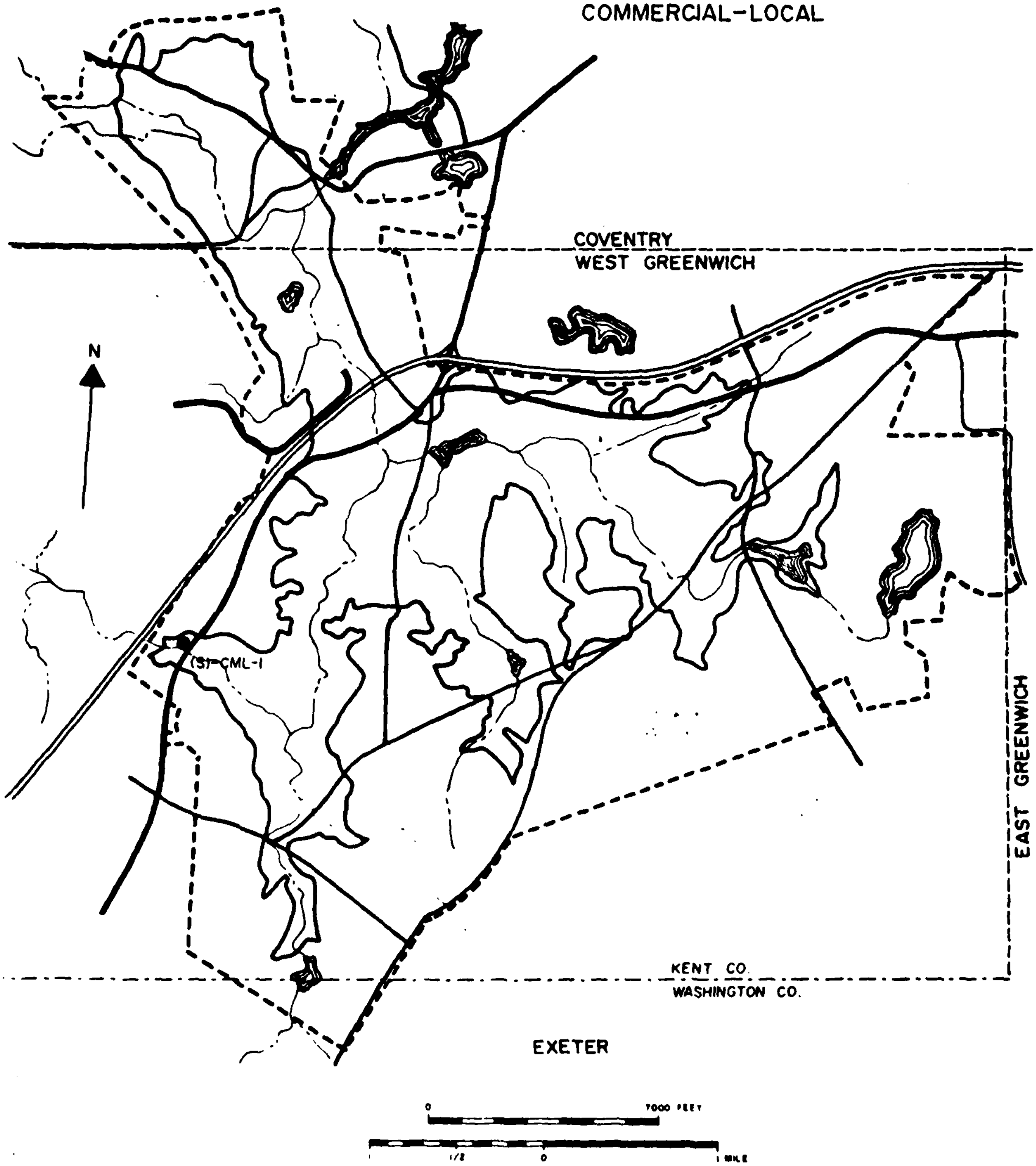
Map History: 1831-1966 - Not shown on any maps.

Present Status: Overgrown, but stones are in good condition.

Relation to Proposed Reservoir: In or near edge of pool.

BIG RIVER RESERVOIR AREA

COMMERCIAL-LOCAL



COMMERCIAL - LOCAL

WEST GREENWICH

NOOSENECK HILL ROAD

SITE OF ANDREWS AND FISH'S STORE

(S)-CML-1 (ALSO INCLUDED AS (S)-IND-11)

Previous Map #: None

Level of Significance: Contributing

Description: Formerly a 2-story wood-frame, clapboarded structure, it stood near the road, the bridge and the river at the bottom of the hill until it was destroyed in the early 1970s.

Significance: This store was one of the early stores in Nooseneck, serving the local area for more than three quarters of a century. It, and Carr's Store atop the hill, were the two most important stores in Nooseneck. The first store in the "hollow" started near William N. Sweet's residence (see RES-19) about 1837. The second store stood across the road until it burned, about 1874. The Andrews-Fish store was said to have been built by Robert Hall, as a mill. It was used for a time as a gristmill; later, it was operated as a spinning mill, perhaps by Tripp and Tillinghast. It was acquired to David Hopkins, who used it as a spinning mill; then a store was opened in the lower story by John Edwards, in 1874 (after the second store burned). About 1876, the property was sold to Ashur Andrews and used as a grocery and provision store; his sons, Isaac and Byron ran the business after that. In 1898, James H. Fish, an in-law of the Andrews, began running the business. He kept a store here until 1940, when road widening left the doorstep a few inches within the highway bounds. Fish then relocated his general store to near his home on the hill a short distance to the south. At that time, the second floor was used by the Nooseneck Hill Club. Next, John "Smoker" Potter ran an antique shop in the building for several years. After condemnation by the state it remained vacant for several years until it was destroyed.

Although the building is now gone, it was an important part of the village of Nooseneck for almost a century and a half, first as one of its industrial buildings, then as a general store--an important community gathering place. Several of the owner-operators, including James Fish and John Potter served for many years in the state government as representatives of West Greenwich.

Map History:
1855 - Hopkins Mill
1870 - Old Mill
1895 - Not identified
1948 - Smoker Potter, Antique Shop
1966 - Not identified

Present Status: Structure is destroyed and the site leveled, but part of the foundation along the river is still visible to indicate the site.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF WATSON HOTEL, EARLY 19th CENTURY

(S)-CMT-1

Previous Map #: None

Level of Significance: Contributing

Description: None available. No field check. No evidence in written records.

Significance: One of a series of hotels, taverns, and inns which stood along the New London Turnpike during its heyday, and probably built in the decades after the turnpike was open to travel in about 1820.

Map History: 1855-1862 - Watson Hotel. Later maps show a Watson place at the corner of Division Street and the Turnpike.

Present Status: Probably obliterated as the area has been worked for gravel and there is a gasoline station at or near the site of the hotel.

Relation to Proposed Reservoir: On fringe of watershed (outside).

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF GREENE'S HOTEL (EARLY 19th CENTURY)

(S)-CMT-2 (ALSO INCLUDED AS (S)-TRN-6)

Previous Map #: C-10

Level of Significance: Contributing

Description: Formerly a 1½-story, rectangular structure, with two brick interior chimneys and two front entrys, set into a hill very close to the road, with a full basement at the rear, and a barn nearby at the left (south) side.

Significance: This structure was one of about a half dozen commercial structures along the West Greenwich section of the New London Turnpike which enjoyed a short period of prosperity in the early 19th century. Little is known of the history of the hotel, which is identified as a hotel only on the 1870 map. It is likely that the structure was built as a toll house, and later used as a hotel after business on the pike declined and after the turnpike became a free road in 1864. The hotel, a part of the Webster Tollgate Site (see S-TRN-6) was still standing and occupied until it burned several years ago.

Map History: 1831 - Gate
1855, 1862 - Toll Gate
1870 - C. Greene, Hotel
1895 - Jesse Carr

Present Status: The structures burned and were leveled in 1977. Part of what was a deep and large fieldstone foundation is still visible to indicate the site.

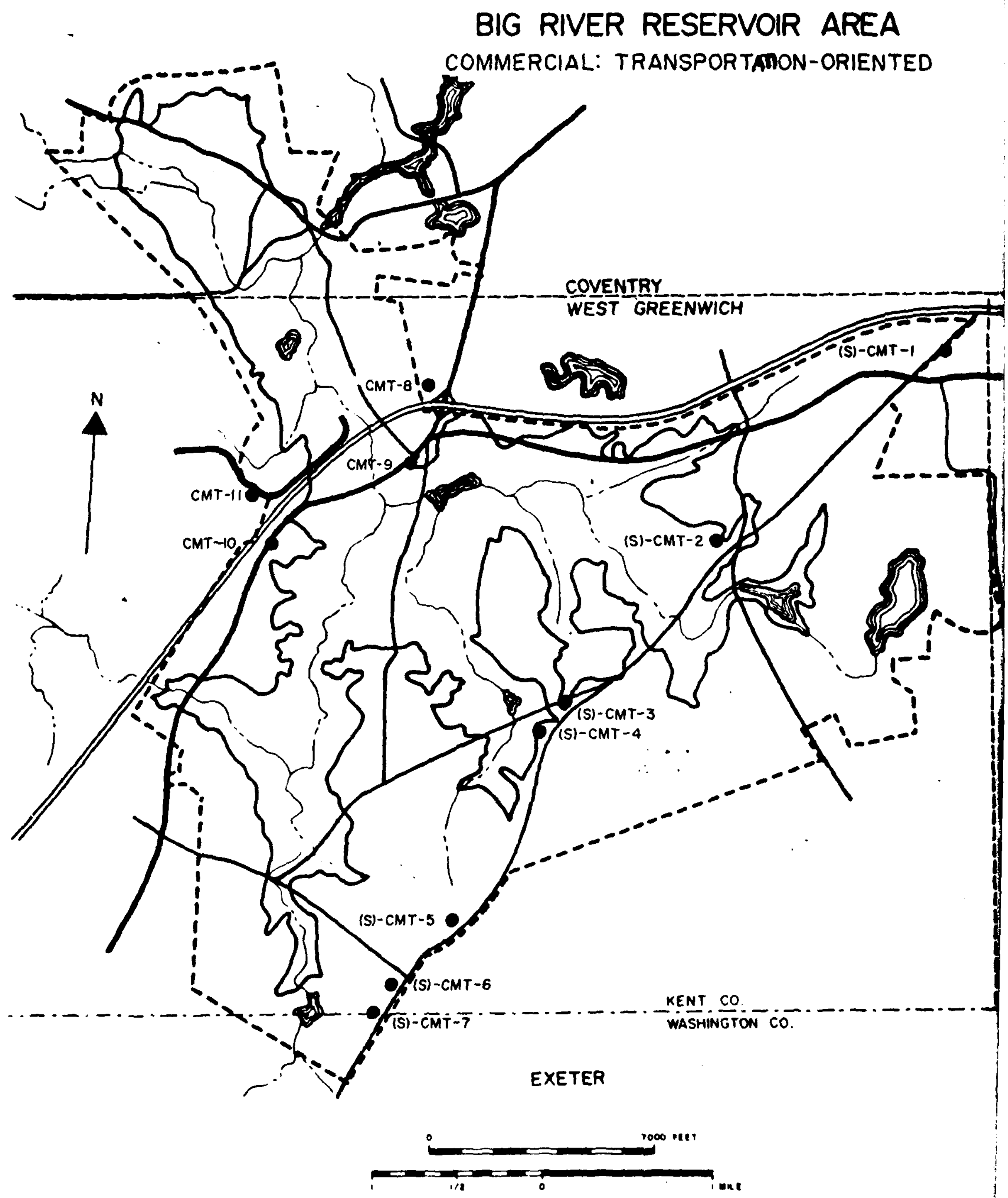
Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF BLAKES HOTEL (c. 1820)

(S)-CMT-3


BIG RIVER RESERVOIR AREA
COMMERCIAL: TRANSPORTATION-ORIENTED
COVENTRY
WEST GREENWICH
N
(S)-CMT-1
CMT-8
CMT-9
CMT-11
CMT-10
(S)-CMT-2
(S)-CMT-3
(S)-CMT-4
(S)-CMT-5
(S)-CMT-6
(S)-CMT-7
KENT CO.
WASHINGTON CO.
EXETER
0
7000 FEET
1
1/2
0
1 MILE

Previous Map #: None

Level of Significance: Contributing

Description: Formerly a long structure, about ninety feet in length, with one end housing twenty-five to forty houses at one time.

Significance: Built about 1820 by Horatio Blake, this hotel was the third stop of the stage-coach schedule of 1827. Known as the Stage House, it was one of the principal stopping points between Providence and New London. The Rhode Island American and General Advertiser of July 15, 1821, announced that "Stagecoach passengers arrive from Boston to dine, and from New York to breakfast at H. Blake's elegant hotel, where he keeps the best productions of our market, and the choisest viands served up in the very best style." The house, said to resemble the Henry Clap Whipple House in Washington village, was later owned by Eben Church, Wilson Hatten, Enos Sweet, and Amos Sweet. As traffic on the turnpike decreased, so did the quality of its customers; unsavory characters, prostitution, gambling, and murder transformed it into a backwoods "redlight" district. Later, Amos Sweet ran a store there, and also kept the town's poor for a while. The building burned in 1870.

Map History: 1831 - Blake's Hotel
1855, 1862 - E. Church
1845 - Not shown

Present Status: Some foundations stones.

Relation to Proposed Reservoirs: In watershed, very close to water's edge.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF CALVIN HOPKINS' BLACKSMITH SHOP

(S)-CMT-4 (ALSO INCLUDED AS (S)-IND-7)

Previous Map #: None

Level of Significance: Contributing

Description: None

Significance: A blacksmith shop stood for many years along the turnpike here. Near Blake's Hotel, it served an important function as part of a chain of commercial activities along the New London Turnpike, and was part of a small local community in the nineteenth century.

Map History: On 1870 map only - B.S. Sh.

Present Status: The structure has been gone for many years. Its site is now indicated by a small depression along the side of the road.

Relation to Proposed Reservoir: In watershed.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF CLEVELAND'S HOTEL (EARLY 19th CENTURY)

(S)-CMT-5

Previous Map #: None

Level of Significance: Contributing

Description: None.

Significance: It was one of several 19th-century hotels along the turnpike. Its history is unknown.

Map History: 1831 - Cleveland's Hotel
1855, 1862 - Shown on map but not identified.
1870 - R. H. Champlain
1895 - S. Harrington Est.

Present Status: An early 20th-century house stands on or near the site of the old hotel, but there are no apparent remains of the structure.

Relation to Proposed Reservoir: In watershed.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF TAVERN

(S)-CMT-6

Previous Map #: None

Level of Significance: Contributing

Description: None

Significance: Local tradition says that there was a stagecoach tavern complex at the intersection of New London Turnpike and Congdon Mill Road. It may be the site of the Rhode Edwards Place. The area, known in the early 19th century as Spencer Four Corners, later received the more colorful nickname of Hell's Half Acre.

Map History: 1831 - Spencer Four Corners - no buildings shown.
1855, 1862 - An unidentified building at the southeast corner (across road from site).

1870, 1895 - Not shown.
1948 - Old Tavern Site; Mrs. L. M. Harris (just to south of site); Hell's Half Acre.
1966 - Old Tavern Site; Hell's Half Acre.

Present Status: At the southwest corner of the intersection is a fieldstone foundation; nearby is a stone-lined well hole.

Relation to Proposed Reservoir: In watershed.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF THE OVEN BIRD TAVERN

(S)-CMT-7

Previous Map #: None

Level of Significance: Contributing

Description: None

Significance: According to local historians, there was a tavern at this site, but there is no documented history of the old Oven Bird Tavern to date.

Map History:
1855 - Shown on map.
1862 - Not shown.
1870 - A. C. Shippee
1895 - J. W. Rathbun
1948 - Old Oven Bird Inn, A. Champlin
1966 - Site of Old Oven Bird Inn.

Present Status: A junk-littered foundation-cellar hole in an open field marks the site of a house, inn, or both.

Relation to Proposed Reservoir: In watershed.

WEST GREENWICH

NOOSENECK HILL ROAD

CONGRESS INN (c. 1966)

CMT-8

Previous Map #: None

Level of Significance: Contributing

Description: A 2-story structure, with a slightly larger central section housing an office and restaurant, and two large flanking wings containing rooms atop a ledge with a view of Route I-95 below. It is a conspicuous landmark from the interstate.

Significance: This hotel, relatively large for rural Rhode Island, is a product and symbol of the present interstate highway era, and is the latest stage in the evolution of highway accomodations which began in the area as early along the New London Turnpike in the early 19th century. Although just outside the limits of the reservoir area, the Congress Inn is locally interesting as an historical-commercial continuity, reflecting changes in style and scale of highway-oriented activities. Although considered a "visual intrusion" into the road corridor, it is important as a statement of its time.

Map History: 1966 - Motel.

Present Status: An active commercial establishment.

Relation to Proposed Reservoir: On fringe of watershed (outside).

WEST GREENWICH

NOOSENECK HILL ROAD

THE PINES MOTEL (1930s)

CMT-9

Previous Map #: C-11

Level of Significance: Contributing

Description: A cluster of small, 1-story clapboarded cottages of "colonial inspiration."

Significance: This motel is typical of many built during the pre-World War II era to provide overnight accommodations for travelers along the highway. It is one of the few surviving motels along Nooseneck Hill Road (Route 3), which, from the 1930s through the early 1960s, was one of Rhode Island's most important and most heavily traveled arteries. In 1960, there were 24 units to the motel.

Map History: 1948 - The Pines; Cabins.
1966 - L. H. Rusack, the Pines Motel.

Present Status: Used as motel.

Relation to Proposed Reservoirs: At edge of pool.

WEST GREENWICH

NOOSENECK HILL ROAD

THE FORMER WAYSIDE/BIG RIVER RESTAURANT (1930s)

CMT-10

Previous Map #: None

Level of Significance: Contributing

Description: A small, 1-story structure along the highway, with a small brick chimney and an enclosed flat-roof addition across the front.

Significance: This structure is typical of many roadside stands of the pre-World War II highway era. Originally known as the Wayside, or Harrington's Wayside after the family that ran it, it was later run by Cora Harrington Lamoureux, the present town clerk. (The Harringtons lived in the next door house but left when their property was taken by the state.) In 1940, when run by Cora Lamoureux, it was described as "one of the best known eating places along Nooseneck Hill Road." It continued serving as a restaurant, but within weeks of the opening of this section of Interstate Route 95, in 1969, it closed its doors to the public. A "Big River Restaurant" sign at a rakish angle still stands along the old highway, a relic of a past era in the history of the Nooseneck Hill Road.

Map History: 1948 - The Wayside
1966 - Big River Restaurant

Present Status: Used as a residence.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

WEAVER HILL ROAD

OLD KIT MATTESON TAVERN (c. 1784 OR EARLIER)

CMT-11 (ALSO INCLUDED AS RES-27)

Previous Map #: C-17

Level of Significance: Recommended for the National Register.

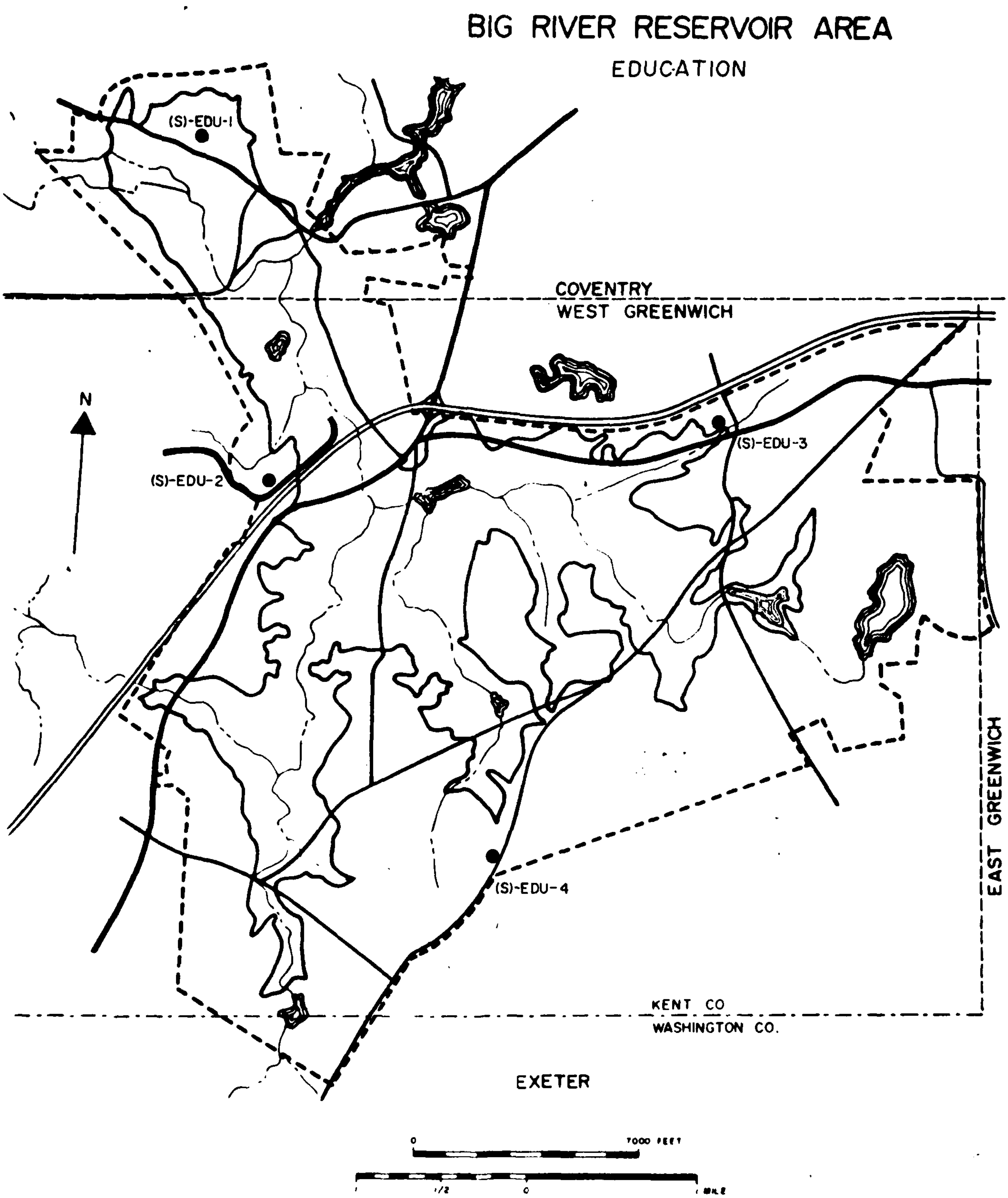
Description: A 2½-story, gable-roofed structure, with a large (rebuilt) center chimney, set on a bank which creates a 3-story elevation on the east side.

Significance: The former tavern, now a residence, stood along one of West Greenwich's major east-west arteries--Division Street. The construction of Route I-95 made the part east of here a dead-end road. The structure, the only surviving tavern of several which operated in West Greenwich in the early 19th century, was originally owned by the Mattesons, an early family, and was in the family until reecently. Erving D. Matteson, who lived here during much of the twentieth century, was a town clerk for thirty-four years.

Map History:
1831 - Shown on map.
1855, 1862 - C. Matteson, Est.
1870 - A. Matteson.
1895 - Benj. Carr.
1948 - E. D. Matteson, Town Clerk.
1966 - Site of Old Kit Matteson Tavern

Present Status: In good condition; well preserved.

Relation to Proposed Reservoir: On fringe of watershed (outside).



BIG RIVER RESERVOIR AREA
EDUCATION
(S)-EDU-1
(S)-EDU-2
(S)-EDU-3
(S)-EDU-4
N
COVENTRY
WEST GREENWICH
EAST GREENWICH
KENT CO
WASHINGTON CO.
EXETER
0
7000 FEET
1/2
0
1 MILE

EDUCATION

COVENTRY

HARKNEY HILL ROAD

SITE OF ANDREW SCHOOL (DISTRICT #9)

(S)-EDU-1

Previous Map #: None

Level of Significance: Contributing

Description: None Available

Significance: One of Coventry's 1-room schoolhouses.

Map History: 1831-1855 - Not shown.
1862 - School
1872 - S. H.
1895 - School
1948 - Not shown.

Present Status: Not located.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

BIG RIVER ROAD

SITE OF KIT'S CORNER SCHOOL (DISTRICT #11)
(MID 19th-CENTURY)

(S)-EDU-2

Previous Map #: None

Level of Significance: Contributing

Description: It was a typical one-room schoolhouse, clapboarded, with two separate entries at the front (gable end), and a small brick chimney at the rear.

Significance: The Kit's Corner School, which stood here for more than a century, was the first of all the 1-room schoolhouses in West Greenwich.

Map History:
1855 - Not shown.
1862 - School.
1870 - S.H.
1895 - School
1948 - Kit's Corner School.
1866 - Old Kit's Corner Schoolhouse.

Present Status: Gone; no visible remains.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

DIVISION STREET

SITE OF BURTON'S (BUTTON'S) CORNER SCHOOL (DISTRICT #12) (MID 19th-CENTURY)

S-EDU-3

Previous Map #: None

Level of Significance: Contributing

Description: It was a typical 1-room schoolhouse, clapboarded, with two separate entries in front (gable end) and a small brick exterior rear chimney.

Significance: The Burton Corner School, locally called "Button's" Corner School, served the immediate neighborhood.

Map History:
1855. 1862 - School.
1870 - S.H.
1895 - School.
1948 - Stillman's Variety Store at or near site; Buttons Corner.
1966 - No structures in area; Buttons Corner.

Present Status: Gone; no visible remains.

Relation to Proposed Reservoir: In or near pool.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF NILES WOODS SCHOOL (DISTRICT #2) (MID 19th-CENTURY)

(S)-EDU-4

Previous Map #: None

Level of Significance: Contributing

Description: It was a typical 1-room schoolhouse.

Significance: A small, local school serving the immediate neighborhood.

Map History:
1855 - Not shown.
1862 - School
1870 - S.H.
1895 - School
1948 - Not indicated.
1966 - Shown as a remains of a structure

Present Status: About 50 feet back from the road are some lichen-covered granite steps and foundations marking the site of the Niles Woods School, which was burned many years ago.

Relation to Proposed Reservoir: In watershed, above pool.

COVENTRY

HARKNEY HILL ROAD

SITE OF JOHN GREENE'S SAW MILL AND DAM

(S)-IND-1

Previous Map #: None

Level of Significance: Contributing

Description: A small point of land, with some stone walls, jutting out into the Big River (the southern end of the Flat River Reservoir) marks the site of a dam and sawmill.

Significance: John Greene, one of the early settlers in this area (he died in 1723) built a dam and sawmill above the bridge across Harkney Hill Road. About 1800, the mill went to the Johnson family; later in the century, it was shown on maps as S. Andrews Saw Mill, and probably stopped working by 1870.

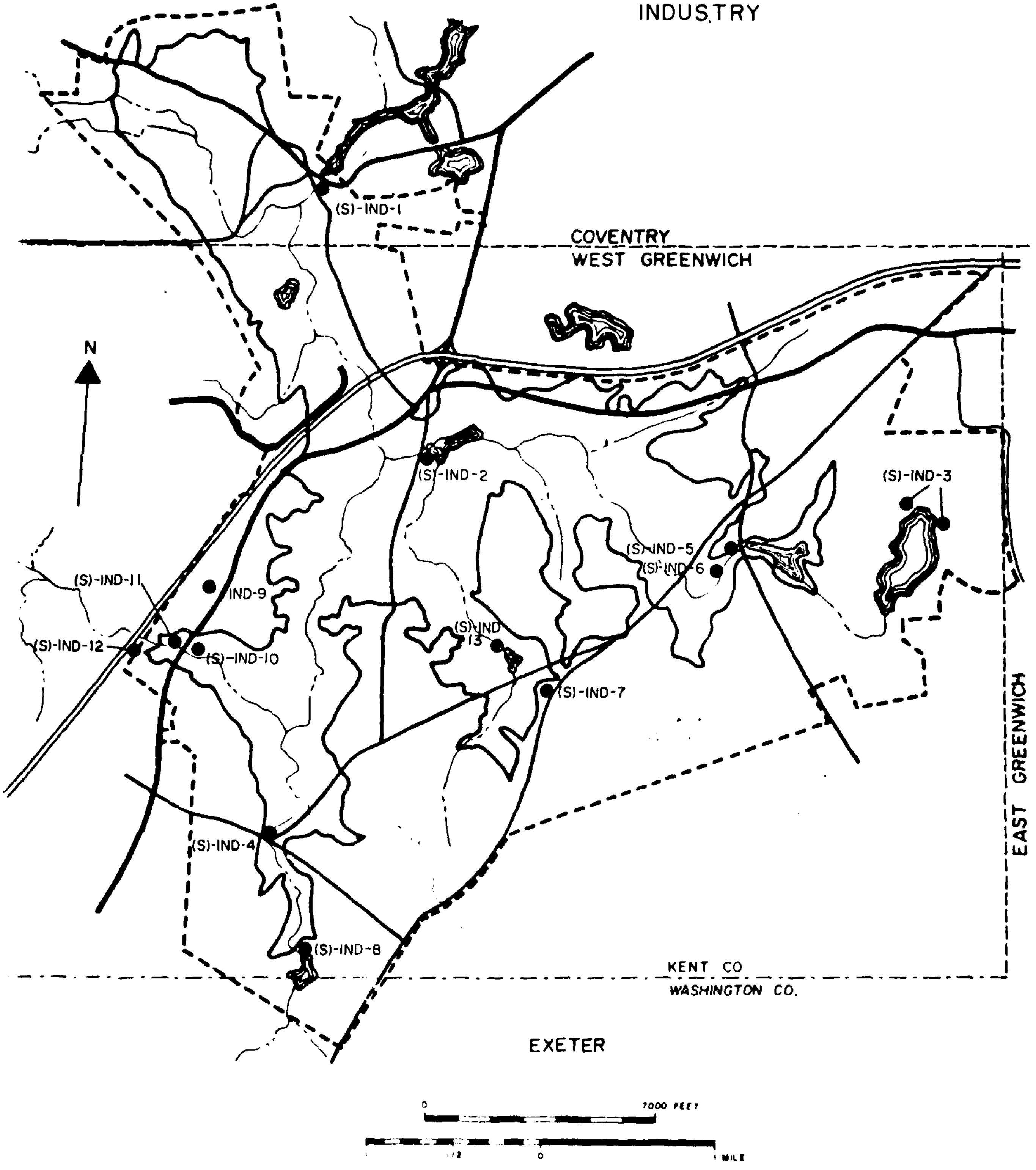
Map History:
1831 - Not shown.
1851 - Saw Mill.
1855, 1862 - Pond; S. Andrews Saw Mill.
1870, 1895 - Not shown.
1962 - Site of Old Mill.

Present Status: No visible trace of the early mill was seen but the peninsula of land is probably the remains of the old dam.

Relation to Proposed Reservoir: In pool (at proposed dam).

BIG RIVER RESERVOIR AREA

INDUSTRY



WEST GREENWICH

BURNT SAWMILL ROAD

SITE OF WHITFORDS/CAPWELL'S MILL AND DAM

(S)-IND-2

Previous Map #: None

Level of Significance: Important

Description: A stone and earth dam, with 20th-century concrete reinforcing, hold back the waters of the Carr River for the Capwell Mill Pond, formerly the site of several mills.

Significance: The dam marks the approximate site of an early mill, which was operated by a man named Whitford in the mid-19th century. Searles Capwell, a local entrepreneur, bought the site after the orginal mill burned (hence the name for the road). Capwell built a modest-sized structure, installed a used turbine and sawed pine shingles. The mill pond today bears his name. The mill was shut down every May 30th and started again on October 1st; it could not operate in the summer because the pond was drained to clean and replant cranberries and to mow bog hay to feed cattle.*

Map History: 1831 - Not shown
1855, 1862 - Whitford's Mill
1870 - S.C.
1895 - Saw Mill (pond shown)
1948 - Pond not shown.
1966 - (Capwell mill pond only shown).

Present Status: The dam appears to be well preserved and in good condition.

Relation to Proposal Reservoir: In pool.

*Source: Howard Barbour, who worked in the mill at one time.

WEST GREENWICH

CARR POND AREA

FORMER GRANITE QUARRIES

(S)-IND-3

Previous Map #: None

Level of Significance: Important

Description: Along and near the northern shores of Carr Pond are several large granite ledges which the sites of former quarrying are evident in numerous chisel marks and in piles or rock and excavations or depressions.

Significance: Several granite ledges were actively worked from the early to middle 19th century until about 1945 by members of the Tarbox family. The quarries furnished granite for some mills in the Pawtuxet Valley, for the courthouse in East Greenwich, and for church steps and curbing in East Greenwich and Warwick. In the early 20th century, three to four quarries were still active. John Tarbox, who carried on the business after his father, had a home near the quarries (now gone); the last of the line of stone cutters, his death in 1957 at the age of 81 marked the end of an era in the history of West Greenwich.

Map History: 1831-1862 - Not shown.
1870 - Granite Quarry.
1896 - Granite Quarry.
1948 - Ledges (northwest side of pond).
1966 - Ledge

Present Status: Abandoned and overgrown.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CONGDON MILL ROAD

SITE OF NICHOLS'/CONGDON'S MILLS

(S)-IND-4

Previous Map #: None

Level of Significance: Important

Description: South of the two bridges which span the Congdon River here is a large earthen dam, with a raceway or sluiceway, lined with stone, near the eastern end. Water flows through the opening and around the western end of the dam. North of the bridges are stone foundations and ruins.

Significance: This is one of several early industrial sites in the area. At one time there was a small community in the vicinity of the mill(s). There is little documentation of this site.

Map History:
1831 - Nichols Mills.
1855, 1862 - Congdons Mills.
1870 - Congdon and Tarbox Mill.
1895 - (No mills, but Wm. Kenyon nearby, on Sweet Sawmill Road).
1948 - Congdon's Mills.
1966 - Congdon's Mill Site.

Present Status: Except for a small area near the river just below the bridges, much of the former mill site appears to be undisturbed.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

HOPKINS HILL ROAD

SITE OF POTTER'S SAWMILL/HOPKINS & TARBOX SAW AND GRIST MILL

(S)-IND-5

Previous Map #: None

Level of Significance: Important

Description: Just below (west of) Hopkins Hill Road is a small area of stone foundations. They mark the site of several local mills which operated along the Carr River.

Significance: A mill, originally an up-and-down sawmill, was established here at an unknown date. It was probably in the Kettle family (the 1831 map identifies it as Kittes Mill). The Potters purchased the place during the Civil War; they raised the level of the dam and pond to provide more power and allow the wheel to be set up better. At this time, the old wooden water wheel was replaced by an iron wheel. The sawmill produced various kinds of lumber--shingles, barrel staves, box boards, and long lumber. The building also housed a planer, a lathe, and a gristmill. The latter operated into the early 20th century grinding corn. Sometime before 1935, the mill ceased to operate when portable sawmills, easily transportable from place to place, came into use. In 1935 the mill was destroyed by fire.

The mill was a continuing family operation, for the Tarbox, Hopkins, and Barbour families intermarried. Howard Barbour, who ran the stationary mill, spent his life cutting wood, in places as far afield as New Hampshire. His grandfather, after operating the mill a short time, went irto the coal business in West Warwick.*

This site is interesting and important. The vine-covered, picturesque ruins (stone work along the river) are a material reminder of a by-gone era when small, water-powered mills were an important part of life. The mill and the owners life habits changes and technological changes brought improvements in machinery and other aspects of manufacturing. At this site, an old, up-and-down, water-powered, wooden wheel was replaced by a metal turbine, and then the mill became obsolete with the use of steam-powered portable mills.

Map History: 1831 - Kittes Mills.
1855, 1862 - Shown on map.
1870 - S. Mill
1895 - Hopkins and Tarbox Sawmill.
1948 - Not shown.
1966 - Not shown.

Present Status: The structure is gone, but the foundations, or stone work ruins, are impressive and relatively well preserved.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

HOPKINS HILL ROAD

SITE OF GREENE'S MILL

(S)-IND-6

*Some personal descriptions and observations of the old mills and wood cutting from interviews with Howard Barbour, are presented in Lucinda Whitehill's unpublished manuscript, "Before the Flooding Waters," U.R.I., December, 1978. See Appendix E.

Previous Map #: None

Level of Significance: Contributing

Description: An earthen dam, long since breached, covered with vegetation and now part of the forest, marks the site a mill.

Significance: The mill at this site, said to be the first in the area, was built by Abel Greene, Nathanael Greene's brother. Nothing is known about the mill or its workings.

Map History: Not shown on any maps.

Present Status: The earthen dam is still plainly visible.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF CALVIN HOPKINS BLACKSMITH SHOP (SEE (S)-CMT-4)

(S)-IND-7

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF MILL

(S)-IND-8

Previous Map #: C-9

Level of Significance: Important

Description: At the north end of Rathbun Pond, a part of the Congdon River system, is an earth and rock dam, a stone-lined raceway, and the foundations of a structure, probably a mill.

Significance: One of a series of small mills along the river; Hopkins Mills was a short distance upstream and Congdon's Mills was downstream.

Map History: The mill is not shown on any maps.

Present Status: The dam (breached), raceway, and foundation are well-preserved.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

FORMER LACE MILL

IND-9

Previous Map #: None

Level of Significance: Contributing

Description: A 1-story, plain cinder-block structure, end to road.

Significance: This structure was built as a lace factory sometime after World War II by John Potter, and was one of three lace mills operating in town in 1960. Two, including this one, were condemned for the reservoir. It is now used as a pottery manufactory.

Map History: 1948 - Not shown.
1966 - Not identified

Present Status: Still being used for industrial purposes.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NOOSENECK HILL ROAD

SITE OF HOPKINS MILL (c. 1867)

(S)-IND-10

Previous Map #: C-14

Level of Significance: Contributing

Description: Originally a 1-story frame mill with a gable roof, a continuous clerestory monitor and stair and water closet towers.

Significance: The Hopkins Mill, built about 1867 by David Hopkins, was a late example of wooden mill construction. In 1881 David Hopkins died, but the mill was run by his family, including son Edwin W., who manufactured braided sash cord, warp, and twine in the latter part of the nineteenth century. It was the last textile mill, of about a half dozen, which lined the banks of the river in Nooseneck. During the late nineteenth century there were sporadic attempts to reintroduce manufacturing, but eventually it ceased to function as a place of manufacture. About 1906 the machinery was removed from the mill, and Henry Lippitt, who owned it from about 1915 to 1931, converted it to a cattle barn; it was known as the Lippitt Barn. Between about 1931 and 1968, when it was condemned for the reservoir, William Russell Halliwell used it for storage. It was entered in the National Register of Historic Places on January 11, 1974, was documented by the Historic American Building Survey in May, 1971, and is included in the Historic American Engineering Record Survey. In September, 1978, it was destroyed by the Water Supply Board after repeated attempts to find an agency to move it failed, and it has been removed from the Register.

Map History: 1870 - Hopkins Mill
1895 - L. R. & E. W. Hopkins, Twine Factory
1948 - Not identified
1966 - Not identified

Present Status: The former factory and barn was destroyed and the site leveled; stone foundations at the southeast corner of the former mill are the remains of an earlier mill or picker house. There are also remains of a raceway which served this structure.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

SITE OF GRIST MILL

(S)-IND-11

(SEE (S)-CML-1)

WEST GREENWICH

NOOSENECK HILL ROAD

SITE OF NOOSENECK FACTORIES

(S)-IND-12

Previous Map #: None

Level of Significance: Recommended for the National Register.

Significance: Sometime around 1789, John and Caleb Hall operated a blacksmith shop and a water-powered trip hammer along the Nooseneck River, manufacturing tools for farmers, and machinery, nails, and other iron work used in the neighborhood. Not long after the beginning of Rhode Island's Industrial Revolution, (shortly after 1800) local entrepreneurs built a series of mills along the banks of the river. The Yard Mill, west of Route I-95 (and just out of the reservoir area), dates from about 1810. The Hoxsie Mill was built about 1812, and in about 1810 a mill was built which became the forerunner of the Stone Mill. At least one more mill was built, about 1838, near the road. The history of the mills is very complex; change of ownership was relatively frequent, and some of the mills were destroyed and replaced by others. Local histories and accounts of early life and mill activities are invariably vague and confusing. Most of the mills were active in the early and middle part of the century, but by the end of the century they were all gone. They were instrumental in transforming the Nooseneck area from a farming region to a locally important settlement and town center; for many years, until the very recent past, Nooseneck was the "capital" of West Greenwich. The trenches and ditches used to divert and control the river's waters, and the foundations of the several dam and structures still line the river banks today. They are both a challenge to an inquisitive mind and comprise a picturesque scene. The concentration of several industrial sites along a relatively short stretch of river, dating from the late eighteenth century, make this one of the most important historic archeological sites of industrial Rhode Island. Its visible material remains, above the ground, are a link with the town's most important industrial activity. Accordingly, the entire area between Nooseneck Hill Road and I-95 is defined as a historic archeological district and recommended for the National Register.

Map History: 1831 - Nooseneck Factories
1855, 1862 - Hoxie's Mill, Mattesons Mill
1870 - Cotton Mill, R. K. Edwards
1895 - Nothing shown.
1948 - Not noted.
1966 - Not identified.

Present Status: Trenches, stone foundations, and remains of dams are well preserved.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

SWEET SAWMILL ROAD

SITE OF SWEET SAWMILL

(S)-IND-13

Previous Map #: None

Level of Significance: Important

Description: The site of the sawmill is indicated by a rock and earth dam at the end of the pond and some foundations below it.

Significance: The sawmill on the Sweet Place was originally an up-and-down sawmill, one of the earliest types. Later there was a portable steam mill which operated until the early twentieth century.

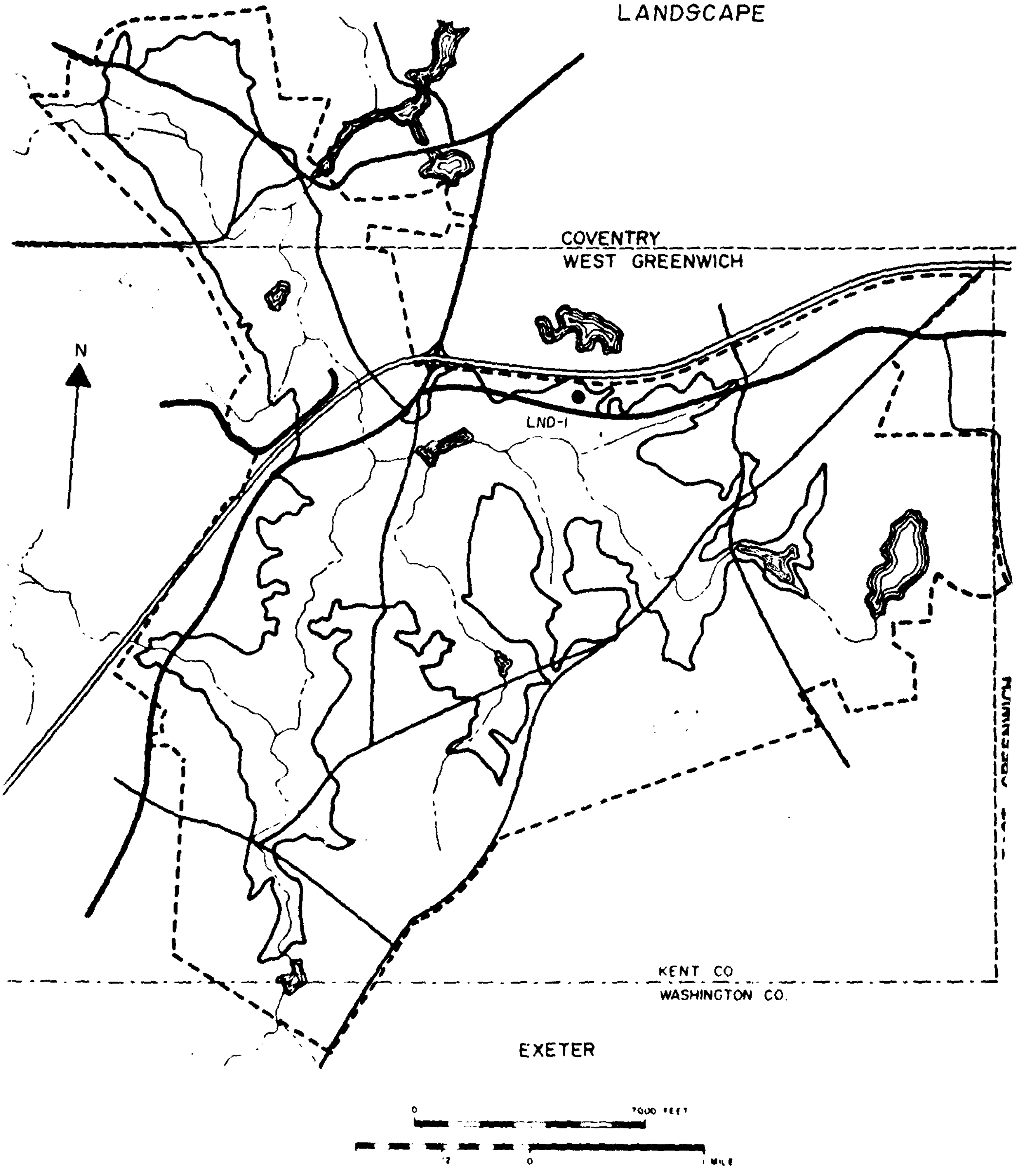
Map History: 1831-1962 - Not shown.
1870 - S. Mill.
1895 - Old Saw Mill.

1948 - (Sweet Pond).
1966 - Saw Mill Site; Sweet Pond.

Present Status: Dam and stone foundations; relatively undisturbed in a remote area.

Relation to Proposed Reservoir: In pool.

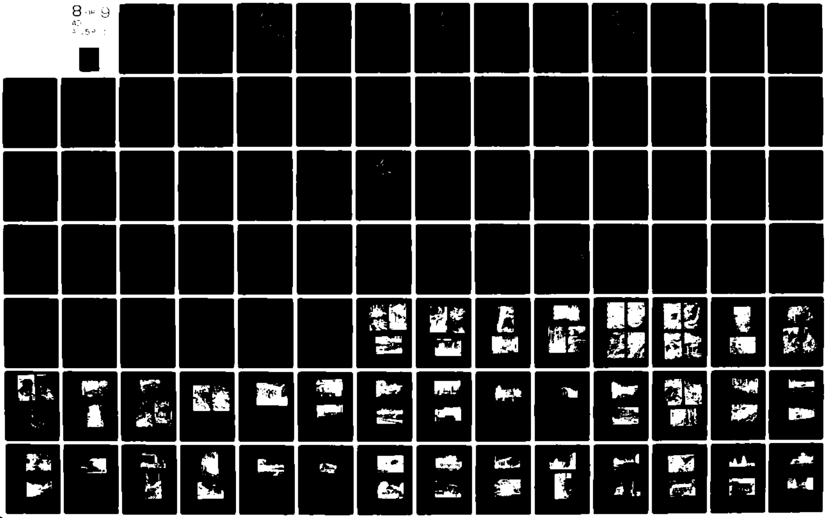
BIG RIVER RESERVOIR AREA
LANDSCAPE



AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED NL

8 OF 9



LANDSCAPE

WEST GREENWICH

DIVISION STREET

THE DESERT OF RHODE ISLAND

LND-1

Previous Map #: None

Level of Significance: Contributing

Description: A relatively large desert-like tract of land, with sand dunes and a hilly topography devoid of vegetation.

Significance: This area's desert-like landscape is unique in interior Rhode Island. The reason for the desert is not known exactly. One theory is that windblown sands probably blew up out of the Mishnock depression and the area grew as the sand enroached on the surrounding vegetation. Sand has been removed continuously during this century, at least, for industrial and other purposes, and the area has always been frequented by vehicles, including today's dune buggies, four-wheel drive vehicles, and so on, so that in large part the desert is a man-made phenomenon and not entirely created by natural agencies.

Map History: 1948 - Sand Bank.
1966 - Sand Bank.

Present Status: Used by various vehicles, continues to exist.

Relation to Proposed Reservoir: In pool.

PUBLIC WELFARE

WEST GREENWICH

CARR POND AREA

FORMER GATEHOUSE

PWL-1

Previous Map #: None

Level of Significance: Contributing

Description: A relatively small, 1-story, hip-roofed stone structure at the outlet to Carr Pond.

Significance: This structure, and several others, was erected in the early 20th century as part of a water system supplying water to several Pawtuxet Valley communities. After the pond became polluted, it was not used. The former gatehouse here controlled the flow (amount) of water.

Map History: 1948 - Not identified.
1966 - Stone Gatehouse

Present Status: In poor condition; vandalized.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CARR POND AREA

WATER TRENCH

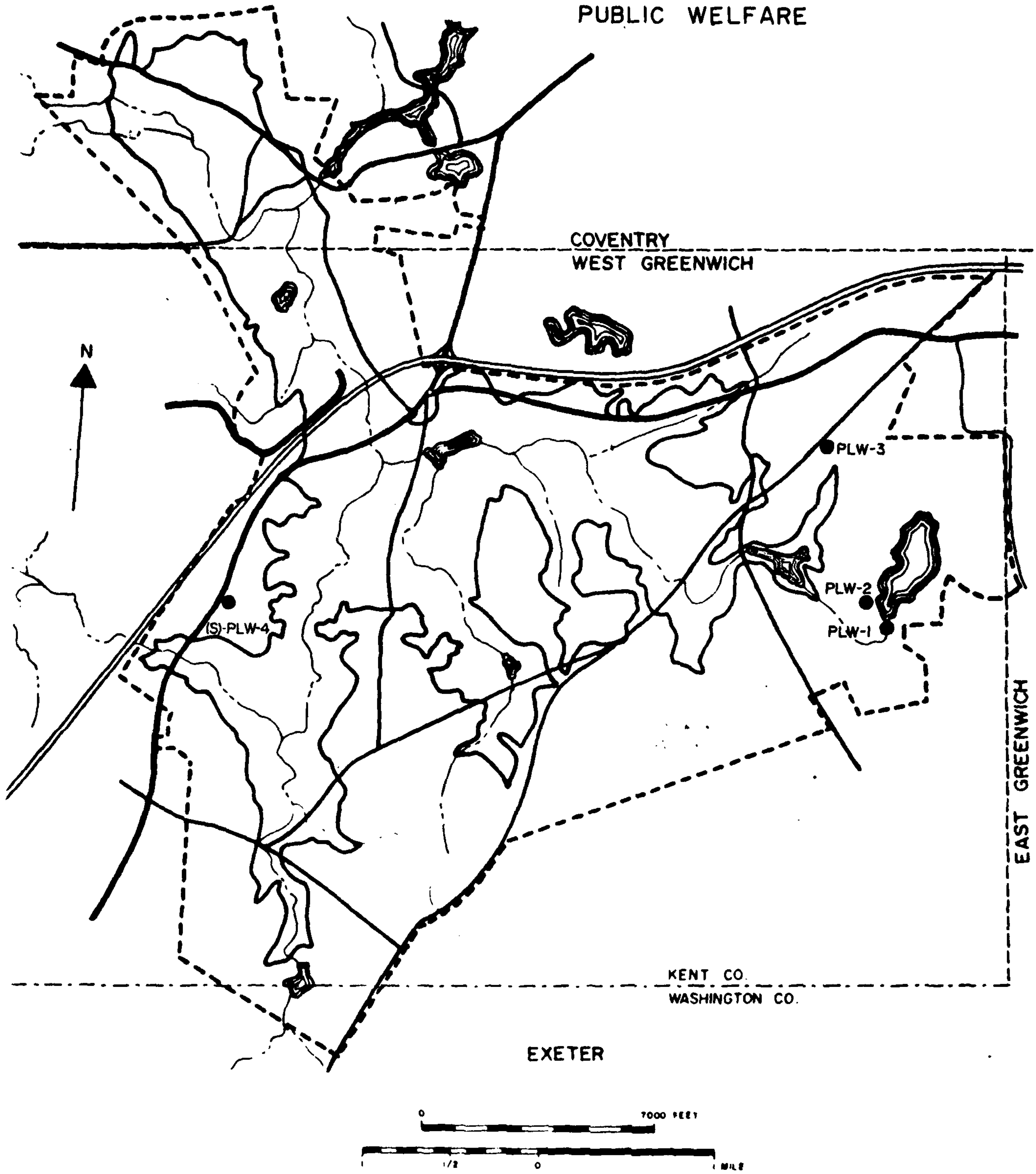
PWL-2

Previous Map #: None

Level of Significance: Contributing

BIG RIVER RESERVOIR AREA

PUBLIC WELFARE



Description: A V-shaped depression, or trench, about ten to twelve feet deep, which carried the water from Carr Pond in a gravity feed to several communities in the Pawtuxet Valley.

Map History: 1966 - Grand Canyon.

Present Status: Still exists.

Relation to Proposed Reservoir: In reservoir, above pool.

WEST GREENWICH

NEW LONDON TURNPIKE

FORMER WATER GAUGING STATION

PWL-3

Previous Map #: None

Level of Significance: Contributing

Description: A small, 1-story, brick, hip-roofed, early 20th-century structure, with a concrete floor and a depression with a large pipe in the bottom.

Significance: Located several miles from Carr Pond, this structure, near the New London Turnpike, was originally used as a water gauging station along the line of the water supply system leading from the pond to the Pawtuxet Valley.

Map History: 1948 - Shown on map.
1966 - Pump House.

Present Status: Abandoned and deteriorating.

Relation to Propsed Reservoir: In watershed, above pool.

WEST GREENWICH

TOWN HALL ROAD

SITE OF WEST GREENWICH TOWN HALL

PWL-4

Previous Map #: C-16

Level of Significance: Contributing

Description: A leveled site marks the site of $1\frac{1}{2}$-story frame early 20th-century structure which was a town hall.

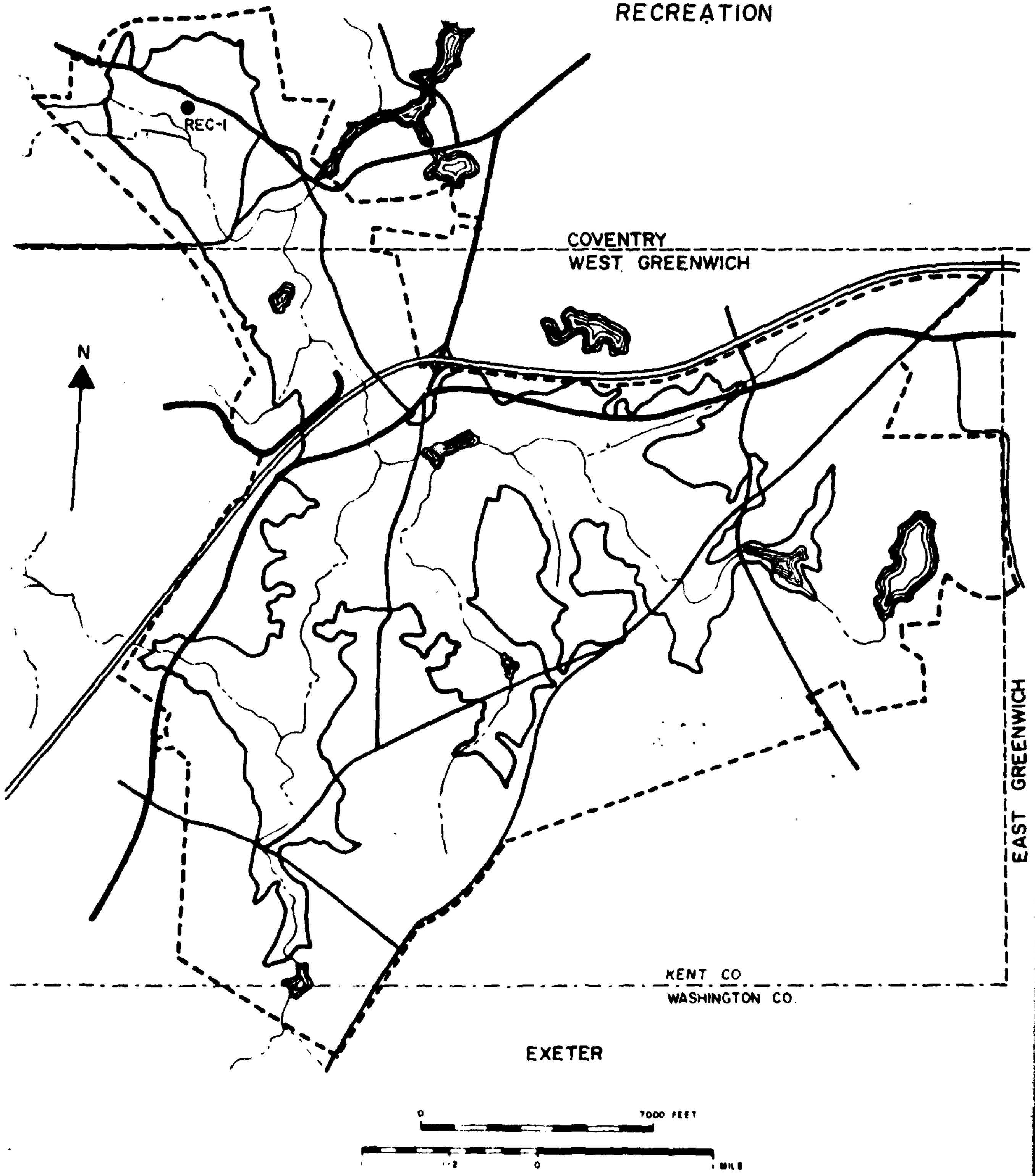
Significance: The town hall, which stood here from 1937 to 1978, was the first town hall in West Greenwich. It served as a classroom and center of official town business and other public uses until 1970, when a new town house was opened on Victory Highway. This structure was moved in 1978 to a site behind an elementary school on Nooseneck Hill Road.

Map History: 1948 - Town Hall
1966 - Town Hall

Present Status: Revoved from site.

Relation to Proposed Reservoir: In reservoir, above pool.

BIG RIVER RESERVOIR AREA
RECREATION



RECREATION

COVENTRY

HARKNEY HILL ROAD

COVENTRY PINES COUNTRY CLUB (1951-1959)

REC-1

Previous Map #: None

Level of Significance: Contributing

Description: A 9-hole golf course covering a 65-acre landscaped tract, laid out and developed on a slightly rolling landscape along Harkney Hill Road.

Significance: This course, opened to the public in 1959, is typical of many others in Rhode Island. Once farmland, the change in use of the land reflects changing societal values.

Map History: 1962 - Coventry Pines Country Club

Present Status: Still operated as a golf course.

Relation to Proposed Reservoir: In pool.

RELIGION

WEST GREENWICH

NOOSENECK HILL ROAD

SITE OF NOOSENECK BAPTIST CHURCH

REL-1

Previous Map #: None

Level of Significance: Contributing

Description: The church was a 1-story frame structure with a small belfry, described in 1899 as "the common type of church that sites on so many country hills in the State."*

Significance: The Nooseneck Baptist Church, built shortly after 1890 in Nooseneck Hollow, replaced the old Union Meeting House which was built about 1810 and which stood atop Nooseneck Hill until destroyed by fire in 1890. The church in the hollow, after condemned by the reservoir project in 1966, was moved to a new site on Victory Highway on November 20, 1971.

Map History: 1895 - Baptist Church
1948, 1966 - Nooseneck Baptist Church

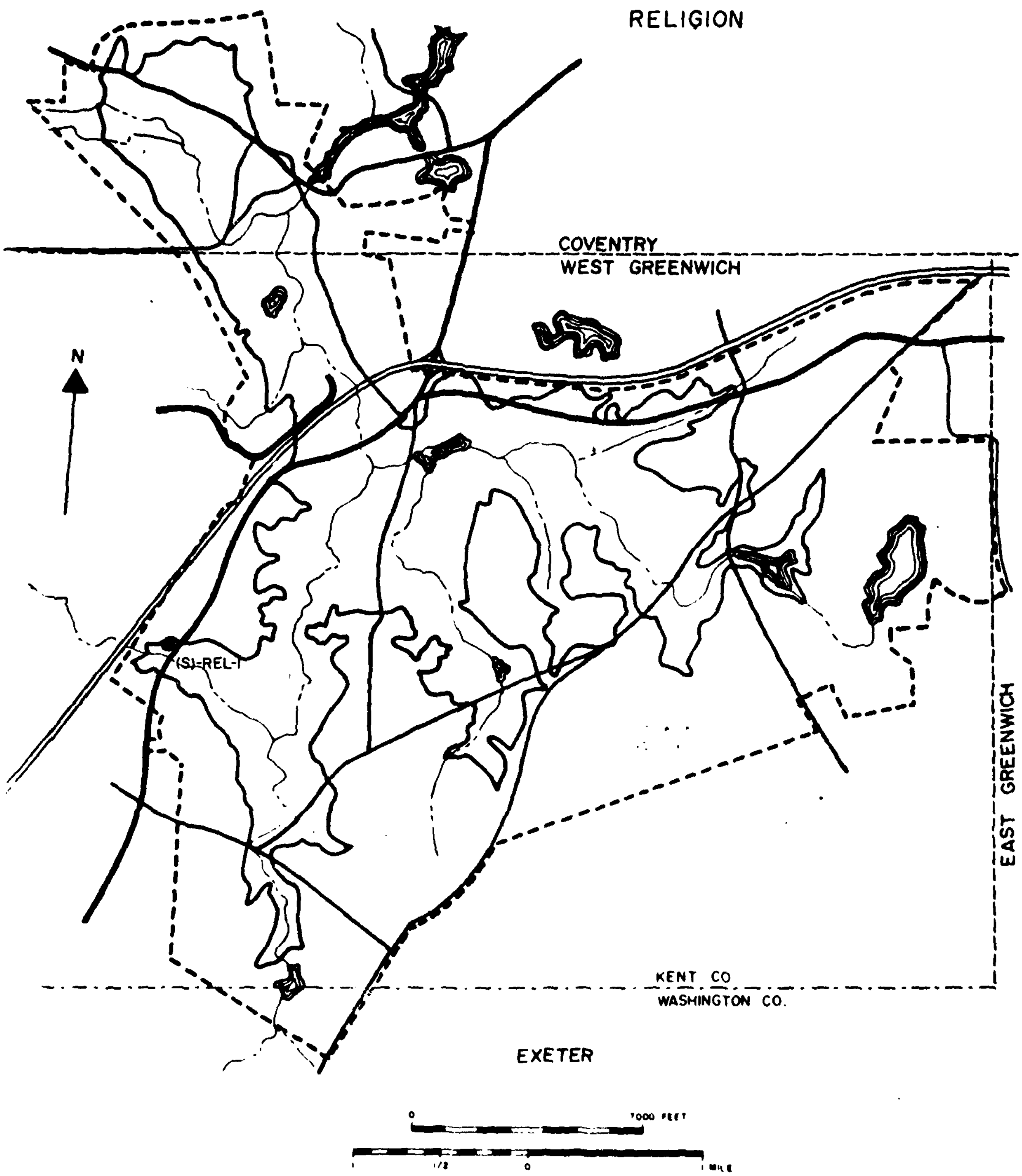
Present Status: Foundations only.

Relation to Proposed Reservoir: In pool.

* "Noose Neck Hill," Providence Journal, June 25, 1899.

BIG RIVER RESERVOIR AREA

RELIGION



RESIDENTIAL

COVENTRY

ARROWHEAD ROAD

SUMMER COMMUNITY (MID 20th-CENTURY)

RES-1

Previous Map #: None

Level of Significance: Contributing

Description: A c. 1940s summer colony of about eighteen cottages near the Big River where it widens out to become part of the Flat River Reservoir.

Significance: This small group of summer cottages is typical of the development along the shores of several other lakes and reservoirs in the Coventry-West Greenwich area shortly before, and after World War II.

Map History: 1962, 1966 - Arrowhead Road (about 18 cottages/buildings).

Present Status: Some homes converted to year-round use.

Relation to Proposed Reservoir: In pool.

COVENTRY

HARKNEY HILL ROAD

THEODORE ANDREWS PLACE (EARLY 20th-CENTURY)

RES-2

Previous Map #: None

Level of Significance: Contributing

Description: An early 20th-century, 1½-story dwelling, with a small, brick, center chimney and several additions. Around it are several outbuildings, including a barn, shed and privy, and a small apple orchard and cleared fields. The complex comprises an interesting farm group in a pleasant setting along the Big River, which is several hundred feet away.

Significance: Interesting as a small, early 20th-century farm complex, a rural-agrarian survivor preserved amidst rapidly expanding suburbanization.

Map History: 1962 - Not shown.
1966 - Not identified.

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

COVENTRY

HARKNEY HILL ROAD

HOUSE (EARLY 19th-CENTURY)

RES-3

Previous Map #: None

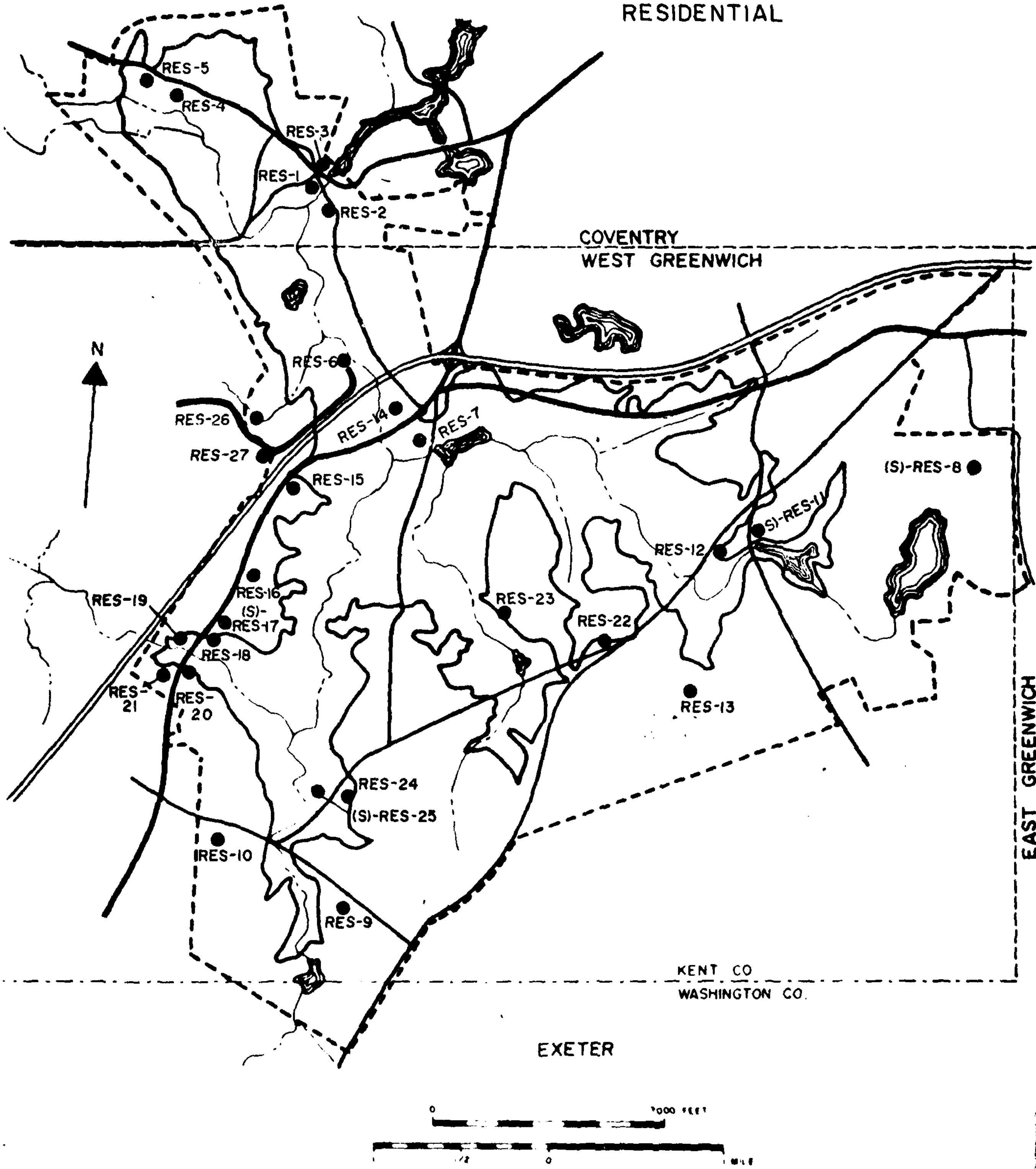
Level of Significance: Contributing

Description: A 1½-story structure, with a small, central, brick chimney, central entry in a 5-bay facade, and an ell with a chimney at the right side, rear. There are several small outbuildings at the rear and a garage at the left side.

Significance: A typical vernacular country dwelling.

BIG RIVER RESERVOIR AREA

RESIDENTIAL



Map History: 1831 - Shown on map.
1855 - A. Sweet
1862 - J. Sweet
1870 - H. Phillips
1895 - H. Phillips (+ outbuilding).
1962, 1966 - J. J. Murray

Present Status: In good condition.

Relation to Proposed Reservoirs: At dam site.

COVENTRY

HARKNEY HILL ROAD

STEPHEN JOHNSON HOUSE/JUDGE RATHBUN FARM (1838).

RES-4

Previous Map #: C-2

Level of Significance: Important

Description: A 2½-story, Greek Revival style structure, with a large off-center chimney, a porticoed off-center entry with sidelights in a five-bay facade across the front, a full 1-story portico across the east end and a large wing at the rear.

Significance: Now the focal point for the Coventry Pines Country Club, the house was probably built by Stephen Johnson. Later, it was owned and occupied by Judge Elmer J. Rathbun. A locally prominent man, who used his property as a barn, he moved a barn here from Mount Vernon in Foster. In 1947 the farm was purchased by Leroy Anderson, who ran it as a chicken farm, then held barbeques for a while. In 1957 Anderson began developing 65 of his 180 acres as a golf course; the 9-hole course was opened to the public in 1959.

Map History: 1831 - Not shown.
1855, 1862 - Shown on map.
1870 - S. Johnson.
1895 - Deserted.
1962, 1966 - Anderson Farm.

Present Status: In very good condition.

Relation to Proposed Reservoir: In pool.

COVENTRY

HARKNEY HILL ROAD

G. W. GREENE HOUSE (MID 19th-CENTURY)

RES-5

Previous Map #: C-3

Level of Significance: Important

Description: A 1½-story, Greek Revival structure with a small, brick, center chimney; central entry in a 5-bay facade; and a 2-story wing at the left side. There is a full basement on the street side. A 2-story Late Victorian (Second Empire) structure at the rear was destroyed in 1978.

Significance: A relatively unaltered example of a plain Greek Revival country house. According to map histories, it was used as a store in the early and mid-19th century. There is no explanation for the presence of the rather urbane Second Empire structure which stood at the rear of the house, although it may have been moved here when the Flat River Reservoir was created.

Map History: 1831 -?
1851 - G. W. Greene, Store.
1855 - G. W. Greene.
1862 - G. W. Greene, Store.

1895 - B. B. Brown
1962 - W. Cole

Present Status: In fair-good condition.

Relation to Reservoir: In pool.

WEST GREENWICH

BIG RIVER ROAD

SUMMER CABINS (MID 20th-CENTURY)

RES-6

Previous Map #: None

Level of Significance: Contributing

Description: Three small summer cottages.

Significance: These three summer cottages are typical of many in the area, built when the recreation potential of the river began to be more fully realized in the mid-20th century.

Map History: Not shown on any maps.

Present Status: One is in good condition, the other two have been vandalized.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

BURNT SAWMILL ROAD

MATTESON HOUSE (c. 1720)

RES-7

Previous Map #: C-5

Level of Significance: Important

Description: A 1½-story, stuccoed, wood-frame gambrel-roof structure with a large, brick, center chimney and entry in a 3-bay facade in an open porch across the front.

Significance: An early house, the former residence of one of the locally important families, the Mattesons, who had their family burying ground nearby, atop a small hill (See HCM-3).

Map History: 1831 - Not shown.
1855, 1862 - Shown on map.
1870 - Miss S. Matteson
1895 - Only an outbuilding shown.
1948 - A. Rabba.
1966 - J. Rantman; Old Matteson Farm.

Present Status: In fair-good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

CARR POND ROAD

SITE OF CAPTAIN DAVID TARBOX II HOUSE

RES-8

Previous Map #: None

Level of Significance: Contributing

Description: Several cellar holes and stone foundations along a cart path off Carr Pond Road mark the remains of the Captain David Tarbox II House.

Significance: Although gone, remains of the house and its supporting outbuildings are relatively well preserved and present interesting ruins. The Tarboxes were an important early family in this part of town, on the East Greenwich-West Greenwich town line. The area was known as Tarbox Corners. Captain David Tarbox II, who lived here, played a part in Rhode Island's Dorr War of the 1840s. The place was also the home of an active family; some of the Tarbox family operated the nearby granite quarries at Carr Pond. There is a well preserved Tarbox cemetery nearby associated with this property. (See HCM-6).

Map History: 1831-1862 - Not shown.
1870 - D. Tarbox 2nd.
1895 - [illegible] 2nd Est.
1948 - Not indicated.
1965 - Site shown.

Present Status: Remains as relatively undisturbed.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CONGDON MILL ROAD

JOSEPH LEMAIR HOUSE (1935)

REC-2

Previous Map #: None

Level of Significance: Contributing

Description: A 2½-story, wood-shingle structure with a small brick chimney at the ridge and several appendages. There are fields around the house.

Significance: This early 20th-century house occupies the site of an early house, and a store which operated in the mid-19th century. The present house was built by Joseph T. Lemaire, a Woonsocket native, from timber on 200 acres of land he purchased here in 1927 when he moved to West Greenwich. He also built a barn, chicken coop, garage, greenhouse, and a small building which housed his sawmill. The vernacular 20th century house is a good example of its type and the farm symbolizes the efforts of a modern-day pioneer. There is a small burying ground on the property containing one grave (See HCM-9).

Map History: 1855, 1862 - S. Hopkins, Store (on site).
1870 - C. Whitford; Old Store.
1895 - C. Whitford; Deserted.
1948, 1966 - J. Lemaire

Present Status: In good condition.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

CONGDON MILL ROAD

HOUSE (18th-CENTURY)

RES-10

Previous Map #: None

Level of Significance: Contributing

Description: A 1½-story, gambrel-roof, wood-shingle structure with an interior brick chimney and an exterior cinder-block chimney; a shed-roof dormer across the front; and a vernacular central doorway with a plain portico.

Significance: A typical early house, with later additions and alterations.

Map History: 18[illegible] Not shown
18[illegible] Shown on [illegible]
18[illegible] [illegible]. Clevel[illegible]
18[illegible] [illegible]. G. Ni[illegible]
189[illegible] [illegible]. G. Alle[illegible]
1948 [illegible] F. Sp[illegible]
1966 [illegible]. Andrew[illegible]

Present Status: In good condition.

Relation to Proposed [illegible]: In watershed above pond.

WEST GREENWICH

HOPKINS HILL ROAD

SITE OF TARBOX FAR[illegible]

(S)-RES-11

Previous Map #: None

Level of Significance: Contributing

Description: Near the pond are several foundations, one of an 18th century house, the other of a barn. They stood here until the property was condemned for the reservoir.

Significance: The nearby pond and river were one of the early industrial sites in West Greenwich, and the old house which stood here--a typical, large, center-chimney, 2½-story dwelling--was probably associated with the mill. The house site is interesting as a ruin and presents potential as an historic archeological site.

Map History: 1831 - Kittes Mill[illegible]
1855-1895 - Not shown
1948 - Tarbox Farm
1966 - Old Potter Farm (house and outbuilding); Potter Sawmill Pond.

Present Status: Ruins, undisturbed.

Relation to Proposed Reservoir: In pool (at edge).

WEST GREENWICH

NEW LONDON TURNPIKE

HOUSE (EARLY 20th-CENTURY)

RES-12

Previous Map #: None

Level of Significance: Contributing

Description: A 1½-story, gambrel-roof, c. 20th-century house, with several outbuildings, surrounded by fields.

Significance: This house occupies the site of an earlier dwelling (see map history). It has a fine setting, with fields around.

Map History: 1855, 1862 - ?
1870 - Rathbun (on site).
1895 - Rob't. Rathbun (on site).
1948 - F. O. Eerolb.
1966 - J. Duffy.

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF PERRY HOPKINS HOUSE

(S)-RES-13

Previous Map #: None

Level of Significance: Contributing

Description: A cellar hole and the remains of an outbuilding mark the site of a farm. Nearby are some nursery planting set out several decades ago by the last occupant, before the property was condemned.

Significance: One of several well-preserved foundations in the Big River area, this one marks the site of a former farm. It burned in 1931, during an extensive forest fire; it was later rebuilt and used as a nursery business. A large field nearby is planted to yews and other nursery stock.

Map History: 1831-1895 - Now shown on maps.
1948 - Olsson Farm.
1966 - Hideaway Farm.

Present Status: Ruins, relatively undisturbed.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NOOSENECK HILL ROAD

WILLIAM MATTESON HOUSE (1810-1819)

RES-14

Previous Map #: None

Level of Significance: Important

Description: A 1½-story, wood-shingle structure, with two brick chimneys. Originally with a central entry in a 5-bay facade, a 2-bay addition was put on the right side later.

Significance: A typical vernacular structure of the rural areas of Rhode Island, this house was built by William Matteson, who was a farmer and sawmill owner. Later, the house went to his son-in-law, Daniel Greene, then to Searles Capwell, a local entrepreneur, who owned the mill on Burnt Sawmill Road (see (S)-IND-2). Soon after, in 1887, the house went to Alanson M. Albro, who served as a state representative, and the house has been in the Albro family since. About 1942 it stopped being used as a farm.

Map History: 1831 - Not shown.
1855, 1862-1870 - S. Greene.
1895 - A. M. Albro.
1948 - John Albro.
1966 - J. Albro.

Present Status: In good condition; somewhat altered from original state.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

LEON D. ANDREWS HOUSE (EARLY 20th-CENTURY)

RES-15

Previous Map #: None

Level of Significance: Contributing

Description: A 1½-story wood-shingled, "Colonial" style structure with a small, brick chimney, central entry in a 5-bay facade; gabled dormers in front; and a small wing at the right side.

Significance: A typical vernacular "Cape" of the early 20th century, this one was occupied by former state senator Leon D. Andrews, who had a turkey farm here in the 1950s and 1960s.

Map History: 1948 - L. D. Andrews, Jr. Andrew Turkey Farm.
1966 - Sen. L. Andrews

Present Status: In good condition.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NOOSENECK HILL ROAD

JOHN MATTESON HOUSE (c. 1720)

RES-16

Previous Map #: None

Level of Significance: Important

Description: A heavily altered early 18th-century structure, covered with tar paper, it has a tall brick chimney.

Significance: This house was probably built by John Matteson, who came to West Greenwich as one of the pioneer settlers. The house, and much land in the area, were in the Matteson family for a long time, and some Mattesons, most notably Hall Matteson, were heavily involved in local industry which resulted in the development of the community at Nooseneck. The family burying ground, just north of the house (see HCM-26) contains the graves of most of the Matteson family members who resided here. Although greatly altered on the interior and exterior, some of the interior framing shows the signs of early house construction, including chamfered girts, posts, and a summer beam. It is probably the oldest extant house in the reservoir area. In 1951 another house was built nearby, and today the John Matteson House is not used as a residence.

Map History: 1831 Not shown.
1855, 1862 - B. Shippee.
1870 - R. Tillinghast.
1895 - P. H. Shippee.
1948 - C. L. Strada
1966 - Old Matteson House.

Present Status: Not used as a residence, but it appears to be in relatively good condition.

Relation to Proposed Reservoir: In watershed, above pool.

WEST GREENWICH

NOOSENECK HILL ROAD

SITE OF HOUSE (c. 1835)

(S)-RES-17

Previous Map #: C-12

Level of Significance: Contributing

Description: The house which stood here was a fine, small, Greek Revival, 1½-story house, which had a full basement at the rear, a small brick chimney near the center, and a central entry in its 5-bay facade. It was destroyed in September 1978.

Significance: This structure was a good example of its style and part of the Nooseneck settlement for about a century and a half.

Map History: 1831 - Not shown.
1855 - Shown on map.
1862 - C. Tripp.
1870 - Mrs. A. Brown
1895 - Ambrose Brown
1948, 1966 - R. Martin

Present Status: Leveled site.

Relation to Proposed Reservoir: In watershed, near edge of pool.

WEST GREENWICH

NOOSENECK HILL ROAD

DAVID HOPKINS HOUSE (c. 1835)

RES-18

Previous Map #: C-13

Level of Significance: Important

Description: A 1½-story clapboarded structure, with a central entry in a 5-bay facade and a wing at the right side. It is largely screened from view by a row of evergreen trees.

Significance: The house, which stands near the 1867 Hopkins Mill, has been closely associated with mill activities in Nooseneck. David Hopkins, who owned the mill and this house, also owned a number of other houses in the village.

Map History: 1831 - Not shown.
1855 - Shown on map.
1862, 1870 - D. Hopkins.
1895 - L. R. & E. W. Hopkins
1948 - J. H. Potter.
1966 - L. Roberts.

Present Status: In good condition.

Relation to Proposed Reservoirs: In pool.

WEST GREENWICH

MOOSENECK HILL ROAD

HOPKINS-SWEET HOUSE (1827)

RES-19

Previous Map #: None

Level of Significance: Important

Description: A 2½-story clapboard house, with a brick center chimney, central entry with a Victorian bracketed hood in a 5-bay facade.

Significance: This house was probably built by Robert Hall in 1827; he also built a gristmill later used as a store (Fish's Store). Later, it was owned by William N. Sweet, whose wife was the daughter of Judge Jonathan Nichols, town clerk of West Greenwich for twenty years. William Sweet became a teacher in the town, and also served for many years as town clerk before moving to the village of Washington. The house was used as the town clerk's office during Sweet's time in office.

Map History:
1831 - ?
1855, 1862 - L. D. Hopkins
1870 - W. N. Sweet
1895 - WM. N. Sweet, Town Clerk's Office
1948 - J. Potter, Jr., & G. Green
1966 - Old Vaughn Farm, Hill?

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HOUSE (c. 1820)

RES-20

Previous Map #: C-15

Level of Significance: Important

Description: A 1½-story, early 19th-century structure, end to road, with an off-center bracketed doorway in a 5-bay facade and a 1-story ell at the west end fronted by an open porch.

Significance: Essentially a Federal house with Greek Revivial modifications, it originally stood near the 1867 Hopkins Mill and was moved to this site about forty years ago when the highway was widened.

Map History: Location at original site uncertain.

1948 - T. Collins
1966 - A. Palmgren

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

HOUSE (LATE 18th-CENTURY)

RES-21

Previous Map #: None

Level of Significance: Important

Description: A [illegible]-story structure with a brick center chimney and an off-center entry in an [illegible] symmetrical [illegible] bay facade.

Sign. [illegible]: A [illegible], early home type, it was the residence of families asso[illegible] [illegible] or industrial [illegible] Moosenack [illegible] the Fish family.

Map [illegible]: [illegible]
[illegible]
1[illegible]0 [illegible]
1[illegible] [illegible]
1[illegible]3 [illegible] General Store.
1[illegible]

[illegible]

[illegible] shed, near [illegible]

[illegible]

[illegible] ROAD

HOUSE [illegible] 20th [illegible]

RES-[illegible]

[illegible]

[illegible] Significance [illegible]

Description: A [illegible] structure, with a [illegible], and several [illegible]

Sign. [illegible]: It is [illegible] structures of the [illegible] reservoir area. It is [illegible] structure in an area which [illegible] residences and a hotel.

Map History: 1[illegible] 13, 19[illegible] [illegible]

Present Status: In good condition.

Relation to Proposed Reservoir: In watershed, near pool.

WEST GREENWICH

SWEET SAWMILL ROAD

SITE OF SWEET FARM

(S)-RES-23

Previous Map #: None

Level of Significance: Important

Description: Foundations, cellar holes, and other stone remains mark the site of the Sweet Farm, one of the pioneer homesteads of West Greenwich. The house burned in 1895 and was never rebuilt. Associated with the farm are the nearby family burying grounds (HCM-32) and the Sweet Sawmill (S-IND-13). The remains of the farm, well preserved and relatively intact, offer potential for archeological investigation.

Map History: 1831 - Not shown.
1855, 1862 - W. R. Sweet.
1870 - E. O. Sweet.
1895, 1948, 1966 - Not shown.

Present Status: Well preserved wall, foundations and cellar holes.

Relation to Proposed Reservoir: In watershed, near pool.

WEST GREENWICH

SWEET SAWMILL ROAD

T. V. WHITMAN FARM (LATE 19th-CENTURY)

RES-24

Previous Map #: None

Level of Significance: Important

Description: A 1½-story residence, with two, small, brick chimneys; gabled dormers; and a central entry in what was originally a 5-bay facade. It is the center of what was once a farm. There are several outbuildings, including a barn and chicken house. To the south is a large field.

Significance: A small, and late farm in the reservoir area, it still contains several outbuildings characteristic of its period.

Map History: 1895 - T. W. Whitman
1948, 1966 - A. Pynnonen

Present Status: In good condition.

Relation to Proposed Reservoir: At edge of, or in pool.

WEST GREENWICH

SWEET SAWMILL ROAD

SITE OF THE BROWN FARM

(S)-RES-25

Previous Map #: None

Level of Significance: Contributing

Description: A cellar hole, a collection of small outbuildings, the charred remains of a dairy barn and a large field mark the site of an early farm.

Significance: This early farm site still contains a relatively large area of open space in the form of open fields, one of the few open areas in the reservoir area, most of which has reverted to forest.

Map History: 1831 - Not shown.
1855, 1862 - Shown on map.
1870, 1895 - Mrs. A. Brown.
1948 - Not shown.
1966 - L. Albro Farm.

Present Status: Abandoned and deteriorating outbuildings.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

WEAVER HILL ROAD

AMOS SWEET HOUSE (c. 1795)

RES-26

Previous Map #: None

Level of Significance: Important

Description: A 2½-story structure with a large, brick, center chimney and a central entry with a Victorian bracketed hood in a 5-bay facade.

Significance: A typical, large, center-chimney Rhode Island house.

Map History: 1831 - ?
1855, 1862 - Shown on map.
1870, 1895 - A. Sweet.

1948 - T. Albro, owner.
1966 - E. Bugnet?

Present Status: In poor condition; neglected.

Relation to Proposed Reservoir: On watershed, above pool.

WEST GREENWICH

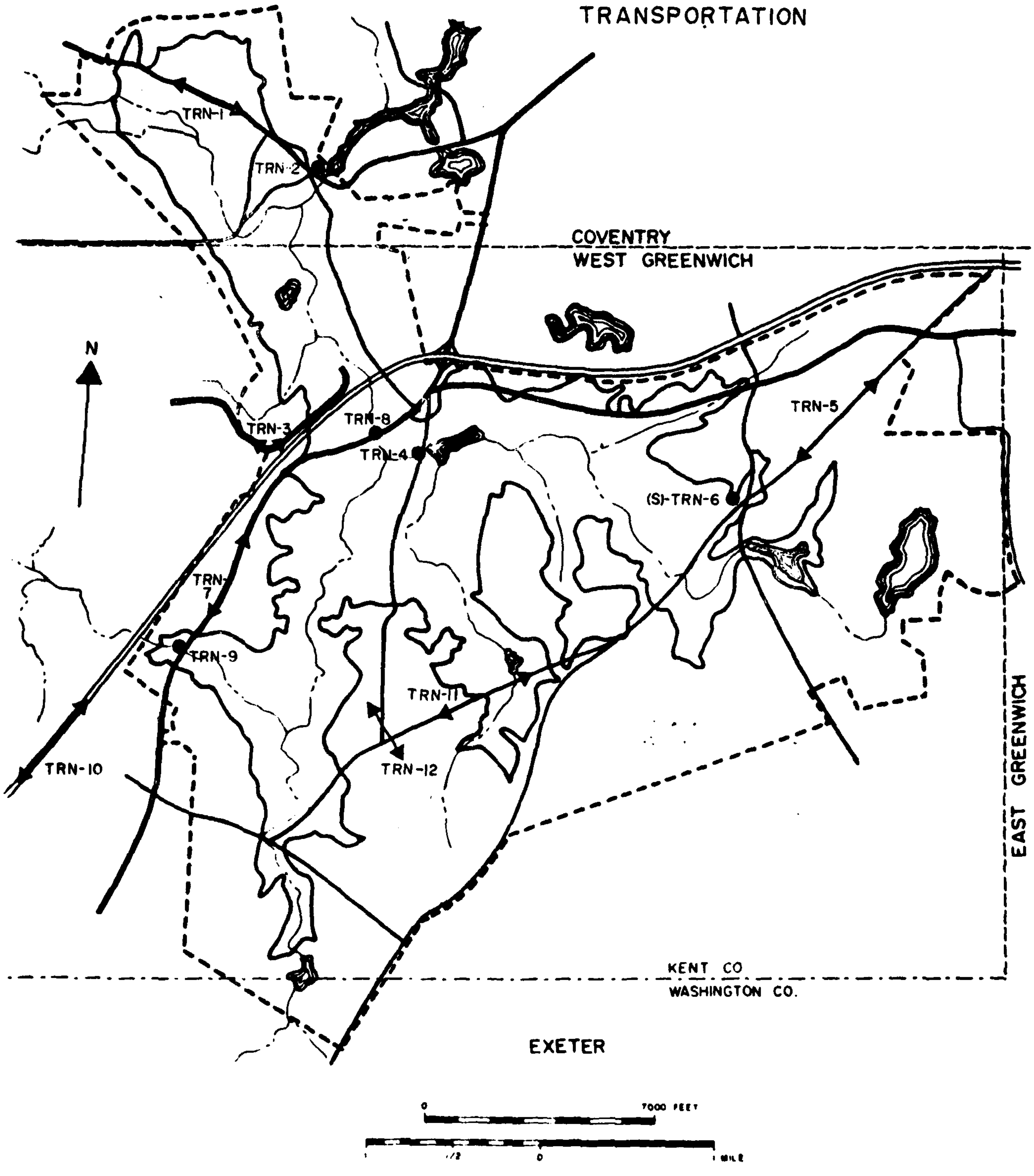
WEAVER HILL ROAD

OLD KIT MATTESON TAVERN (c. 1784 OR EARLIER)

RES-27 (SEE CMT-11 FOR INFORMATION)

BIG RIVER RESERVOIR AREA

TRANSPORTATION



COVENTRY

HARKNEY HILL ROAD

HARKNEY HILL ROAD

TRN-1

Previous Map #: None

Level of Significance: Contributing

Description: A 2-lane, asphalt road, with shoulders.

Significance: This is one of Coventry's colonial roads. The eastern part (east of Zeke's Bridge) was laid out before 1728. In 1728 the road was laid out westward over Harkney Hill (just west of the reservoir area) to the Connecticut line. It was one of the early and important east-west roads in Coventry. Although covered with asphalt, it still retains much of its original character as a pleasant country road.

Map History: Shown on 1831 and all later maps.

Present Status: In good condition.

Relation to Proposed Reservoir: Most of road in reservoir area in pool.

COVENTRY

HARKNEY HILL ROAD

JOHN GREENE'S/ZEKE'S BRIDGE

TRN-2

Previous Map #: None

Level of Significance: Contributing

Description: A simple wooden bridge spanning the Big River, with a wooden plank road surface, wooden rails, and stone abutments.

Significance: Originally known as John Greene's Bridge after the builder, who also built a dam above the bridge and a mill along the river near here (see (S)-IND-1), it is known today as Zeke's Bridge for one of John's sons, Uzal. It is believed that the present name of the bridge is a variant of the spelling of his name. This bridge is one of a few, simple, all wood bridges surviving in the rural outback of Rhode Island today.

Map History: 1962 - Zeke's Bridge.

Present Status: It appears to be in sound condition.

Relation to Proposed Reservoir: At site of proposed dam.

WEST GREENWICH

BIG RIVER ROAD

BIG RIVER ROAD

TRN-3

Previous Map #: None

Level of Significance: Contributing

Description: A short section of 2-lane, asphalt-surfaced road east of Kitt's Corner.

Significance: This road, which was originally part of Division Street and one of the oldest roads in town, was "cut off" when Interstate Route 95 was constructed. Today it is a short section leading to the Big River and is a relict feature of an earlier transportation age, its asphalt surface disintegrating. In parts, there are the older type wooden guard rails, and atop the hill several hundred feet east of the former Kit Matteson Tavern is an old stone retaining wall at a road cut.

Map History: Shown on all maps.

Present Status: Deteriorating.

Relation to Proposed Reservoir: In watershed, above pool (the lower, more recent section, will be in pool.)

WEST GREENWICH

BURNT SAWMILL ROAD

CARR RIVER BRIDGE (1923)

TRN-4

Previous Map #: None

Level of Significance: Contributing

Description: A single-arch reinforced-concrete span which carries Burnt Sawmill Road over the Carr River, in a pleasant setting.

Significance: A typical road bridge of the early 20th century.

Map History: Not identified as a bridge on any maps.

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

INTERSTATE HIGHWAY I-95

INTERSTATE 95 (I-95)

TRN-5

Previous Map #: None

Level of Significance: Contributing

Description: A 4-lane, limited-access, divided, express highway, with landscaping, guard rails, long straightaway, and gentle curves.

Significance: Route I-95 is a typical interstate highway, built as part of the interstate highway system which began in the late 1950s. In West Greenwich, the last section (south of Weaver Hill Road) was opened to traffic in 1969 and had a profound influence on traffic and commerce along Nooseneck Hill Road. The modern highway is an interesting link/continuity in the area's road system, which is characterized by the successive building or reconstructing of new roads and the abandonment and disuse of others. Route I-95 is Rhode Island's major highway today. It was designed with the proposed Big River Reservoir in mind.

Map History: 1966 - Shown only as far south as Weaver Hill Road.

Present Status: In good condition.

Relation to Proposed Reservoir: In watershed, at edge of pool and part of it crossing the reservoir.

WEST GREENWICH

NEW LONDON TURNPIKE

NEW LONDON TURNPIKE (1816-1821)

TRN-6

Previous Map #: C-9

Level of Significance: Recommended for the National Register.

Description: An unimproved dirt road, about 20 feet wide, bounded largely by forest and lined with telephone poles.

Significance: The New London Turnpike, originally the Providence and Pawcatuck Turnpike and originally three rods wide (about 50 feet), it was laid out between 1816 and 1821, during Rhode Island's turnpike era. It connected Providence with the Connecticut state line, where a Connecticut segment went to New London, thus establishing a shorter and more direct route between Providence and New London where travelers made connections with New York boats. The turnpike was most actively used during the first few decades of its existence; by mid-century a railroad had been established to New York and this turnpike was rendered obsolete. Traffic fell off considerably and in 1864, the New London Turnpike ceased being a toll road. Traffic became virtually nonexistent with the decision to make Nooseneck Hill Road the major highway across the town in the first years of the 20th century. Several transportation-oriented establishments along the pike, including a blacksmith shop, toll gate, and several taverns in the Big River area were eventually abandoned and destroyed. Today there are no extant structures associated with the turnpike era along the route, but the foundations remains survive in some places and are potential historical archeological sites. The road, never improved, is the longest section of original early 19th century turnpike in the state and still provides a strong feeling of the original turnpike of a century and a half ago.

Map History: 1831 - Pawcatuck Turnpike
1855, 1862, 1870 - Not named
1895 - Providence and New London Turnpike
1948, 1966 - Old New London Turnpike

Present Status: In good condition; well-preserved.

Relation to Proposed Reservoir: Partly in pool.

WEST GREENWICH

NEW LONDON TURNPIKE

SITE OF WEBSTER GATE

(S)-TRN-7

Previous Map #: C-10

Level of Significance: Contributing

Description: A tollgate and a hotel (see (S)-CMT-3) once stood along the turnpike here.

Significance: The tollgate was one of several established along the road and used until the turnpike was made a free road in 1864. A simple 1½-story structure and associated barn stood here until destroyed in the recent past. It is important as an historical site for the role it played in the turnpike era and because of its potential as an historical archeology site.

Map History: 1831 - Gate
1855, 1862 - Toll Gate
1870 - C. Greene, Hotel
1895 - Jesse Carr
1943 - Old Toll Gate House, A. Sundelin
1966 - Old Toll Gate House, M. Sundelin

Present Status: Site leveled, but some foundations walls still stand at the rear.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

NOOSENECK HILL ROAD

TRN-8

Previous Map #: None

Level of Significance: Contributing

Description: A 4-lane, reinforced-concrete, undivided highway.

Significance: The date of the Nooseneck Hill Road is uncertain, but it probably dates from the initial period of settlement in this area. It was by-passed in importance in the early 19th century when the New London Turnpike was laid out parallel to its route, but soon after the beginning of the period of modern road improvements, which began in the early 1890s, the Nooseneck Road became an important highway. In 1902 the State Board of Public Roads was created and the original highway system adopted. At this time, Nooseneck Hill Road was a typical unimproved country road. Although the New London Turnpike offered a shorter and more direct route across the state, it was found to be very hilly and another route, incorporating most of Nooseneck Hill Road, was chosen as part of the state highway system because it was less expensive to construct and because it went through more towns and villages and would be of more value to people. Beginning in 1904, improvements were made to the road. In 1920 a section of the highway in Coventry was relocated and a bituminous asphalt covering put over the old surface. In 1937 the road was reconstructed north of the Big River, and in 1939 it was further reconstructed and modernized south of the Big River. The pavement was a 4-lane dual type reinforced concrete and bituminous macadam, 47 feet wide, bringing the highway to its present condition and dimensions, and resulted in the replacement of the Big River Bridge (see TRN-8) and the widening of the Nooseneck River Bridge (TRN-9).

Map History: Shown on all maps.

Present Status: Deteriorating.

Relation to Proposed Reservoir: Partly in pool.

WEST GREENWICH

NOOSENECK HILL ROAD

BIG RIVER BRIDGE, #34 (1937)

TRN-9

Previous Map #: None

Level of Significance: Contributing

Description: A single-span, reinforced-concrete arch bridge over the Big River, 47 feet wide with a span of 40 feet across the river.

Significance: The last in a series of bridges over the Big River, this one is typical of the state-built pre-World War II reinforced-concrete arch bridges found throughout Rhode Island. At one time there were two bridges across the river here; in the early 20th century they were considered the most dangerous point on the so-called short route to Westerly because of their restricted width. The highway was redesigned and the span of the new (1919) bridge increased to forty feet, thereby providing a span over the waterway equivalent to both old structures and eliminating one structure. In 1937, as part of the Nooseneck Hill Road reconstruction project, the bridge was widened to 50 feet for the 4-lane highway.

Map History: Not noted on any maps.
1831 - Ishmaels Bridge
1855, 1862 - Ishmael Bridge

Present Status: In good condition except for erosion of stone railings.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

NOOSENECK HILL ROAD

NOOSENECK RIVER BRIDGE, #36 (1939)

TRN-10

Previous Map #: None

Level of Significance: Important

Description: A single-span, reinforced-concrete arch bridge, with rubblework granite facings, over the Nooseneck River.

Significance: This bridge, of the pre-World War II period, like most, was improved several times in the past. The "old" bridge was a twenty-foot span, built in 1913; it was widened to thirty-eight feet in 1923. The present bridge was widened in 1939 by the M. A. Gammino Construction Company as part of the road reconstruction program. The stone facing on the bridge is an attempt to make it more aesthetically pleasing than most of the other concrete spans in the state, and make it an atypical highway bridge.

Map History: Not noted on any maps.

Present Status: In good condition.

Relation to Proposed Reservoir: In pool.

WEST GREENWICH

SWEET SAWMILL ROAD

SWEET SAWMILL ROAD

TRN-11

Previous Map #: None

Level of Significance: Recommended for the National Register.

Description: An unimproved dirt road, about twelve feet wide, bounded in most places by stone walls and forest, and meandering in its approximately two-mile course.

Significance: Sweet Sawmill Road, a colonial road, is probably one of the town's original roads, and served several farms. It is significant because it has suffered few, if any, modern intrusions and is one of the best preserved stretches of colonial road in the state. Bounded by stones walls in part of its course, and passing through forest in its irregular path, it provides an intimate sense of a past era in the area's history.

Map History: Shown on all maps after (and not including) 1831.

Present Status: Well preserved.

Relation to Proposed Reservoir: Partly in pool.

WEST GREENWICH

TWO ROD ROAD

TWO ROD ROAD

WRN-12

Previous Map #: None

Level of Significance: Contributing

Description: A narrow roadway in the woods hemmed in by the encroaching forest.

Significance: The Two Rod Road, so-called because of its width, is an early road; it connected several other roads in the area, but has not been used as a public thoroughfare for many years. It survives as a primitive path through the West Greenwich woods.

Map History: 1831-1895 - Not shown
1948, 1966 - Shown on map.

Present Status: Extant in places.

Relation to Proposed Reservoir: In watershed, above pool.

APPENDIX A: THE NATIONAL REGISTER OF HISTORIC PLACES

The National Register of Historic Places is a record maintained by the Heritage Conservation and Recreation Service, United States Department of the Interior, of structures, sites, areas and objects significant in American history, architecture, archeology and culture. Authorized by the National Historic Preservation Act of 1966 as the official inventory of the cultural and historic resources of the nation, it includes historic properties in the National Park System, National Historic Landmarks, and properties of national, state, and local significance nominated by states or by federal agencies and approved by the Secretary of the Interior. It is an authoritative guide for federal, state, and local governments, planners and private groups and individuals everywhere, identifying those properties which are worthy of preservation throughout the nation. Registered properties are protected from federally funded and licensed activities by a state and federal review process. Listing in the National Register is a prerequisite for eligibility for federal restoration matching funds administered locally by the Rhode Island Historical Preservation Commission.

One building in the Big River Reservoir Area--the 1867 Hopkins Mill in Nooseneck--was entered in the National Register. However, this mill was destroyed in September, 1978, and its entry in the Register has been withdrawn as a result.

The properties in the reservoir area listed below may also be eligible for nomination to the Register. They require further investigation to determine their eligibility.

- CMT-1 Kit Matteson Tavern, Weaver Hill Road.
- (S)-IND-12 Sites of Nooseneck Factories, Nooseneck.
- TRN-5 New London Turnpike.
- TRN-11 Sweet Sawmill Road.

The twenty-nine properties listed below have been preliminarily evaluated as "important." Further investigation is required to determine their eligibility for the Register. In the case of structures, an investigation of the interiors is necessary and will undoubtedly eliminate some from consideration. In the case of the sites, further investigation by archeologists will be required.

- CEM-4 Historical Cemetery Number Twenty-seven (Whitford), Burnt Sawmill Road.
- CEM-6 Unnumbered (Tarbox, Jackson), Carr Pond Road.
- CEM-7 Number Twenty-nine (Tarbox, Shippee, Whitford), Carr Pond Road.
- CEM-13 Number Forty-seven (?) (Harrington), Division Street.
- CEM-15 Number Thirty-seven (King, Howard), Division Street.
- CEM-19 Number Thirty (Barbour, Hopkins, Potter), Hopkins Hill Road.
- CEM-26 Unnumbered (Matteson, Shippee), Nooseneck Hill Road.
- CEM-27 Unnumbered (Matteson), Nooseneck Hill Road.
- CEM-29 Number Twenty-three (Hall), Nooseneck Hill Road.
- CEM-32 Unnumbered (Sweet), Sweet Sawmill Road
- CEM-34 Unnumbered (Cleaveland, Congdon, Nichols), Sweet Sawmill Road.
- (S)-IND-2 Site of Whitford's-Capwell's Mill, Burnt Sawmill Road.
- IND-3 Former granite quarry, Carr Pond.
- (S)-IND-4 Site of Nichol's-Congdon's Mill, Congdon Mill Road.
- (S)-IND-5 Site of Potter Saw Mill-Hopkins & Tarbox Saw and Grist Mill, Hopkins Hill Road.
- (S)-IND-13 Site of Sweet Sawmill, Sweet Sawmill Road.
- RES-4 Stephen Johnson House'Judge Rathbun Farm, Harkney Hill Road, Coventry.
- RES-5 G. W. Greene House, Harkney Hill Road, Coventry.
- RES-7 Matteson House, Burnt Sawmill Road.
- RES-14 William Matteson House, Nooseneck Hill Road.
- RES-16 John Matteson House, Nooseneck Hill Road.
- RES-18 David Hopkins House, Nooseneck Hill Road.
- RES-19 Hopkins-Sweet House, Nooseneck Hill Road.
- RES-20 House, Nooseneck Hill Road.
- RES-21 House, Nooseneck Hill Road.

- (S)-RES-23 Site of Sweet Farm, Sweet Sawmill Road.
- RES-24 T. W. Whitman Farm, Sweet Sawmill Road.
- RES-26 Amos Sweet House, Weaver Hill Road.
- TRN-9 Nooseneck River Bridge (#36), Nooseneck Hill Road.

APPENDIX B: ALTERNATIVES AND FEEDER SYSTEMS TO THE BIG RIVER RESERVOIR.

DESCRIPTION OF PROPOSED FACILITIES

Big River Reservoir

The Big River Reservoir would be located in the towns of Coventry and West Greenwich, Rhode Island. The reservoir would have a surface area of approximately 5.9 sq. miles (15.3 sq. km.) at a normal pool elevation of 302.5 mls. Flood pool is currently planned at 2.5 feet above normal pool (Map 4).

Archeological field reconnaissance at this stage of planning was confined to the Big River Reservoir area, as location of treatment and transmission facilities have not as yet been finalized.

Several alternatives and feeder systems are presently undergoing initial examination by the Corps of Engineers. These include diversion of water from various streams in the drainage basin or possible feeder reservoirs. Of these alternatives, the locations of five potential reservoir sites were sufficiently outlined to allow collection of prehistoric and historic background data relating to their sensitivity for cultural resources. The possible reservoir locations are as follows:

1. Wood River Reservoir in West Greenwich and Exeter, Rhode Island. Potential pool of 1.4 sq. miles (3.6 sq. km.) would be available at an elevation of 170.0 msl.

2. Bucks Horn Brook Reservoir in West Greenwich, Rhode Island. A possible pool of 0.8 sq. miles (2.1 sq. km.) would be available at 450.0 msl.

3. Moosup River Reservoir in West Greenwich, Rhode Island. A possible pool of 0.8 sq. miles (2.1 sq. km) would be available at 350.0 msl. The dam would be in Oneco, Connecticut.

4. Nooseneck River Reservoir in West Greenwich, Rhode Island. A possible pool of 1.1 sq. miles (2.8 sq. km) would be available at 370.0 msl.

5. Fisherville Brook Reservoir in Exeter, Rhode Island, with a possible elevation of 200 msl.

WOOD RIVER ALTERNATIVE
West Greenwich/Exeter, Rhode Island
Hope Valley Quad

WOOD RIVER ALTERNATIVE
Exeter and West Greenwich, Rhode Island
PRELIMINARY LIST OF CULTURAL RESOURCES

There are no recorded cultural resources in this area as recorded in Rhode Island Historical Preservation Commission preliminary surveys of the two towns.

Rhode Island Historical Preservation Commission
January 1979.

BUCKS HORN BROOK ALTERNATIVE
Coventry, Rhode Island
PRELIMINARY LIST OF CULTURAL RESOURCES

1. SUMMIT VILLAGE (39)*

Though located on a ridge between the watersheds of the Flat and Moosup Rivers, the area now called Summit was known as Perry's Hollow in the 18th century. It was the site of a sawmill, gristmill, store, and no more than five houses. The village grew up when the Hartford, Providence, and Fishkill Railroad came through in 1856 and established a station. The village's name became Summit because it was the highest point on the railroad line. The railroad is gone and the depot demolished, although the other public buildings have survived.

2. HIDDEN HOLLOW FARM (mid-19th century) (22)*

A 1½-story farmhouse with a steeply pitched roof and gable dormers, with many alterations and additions. The property is distinguished by its setting in a cluster of pine trees, near a pond and is surrounded by fine stone walls.

3. HISTORICAL CEMETERY

4. HISTORICAL CEMETERY

Rhode Island Historical Preservation Commission
January 1979

* Refers to entry in RIHPC Coventry Preliminary Report, 1978.

BUCKS HORN BROOK ALTERNATIVE
Coventry, Rhode Island
Coventry Center Quad

Carbuncle Hill
Carbuncle Pond
Fox Hill
MOOSUP RIVER ALTERNATIVE
Coventry, Rhode Island
Sterling, Connecticut
Oneco Quad

MOOSUP RIVER ALTERNATIVE
Coventry, Rhode Island
PRELIMINARY LIST OF CULTURAL RESOURCES

1. Hopkins Hollow Historic District.*

Two miles south of Greene is the hamlet of Hopkins Hollow. This area was first settled by Captain Richard Rice of Warwick who build a saw-mill, gristmill, and house here before 1750. By the first quarter of the 19th century, the name Rice's Mills disappeared from use and from maps. Jeremiah and Samuel Hopkins moved into the hollow, built a mill and a blacksmith's shop, and the name of the area soon changed. The mill site is now part of the Arnold Farms. The church survives, as does the schoolhouse, but the de-population of the area is such that neither are in use.

Rhode Island Historical Preservation Commission
January 1979

* #15 in RIHPC Coventry Preliminary Report, 1978.

NOOSENECK RIVER ALTERNATIVE
West Greenwich, Rhode Island
PRELIMINARY LIST OF CULTURAL RESOURCES

1. Historical Cemetery

2. Site of Frye's Mills

   Near Fry Pond Road along the Nooseneck River. Mill was active in the 19th century.

3. Site of Robin Hollow Cotton Mill

   West of Route I95, near Robin Hollow Road, along Raccoon Brook. Cotton mill was built in 1845 and was destroyed in 1875, and never rebuilt.

4. Site of Yard Pond

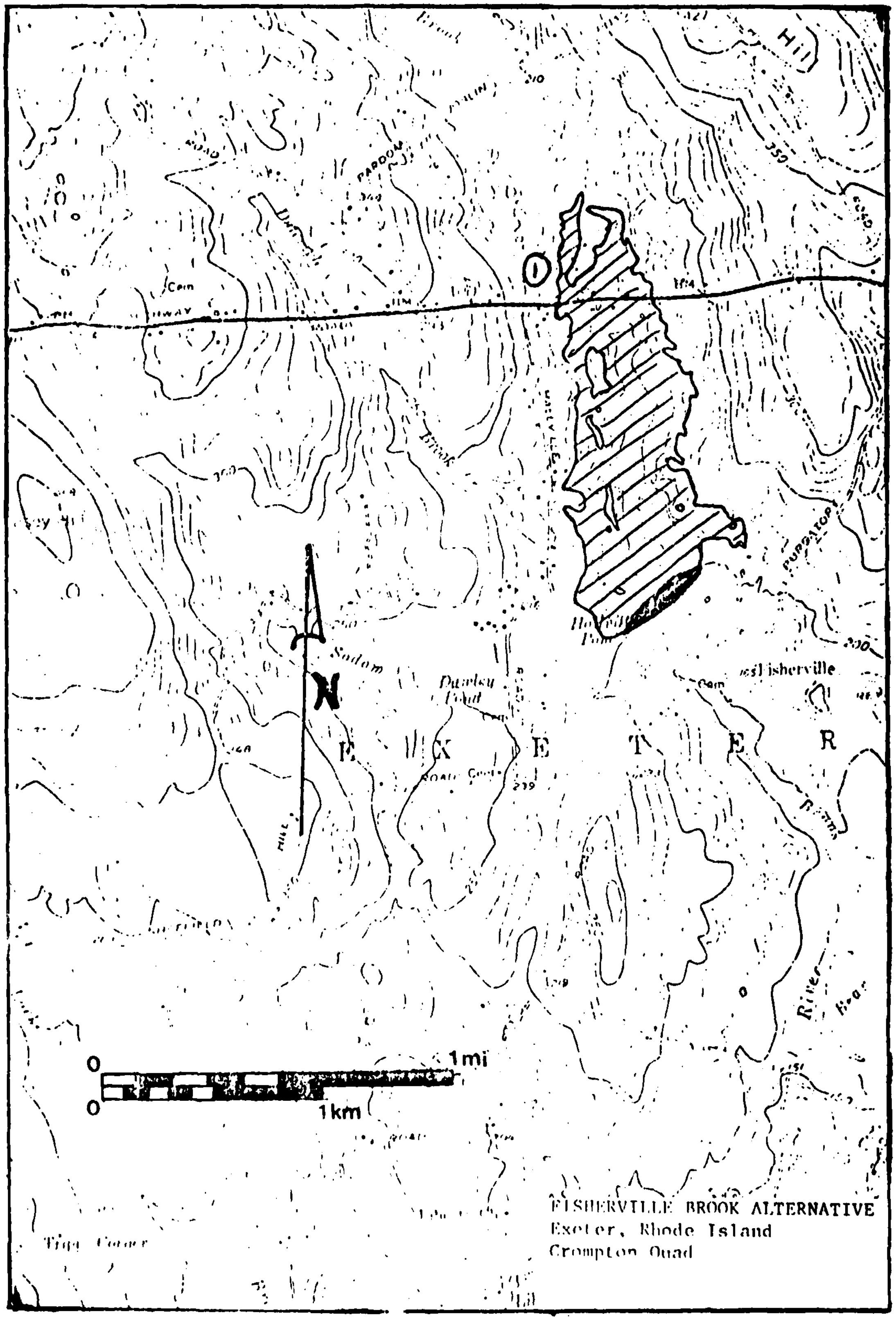
   West of Route I-95, along the Nooseneck River, at Yard Pond. Originally the site was used for a saw mill; later the Yard Mill, which manufactured textiles, was built here.

5. House Sites

   Several homes once stood in the area included in this project; they date at least from the mid-19th century.

Rhode Island Historical Preservation Commission
January 1979.

NOOSENECK RIVER ALTERNATIVE
West Greenwich, Rhode Island
Coventry Center/Hope Valley Quads



Hill
Sodom
Brook
Dawley Pond
Fisherville
E X E T E R
River
0
1mi
0
1km
FISHERVILLE BROOK ALTERNATIVE
Exeter, Rhode Island
Crompton Quad

FISHERVILLE BROOK ALTERNATIVE
Exeter, Rhode Island
PRELIMINARY LIST OF CULTURAL RESOURCES

1. Lawtonville Historic District (4)*

A relatively large area along Ten Rod Road, extending some distance south along Hallville Road, centered about a complex with houses, a mill, and farm outbuildings, in a fine rural-natural environment. About 1795 a "snuff manufactory" was established here. In 1825 it was renovated and changed into a cotton factory. Burned and rebuilt, it manufactured warps, then became a sawmill and gristmill. Thomas A. Lawton formerly kept a hotel there, and there was a store at one time. Noteworthy are:

A. Lawton's Mill. A 2-story wood-frame structure along the road and next to Fisherville Brook, which powered the mill. A raceway from a small pond runs alongside the mill. (1870 - S. Mill, T. Lawton Estate).

B. House. A 2-story, 18th-century, center-chimney gambrel-roof dwelling. (1870 - T. Lawton Estate).

C. House. A 3-story, early 20th-century, complex house near a pond, on a well landscaped setting.

D. House. A 2-story, wood-shingle cottage with a center stone chimney. It is located near a pond.

E. Farmscape. Located south of Ten Rod Road, mostly along Hallville Road, there are large, rocky pastures bounded with stone walls which, for most of their length, are capped with a split rail fence.

Rhode Island Historical Preservation Commission
January 1979

* Refers to number in RIHPC Exeter Preliminary Report

PHOTOGRAPHS OF

INVENTORIED PROPERTIES

CEM-1

CEM-2

CEM-3

CEM-4

CEM-5

CEM-6

CEM-7

CEM-8

CEM-9

CEM-10

CEM-11

CEM-12

CEM-13

CEM-14

CEM-15

CEM-16

CEM-17

CEM-18

CEM-19

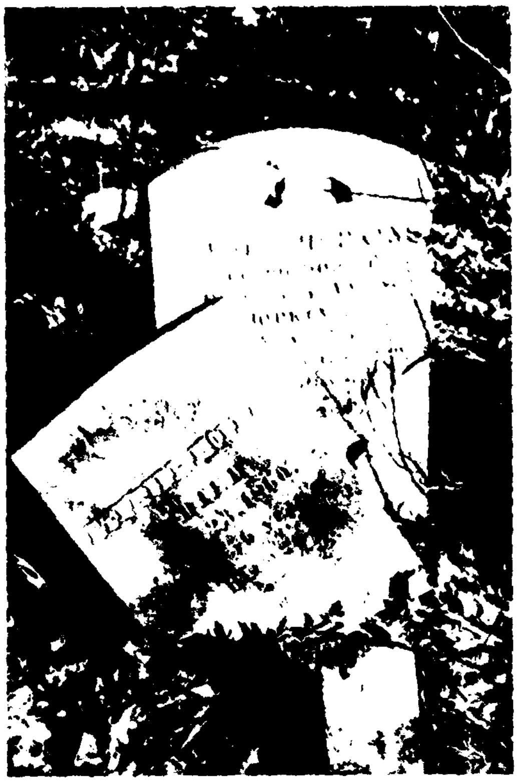
CEM-20

CEM-21

CEM-22

CEM-23

CEM-24



CEM-25

CEM-26

CEM-27

CEM-28

CEM-29

CEM-30

CEM-31

CEM-32

CEM-33

CEM-34

(S)-CML-1 Photo taken 1972.

(S)-CMT-2   Photo taken 1977.

(S)-CMT-4

N.B. No photo for (S)-CMT-1 and (S)-CMT-3

(S)-CMT-7

CMT-8

N.B. There is no photo for (S)-CMT-5 and (S)-CMT-6

CMT-9

CMT-10

CMT-11

(S)-EDU-3 Photo c. 1950. Barbour Collection

N.B. There is no photo for (S)-EDU-1, (S)-EDU-2 and (S)-EDU-4

(S)-IND-1

(S)-IND-2

(S)-IND-3

(S)-IND-4

(S)-IND-5

(S)-IND-6

(S)-IND-8

N.B. For (S)-IND-7, see (S)-CMT-4

IND-9

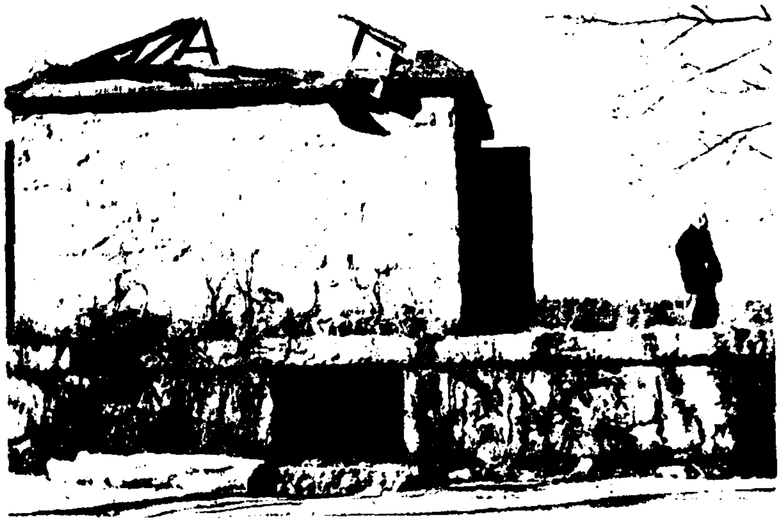
(S)-IND-10 Photo taken 1977.

N.B. For (S)-IND-11, see (S)-CML-1

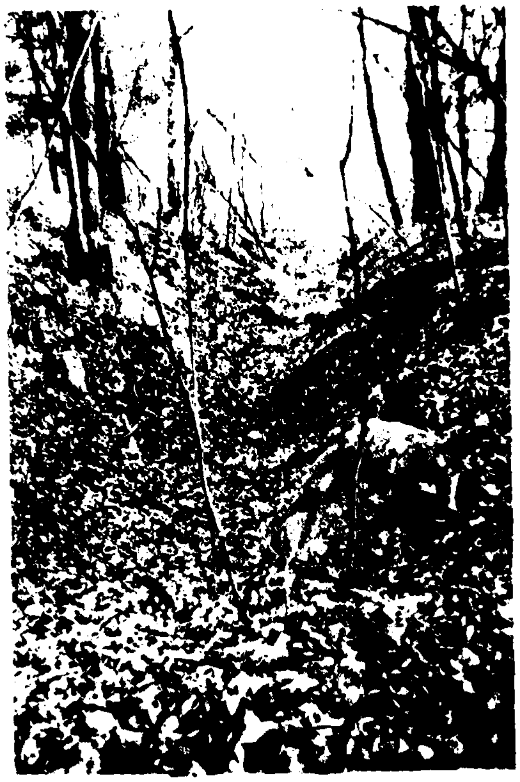
(S)-IND-12

(S)-IND-13

LND-1



(S)-PWL-1

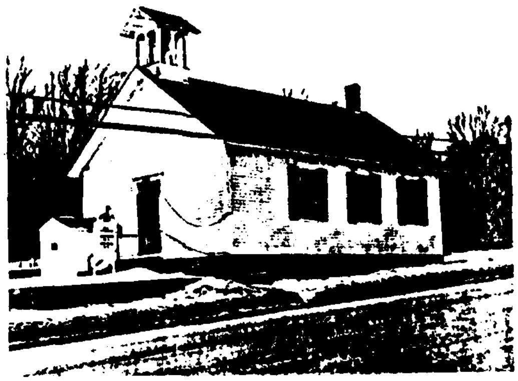


(S)-PWL-2

(S)-PWL-3

(S)-PWL-4 Photo taken 1977.

REC-1



(S)-REL-1 Photo taken 1970.
Wm. H. Gerold (RIHPC)

RES-1

RES-2

RES-3

RES-4

RES-5

RES-6

RES-7

(S)-RES-8

RES-9

RES-10

(S)-RES-11

(S)-RES-11 Photo taken c. 1960
Barbour Collection

RES-12

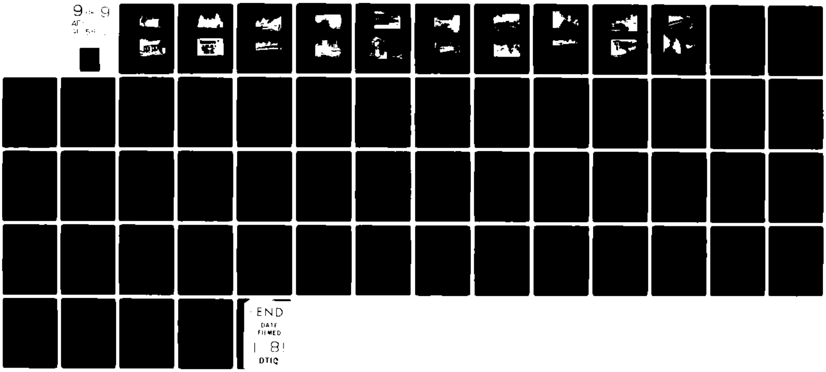
(S)-RES-13

RES-14

RES-15

AD-A105 822 CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV F/G 13/2
BIG RIVER RESERVOIR PROJECT - PAWCATUCK RIVER AND NARRAGANSETT --ETC(U)
JUL 81

UNCLASSIFIED NL



RES-16

(S)-RES-17 Photo taken 1977.

RES-18

RES-19

RES-20

RES-21

RES-22

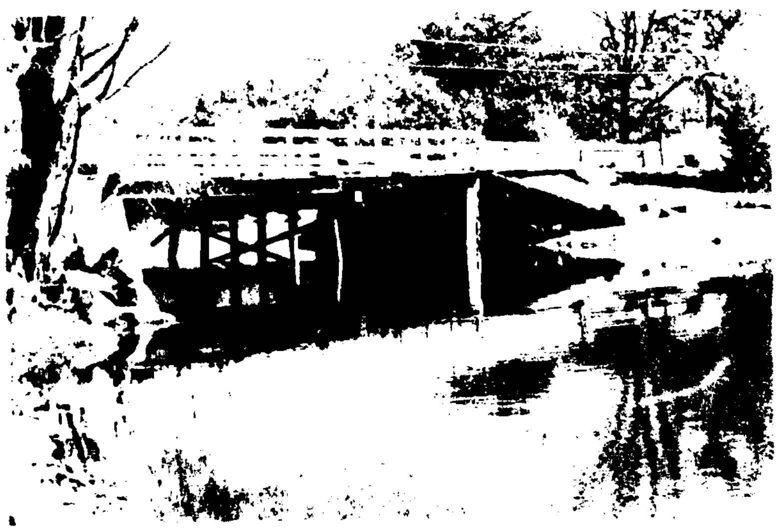
(S)-RES-23

RES-24

(S)-RES-25

RES-26

TRN-1



TRN-2

TRN-3

TRN-4

TRN-5

TRN-7

N.B. For (S)-TRN-6, see (S)-CMT-3

TRN-8

TRN-9

TRN-10

TRN-11

TRN-12

BIBLIOGRAPHY

Adams, Ginny, 1977. "A Study of Tollgates and Taverns Along the New London Turnpike." Unpublished ms.

Adams, Ginny, 1977. "New London Turnpike." National Register Nomination, Significance statement, First draft, December 1977. Rhode Island Historical Preservation Commission.

Arnold, Agnes, 1970. "Zeke's Bridge Over Big River in Coventry." The Hinterlander, v. 14, #3, Dec. 1970.

Baker, Roberta, 1976. Bits and Pieces of West Greenwich Memoranda.

Barrett, Mark, 1976. "The Albro House of West Greenwich, Rhode Island." Unpublished ms. for Brown University, Anthropology 191.

Bates, Frank G., undated. "How Coventry Came to be." Souvenir booklet. c. 1966.

Beers, J. H. & Company, 1908. Representative Men and Old Families in Rhode Island.

Bellerose, George A., 1970. "A Special West Greenwich House." Providence Journal, October 19, 1970.

Butterfield, Bruce D., 1975. "The Big River Leads to 'No-man's-land'." Providence Journal, January 5, 1975.

Cole, J. R., 1889. History of Washington and Kent Counties.

Coleman, Peter J., 1963. The Transformation of Rhode Island, 1790-1860.

Gale, William, 1969. "House of God Must Move." Providence Journal, December 21, 1969.

Gray, Sonya, 1966. "Big River Reservoir Uprooting W. Greenwich." Providence Journal, June 5, 1966.

Hale, Stuart O., Jr., 1945. "Last of Famous West Greenwich Stone Cutters at 70 Can Press 190 Pounds Over His Head; Trained Boys for War." Providence Journal, October 7, 1945.

Hammerschlag, Dieter, Barber, Brian K., and Everett, J. Michael, 1976. The Interstate Highway System and Urban Structure: A Force for Change in Rhode Island. July 1976.

Hoag & Wade, publishers, 1878. History of the State of Rhode Island.

Horvath, Steven, 1976. "Anderson House, Harkney Hill Road, Coventry, Rhode Island." Unpublished ms., Anthropology 191, Brown University.

Lake, John B., 1960. "An End for Some, Start For Others." Providence Journal, February 18, 1960.

Maguire, Charles A. & Associates, 1952. "Report of the Water Resources of the State of Rhode Island." January, 1952.

Metcalf & Eddy, Engineers, 1967. "Report to the Water Resources Coordinating Board on A Development Plan for the Water Resources of Rhode Island." June 30, 1967.

Munroe, Henry F., 1972. "Activities of the Rhode Island Water Resources Board." New England Water Works Association, September, 1972.

Providence Journal, February 5, 1893. "Abandoned Farms."

Providence Journal, June 25, 1899. "Noose Neck Hill."

Providence Journal, December 13, 1903. "Relics of the Past."

Providence Journal, March 3, 1907. "West Greenwich."

Providence Journal, May 31, 1908. "Nooseneck: The Story of a Street Which Became a Road."

Providence Journal, April 9, 1922. "Stage Coach Roads Crumble Under Tractor Traffic."

Providence Journal, September 3, 1925. "Nooseneck Mecca on Old Home Day."

Providence Journal, June 18, 1926. "Nooseneck Mill to Open After 25 Years."

Providence Journal, February 14, 1927. "Nooseneck Store Reminder of Old New England Days."

Providence Journal, August 15, 1940. "Many Changes Along Reconstructed State Highway in Nooseneck."

Rhode Island Audobon Society, 1971. "Survey of Unique Natural Areas." Unpublished manuscript.

Rhode Island Board of Public Roads. Annual Reports.

Rhode Island Department of Public Works. Annual Reports.

Rhode Island Historical Preservation Commission, 1978. Historical and Architectural Resources of Coventry, Rhode Island. A Preliminary Report. February 1978. Vivienne Lasky, author.

Rhode Island Historical Preservation Commission, 1978. Historical and Architectural Resources of West Greenwich, Rhode Island. A Preliminary Report. October, 1978. Vivienne Lasky, author.

Sande, Theodore A., 1972. The Architecture of the Rhode Island Textile Industry, 1790-1860. Dissertation in Architecture, University of Pennsylvania.

Starr, Sandy, 1975. "The Goodenough House." Unpublished ms., Anthropology 191, Brown University.

Wood, Frederic J., 1919. Turnpikes of New England.

MAPS

1819. "Map of Rhode Island and Providence Plantations." Bononi Lockwood.

1831, 1846. "A New Topographical Map of the State of Rhode Island and Providence Plantations," Surveyed by James Stevens (with additions and corrections by S. B. Cushing and H. F. Walling in 1846 edition).

1851. "Map of Providence County, Rhode Island," with some of the adjacent towns from original surveys. H. F. Walling.

1855. "Map of the State of Rhode Island and Providence Plantations." H. F. Walling.

1862. "Map of the State of Rhode Island and Providence Plantations." H. F. Walling.

1870. Atlas of the State of Rhode Island and Providence Plantations. D. G. Beers & Company.

1895. New Topographical Atlas of Surveys, Providence County, Rhode Island. Everts and Richards.

1948. "Map of West Greenwich." George E. Matteson.

1962. "Map of Coventry, Rhode Island." George E. Matteson.

1966. "Map of West Greenwich, Rhode Island." George E. Matteson.

1953-1955 (photorevised in 1970). U. S. Geological Survey Quadrangles at a Scale of 1:24,000, for Coventry Center, Crompton, Hope Valley and Slocum.

ADDENDA AND ERRATA TO
Appendix J, "Economics"

1. p. J-3 - fourth and fifth paragraphs: references to study year 2020 should read 2030.

2. p. J-8 - Table 3: Big River Reservoir cost of development stated as 16,033 should be 17,024.

   Total cost for development in 1995 stated as 134,283 should be 135,274.

3. p. J-9 - Table 4: Costs for Plan C are based on incorrect information from Table 3. They should read:

Total First Cost	$51,642,000
Interest During Construction	6,862,000
Total Investment	$58,504,000

4. p. J-9 - Table 5: Costs for Plan C are incorrect and should read:

   Interest and Amoritization $ 4,318,000
   (Operation and Maintenance and Major Replacement costs are correct).
   Total Annual Cost $ 5,253,000

5. p. J-9 - Table 6: Costs for Plan C are incorrect and should read:

   Total Investment $67,280,000
   Interest and Amortization 4,966,000
   (Operation and Maintenance and Major Replacement costs are correct).
   Total Annual Cost $ 6,042,000

6. p. J-13 - last sentence: $4,963,000 should be $4,936,000, as shown in Tables 8 and 9.

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX J

ECONOMICS

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

APPENDIX J

ECONOMICS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

This appendix contains details of the economic impacts, including project costs and benefits, associated with implementation of the proposed water supply alternatives for the 17 community study area in northern and central Rhode Island. These impacts will be discussed in the context of underlying baseline economic conditions, as well as conditions anticipated in the future if no Federal action is taken.

General economic criteria applied in the evaluation of alternatives include consideration of both National Economic Development and Regional Development. Plans to be considered economically justified must exhibit a ratio of benefits to costs greater than unity, i.e. resulting in a return of one dollar or more on each dollar invested. The scope of development selected from among the economically justified alternatives should be that which maximizes net benefits. The selected plan for National Economic Development must be the most economical means, evaluated on a comparable basis, of accomplishing the project purposes.

Indirect or secondary economic impacts of the proposed Big River Reservoir and other major alternatives are also included in this appendix. Short term and long term effects on employment, income, and commercial and industrial development are discussed in relation to proposed water supply improvements.

II. ALTERNATIVE PLANS AND THEIR ECONOMIC IMPACTS

Several alternative methods of dealing with the anticipated future water shortage in Rhode Island, particularly in the metropolitan Providence area, have been proposed and studied in detail over the past two decades. Consideration of several potential well field sites and surface reservoir locations culminated in the decision by the State of Rhode Island to purchase the site of the proposed Big River Reservoir as the most efficient, feasible solution to the problem.

Three alternative plans have been selected for detailed analysis including:

Plan A. Provides for a Demand Modification program to be implemented immediately throughout the study area, with a total water saving of 15 mg on an average day and 28 mg on a maximum day by 2030; development of ground water resources totaling .5 mgd in 1990 and .5 mgd in 2020 for Foster, and 1.0 mgd in 1990 and 1.0 mgd in 2010 for Glocester, development of local ground water sources (3.0 mgd immediately, 1.0 mgd in 1995, and 2.0 mgd in 2015) in Rehoboth, Massachusetts to serve Bristol County, Rhode Island; and development of Big River Reservoir to produce water by 1995, which in combination with the Scituate Reservoir would provide a safe yield of about 113 mgd, considered sufficient to meet the average and maximum day demands projected by the year 2030. Big River Reservoir would be constructed as a multipurpose facility, with flood control and recreation features incorporated into the design. Measures for mitigating potential losses of cultural and natural resources are also included in the plan.

Plan B. Provides all development described in Plan A, with additional construction of environmental habitats, such as wetlands and waterfowl habitats. All roads except Division Street would be relocated.

Plan C. Similar to Plan A, except that it provides a more regional approach to supplying the entire study area. Local source development in Bristol County would not be as intensive as in Plans A and B. Instead, pipeline connections would be established between the Providence system and Bristol County Water Company, crossing the Providence and Warren Rivers from Cranston to Warren.

Each of these plans would be adequate to meet the water supply needs of the study area over the foreseeable future, and would lessen the threat of future flood damages and provide additional recreational opportunities for surrounding communities. Failure by the Federal Government, State government, or local governments to implement any of the proposals described above or any similar plan to provide additional sources of supply would result in actual shortages sometime between 1990 and 1995. The most probable future scenario would be the establishment of a new balance between supply and demand around the year 1990, at the time that demand first exceeds available supply. Institutional restraints on growth may become necessary to prevent any future increases in consumption. Since this new balance would occur at or near the supply capacity of existing sources, spot shortages would remain a problem during extended dry periods in subsequent years.

During periods of severe drought, business and industry may be forced to limit or cease operation to accord top priority to residential requirements. Lack of water or reduced water pressure for combating fires may result in increased damages and higher insurance rates. The area would become less attractive to new industries and commercial enterprises, and existing business may choose to relocate to avoid the uncertainty of potential financial losses resulting from restricted water use. Commercial and residential property values would decline as the general area develops a reputation as an undesirable place to live and work, particularly if rationing becomes necessary. Overall, the effects on employment and therefore on aggregate income would be adverse or negative, in an area which already compares unfavorably with national averages in unemployment.

The major beneficial economic impact associated with the improbable decision to provide no additional supply sources would be cost savings over actual reservoir development. Although the overall supply would be adequate for the area as a whole until approximately 1990, negative economic effects would begin to appear shortly thereafter. It should also be recognized that spot shortages exist at the present time in Bristol County, with an additional 3.0 mgd needed immediately and a subsequent increase of 2.0 mgd required by 1995. Although surrounding communities enjoy excess supply at the present time, there is currently no physical means for Bristol County to tap that resource.

An analysis of economic impacts associated with implementation of proposed Plans A, B and C indicates that each plan seeks to fully address the water supply needs of the entire study to allow continued growth and prevent the negative impacts of no action for additional supply. Since the major feature of each plan is the construction of Big River Reservoir over 3,280 acres of inundated land, storing 24,000 mg (73,600 acre-ft.) of water for public supply, many of the economic impacts would be shared by all three plans. Impacts of providing 9,500 acre-feet of flood control storage and of including recreational features in all plans would also be identical among the three alternatives. Thus, general economic impacts can be discussed for all three as a group.

The non-structural element of the overall plans, demand modification, would involve the implementation of a multifaceted program designed to reduce water consumption through education of the public, installation of water saving devices, establishment of building code restrictions, and detection and repair of leaks. As currently proposed, the demand modification program would be initiated almost immediately with an ongoing effort to keep the public informed of the need for conservation and the methods by which significant savings can be realized, in addition to a continuing program of replacement of appliances and transmission facilities with water saving counterparts over time.

Anticipated water savings from the educational portion of this program would total approximately five percent of average daily demand by the study year 2020. An additional two percent savings could be expected through the same study period as a result of a leak detection and repair program preceded by a more extensive system of metering of all services and the estimation of unmeterable uses. The institution of building code restrictions which would require the use of water saving fixtures in new homes would reduce average daily demands in the study area by approximately two percent in 1995 and four percent in 2020.

Thus, the overall effect on the growth of demand from a comprehensive water demand modification program involving all of the above techniques is estimated at eleven percent reduction by 2020. These anticipated percentage savings were derived from a study conducted by Schoenfeld Associates, Inc., Engineers, Architects, and Planners under contract with the New England Division to determine the applicability of several demand modification programs implemented nationwide to the Big River Study Area.

Although demand modification would successfully forestall the need for additional water supply for several years, those conditions described as a result of taking no action would eventuate. Demand modification, in itself, would not provide a solution to the water supply problem in the study area.

Many of the adverse economic impacts associated with a project of the magnitude of Big River were dealt with at the time the land was purchased by the State of Rhode Island in 1963. The impoundment area for the reservoir remains relatively undeveloped in a state which has little open space, and is currently underutilized for a mixture of residential, recreational, and a few commercial purposes. Approximately 110 tenants, for a total resident population of 440, are renting their residences in the Big River area from the state with the knowledge that relocation will be necessary when the planned development actually occurs. Housing for approximately 134 people included in this total population is concentrated in 79 mobile homes located in the Maple Root Trailer Park situated near the site of a proposed treatment facility.

The major commercial activity in the impoundment area that would be eliminated by the construction of the reservoir is the mining of sand and gravel in the vicinity of Division Road and Interstate Route 95. Three private contractors are currently removing one million cubic yards each under agreement with the state, a task that will not be completed until 1980 or 1981. It is estimated that over thirty million cubic yards of sand and gravel remain in the area, with a commercial value of $1.00 to $1.50 per cubic yard, depending on the texture and quality of the product at the pit. Total commercial value is therefore between $30 million and $45 million at the present time, and will be between $27 million and $40.5 million after the ongoing contracts are completed. These values attached to sand and gravel deposits are reflected in the estimated value of real estate in the impoundment area, and are therefore considered in the formal economic justification of the project.

It should be noted that the State of Rhode Island is currently preparing guidelines for a study to be conducted to determine whether or not it would be feasible to remove all or most of the sand and gravel prior to construction of a reservoir and stockpile it at a nearby site. Because the State owns the land on which the sand and gravel are located and recognizes that the resource is non-renewable, the upcoming study is expected to result in a management plan designed to mitigate the potential loss of the resource.

The economic value of the sand and gravel and the effects of eliminating its mining on the regional economy acquire increased significance when weighed against the predicted scarcity of sand and gravel for construction purposes in Southeastern New England and in particular, Rhode Island. Those contractors currently involved in excavation operations at the Big River site claim that this source provides the highest quality sand and gravel for the lowest cost possible in the state. Although none of the three contractors employ any workers solely to complete their contractual agreement with the state, several of their employees are involved in that operation at various times. While two of the three contractors regard their excavations in the Big River area as a small portion of their overall operation, one claimed that his business was largely dependent on the contract to remain profitable. Alternative sources of sand and gravel exist but involve much greater transportation distances at greater expense. Transportation costs have been estimated at $30 per hour per truckload of approximately 20 cubic yards. It is also estimated that one hour is required to complete a round trip delivery for each additional seven to eight mile distance from the source to the purchaser. These additional transportation costs are reflected in the price of sand and gravel in the local market, and therefore passed on to the construction industry.

Other commercial activities at the proposed reservoir site include the operation of a single drinking establishment in a building rented from the state and the harvesting of a small quantity of timber under agreement with a private contractor. Most of the vegetative cover is of a scrub variety, with little or no commercial value. Several sections of softwood sawtimber do exist and could be harvested before any proposed development occurs. Although the hardwood trees in the area are not generally large enough for sawtimber, they could be sold for other purposes such as pulp, poles, posts, and firewood.

One activity in the impoundment area with significant recreational and commercial value is golf. A nine-hole course is located along Harkney Hill Road in Coventry and would be completely eliminated by the construction of the reservoir. Usually open from mid-March to mid-December, the club employs five persons, full time and part time with a total payroll of approximately $25,000. Although no figures for annual revenue generated are available, they can be estimated using the known green fees and utilization rates. On the average day, 150 to 175 golfers use the course for a fee of $3.00 for nine holes or $5.00 for eighteen holes. On Sundays, the peak day of use, up to 200 golfers are common. Thus, an average of 168 golfers per day for an average fee of $4.00 use the course on approximately 260 days, resulting in a total gross revenue of $181,440. This estimate could be considered minimal because it ignores the additional revenues obtained from equipment sales and rentals and the operation of a snack bar. Golf is the only recreational activity in the area for which a fee is required.

Other recreational activites common at the Big River site include boating, fishing, hiking, horseback riding, hunting, picnicking, and swimming. Current utilization of available recreational opportunities falls far short of the capacity that exists in the impoundment area, possibly due to lack of public knowledge of available opportunities, lack of parking facilities, or a preference for other better managed recreational sites in the local area. Thus, the inclusion of recreational development in Plans A, B and C should enhance the recreational value of the Big River site.

Since implementation of any of the proposed Federal Plans would ensure a surplus water supply throughout the fifty year planning period, continued population growth and prevention of the loss of business and industry necessary to support an increased population would be expected. Property values would be protected against the threat of decline resulting from fear of insufficient supply to meet residential, commercial and industrial demand.

Economic benefits in addition to those already described could be expected throughout the entire study area. The types of industry attracted to the State of Rhode Island and the study area in particular at the present time are not considered major water users. The overall employment trends in the state indicate a growth in service industries and a gradual decline in manufacturing. However, the existence of coal deposits in southeastern Massachusetts and Rhode Island and possible oil deposits off the New England coast could conceivably lead to future development of refineries, which generally consume large quantities of water. While an adequate water supply would not ensure the location of these facilities in the study area, lack of water would preclude that possibility.

Temporary economic benefits could also be expected in the local area during the active construction period. A project of Big River Reservoir's magnitude would require a moderate construction work force over a four-year period and may result in some permanent and temporary relocations to the surrounding area. Employment benefits would accrue to the entire State of Rhode Island, where the unemployment problem is typically significantly more severe than the national average, and particularly to those towns adjacent to the impoundment area, including West Greenwich, Coventry, East Greenwich, and Exeter. Increased employment in the area may have an especially beneficial impact on nearby North Kingstown, where many employment opportunities were lost as a result of the closing of military installations located there. Increased aggregate income consequent to increased employment could also be expected. Additional population, including temporary residents, should increase the viability of commercial enterprises and lodgings in the vicinity of the project, stimulating even greater income growth.

Negative economic impacts associated with the construction of Big River Reservoir may also result. If population in the local area increased significantly, greater municipal expenditures for the extension of services may be required, only partially offset by the broadening of the tax base. A large number of new families with children might force the establishment of a school system in West Greenwich, which currently educates its elementary students in the West Greenwich - Exeter regional school system and transports its high school students to North Kingstown High School. An increased population may also necessitate the enlargement of the two-member police force and the establishment of a fire department, which is strictly volunteer at the present time. Obviously, these expanded services would require collection of additional property tax revenues. Whether or not large numbers of permanent relocations occur would depend on the size of the work crew over the estimated four-year construction period.

III. Costs of Alternative Plans

Preliminary cost estimates have been prepared for each of the alternative plans described. Implementation of all three plans would be phased over a period of 35 years beginning with the immediate implementation of a demand modification program and the local development of ground water. Estimated expenditures for each of the three plans are displayed by the year in which actual expenditures are anticipated in Tables 1 through 3, calculated at January 1979 price levels. These same cost estimates are expressed in present worthed dollars in Table 4 for all three plans, reflecting differences in real dollar values resulting from phased implementation. All calculations were made at an interest rate of 7-3/8 percent for a 100-year project life. Interest during construction would accrue only during the development of the Big River Reservoir component of the overall plans, an anticipated period of four years. Annual costs based on these present worthed construction estimates are shown in Table 5.

Cost estimates displayed in these Tables and in Appendix G, entitled Design and Cost Estimates, have been updated to June 1980 price levels to correspond with the 1980 base year for project benefits, a necessary step for formal comparison of annual costs and benefits in the economic justification of proposals. These updated estimates are displayed in Table 6.

Table 1

ESTIMATED CONSTRUCTION COSTS FOR PHASED IMPLEMENTATION OF PLAN A
THOUSANDS OF DOLLARS

CAPITAL COST	1980	1990	1995	2005	2010	2015
Ground water	2,147	2,527	393		325	188
Big River Reservoir						
Development			16,033			
84" Tunnel			16,488			
55 mgd WTP			27,550			
55 mgd STP			1,950			
Recreation			430	121		
Cultural Mitgation			390			
Natural Resource Mitigation			550			
Contingencies	429	506	12,757	24	65	38
Engineering and Design	412	495	9,209	26	74	43
Supervision and Administration	258	304	6,321	19	43	25
Real Estate	70	47	31,560		47	24
Demand Modification	100					
Total	3,416	3,879	123,631	190	554	318

Table 2

ESTIMATED CONSTRUCTION COSTS FOR PHASED IMPLEMENTATION OF PLAN B
THOUSANDS OF DOLLARS

CAPITAL COST	1980	1990	1995	2005	2010	2015
Ground water	2,147	2,527	393		325	188
Big River Reservoir						
Development			27,374			
84" Tunnel			16,488			
55 mgd WTP			27,550			
55 mgd STP			1,950			
Recreation			430	121		
Cultural Mitgation			390			
Natural Resource Mitigation			2,411			
Contingencies	429	506	15,398	24	63	38
Engineering and Design	412	495	11,110	26	74	43
Supervision and Administration	258	304	6,748	19	43	25
Real Estate	70	47	31,560		47	24
Demand Modification	100					
Total	3,416	3,879	141,802	190	554	318

Table 3

ESTIMATED CONSTRUCTION COSTS FOR PHASED IMPLEMENTATION OF PLAN C
THOUSANDS OF DOLLARS

CAPITAL COST	1980	1990	1995	2005	2010
Ground water	1,949	2,527			325
Big River Reservoir					
Development			16,033		
84" Tunnel			16,488		
60 mgd WTP			29,270		
60 mgd STP			2,070		
Recreation			430	121	
Cultural Mitgation			390		
Natural Resource Mitigation			550		
Transmission			6,403		
Contingencies	390	506	14,327	24	65
Engineering and Design	374	495	10,316	26	74
Supervision and Administration	234	304	6,492	19	43
Real Estate	70	47	31,514		47
Demand Modification	100				
Total	3,117	3,879	134,283	190	554

Table 4

PRESENT WORTHED VALUES OF CONSTRUCTION COSTS
JANUARY 1979 PRICE LEVELS

	PLAN A	PLAN B	PLAN C
Total First Cost	$47,963,215	$54,212,585	$51,301,297
Interest During Construction	6,271,578	7,193,360	6,811,935
Total Investment	$54,234,793	$61,405,945	$58,113,232

Table 5

ANNUAL COSTS; JANUARY 1979 PRICE LEVELS

	PLAN A	PLAN B	PLAN C
Interest and Amortization	$4,003,070	$4,532,373	$4,289,338
Operation and Maintenance	831,148	831,148	889,900
Major Replacements	43,075	43,075	45,537
Total Annual Cost	$4,877,293	$5,406,596	$5,224,775

Table 6

UPDATED CONSTRUCTION COSTS AND ANNUAL COSTS
JUNE 1980 PRICE LEVELS

	PLAN A	PLAN B	PLAN C
Total Investment	$62,370,263	$70,616,837	$66,830,217
Interest and Amortization	$4,602,907	$5,211,523	$4,932,000
Operation and Maintenance	955,820	955,820	1,023,385
Major Replacements	49,536	49,536	52,368
Total Annual Cost	$5,608,263	$6,216,879	$6,007,823

IV. BENEFITS AND ECONOMIC JUSTIFICATION

Benefits from municipal water supply storage result from improvements in conditions of water use, largely in regard to quantity and dependability, quality, and physical convenience. In basic concept, the limiting values of such improvements are the maximum amounts prudent users would be willing to pay for the water supply storage components of municipal water supplies, assuming that decision would be made on the basis of a broad public viewpoint rather than a regional or local viewpoint. Because maximum willingness to pay is difficult to ascertain, it is often impossible to quantify benefits in this manner. It would appear to be a reasonable assumption, however, that people's willingness to pay is reflected by existing market rates.

Another approach to computing benefits accruable to water supply storage involves comparison with alternative costs, i.e. the cost of the most likely alternative in the absence of Federal involvement, assuming equal quantity and quality of water produced. In the case of Big River Reservoir, however, it is difficult to determine exactly what course of action that the State of Rhode Island, local governments, or private water authorities would take if the Federal Government failed to implement a plan for development of additional water resources. The clearest indication is that the State would eventually respond on its own to implement a single purpose water supply reservoir similar in nature to Big River Reservoir, with a minimal expenditure on mitigation measures. Although Rhode Island is not officially committed to such development, it appears to be the most reasonable future scenario due to the enthusiastic support for the project at the State Government level, the fact that the State has already purchased the land, and because of ongoing studies by the State as to how the construction of the Reservoir could be accomplished in the absence of Federal participation. Thus, benefits for Big River Reservoir could be at least partially based on the cost of this "most likely alternative," the construction of a reservoir on the Big River site by the State of Rhode Island. Local ground water resources would also be likely to be developed by State or local interests if no Federal action is forthcoming.

In the event that no most likely alternative can be established, Corps regulations suggest that an average unit cost of raw water from recently constructed or planned projects in the general region providing comparable units of dependable yield be utilized. Once again, difficulties are encountered in attempting to apply this methodology directly to the Big River Reservoir Study because no other projects of similar magnitude have been planned or constructed in the area for several decades.

A unit value for water obtained from a proposed new surface source could be established by considering the current selling price of raw water from existing sources of supply in the study area. Since water rates are set at a level necessary to at least recover the cost of the investment, the selling price is also somewhat reflective of the cost of development of the source. The Big River study area is primarily dependent upon the Scituate Reservoir to meet its present water supply needs, supplemented by local ground water development. Since the Scituate Reservoir was completed in 1926, when construction costs and interest rates were much lower, the total investment to be repaid through revenue returned through the marketing of water is also much lower than for the proposed Big River Reservoir. Thus, utilizing a unit value for water in the region based on costs associated with existing surface supply sources will conservatively bias the resulting benefit.

Attaching a unit value to a surface water supply also presents problems due to the variation in existing rates among different regions of the study area. Established rates also reflect differing amounts of pumping and treatment required, depending on geographic locations and source of supply.

In the case of proposed new ground water sources, a uniform estimate of unit value for raw water throughout the study area is readily available. The average cost of water at four major wells operated by the Kent County Water Authority at an elevation of 242 ft. above sea level, reflecting the original investment and pumping, but no treatment costs, is $489.00 per million gallons. The actual cost of producing and delivering well water can be significantly greater when the well is located closer to sea level and gravity flow is not sufficient to supply the area of demand.

Thus, a reasonable approach to quantifying water supply benefits for the specific alternatives proposed in this report would be based on a combination of the principles underlying all three of the methodologies described. Benefits for the surface water provided by Big River Reservoir would be computed on the basis of comparable cost of a similar, likely alternative project undertaken in the absence of Federal involvement while benefits for ground water would be determined through the use of an average unit value in the study area of $489.00 per million gallons. Since the total benefit for increased water supply for Plan A would be identical to that of the most likely alternative water supply development, that benefit is also attributed to Plans B and C.

It should also be noted that benefits would be expected to accrue to each of the three proposed Federal plans due to the demand modification component included in each. Whether or not a demand modification program would precede or be included as part of an overall water supply management plan implemented by a non-Federal authority is difficult to ascertain due to the fact that it would not be required as it is in the Federal planning process. Therefore, any reduction in demand for water must be quantified and treated as an economic benefit to all three Federal plans. For purposes of this report, it would appear reasonable to assign a value to water conserved based on the average unit value obtained for ground water.

The first proposed alternative to be considered, identified as Plan A, would provide for: a demand modification program resulting in a total annual water savings of 15 mgd on an average day and 28 mgd on the maximum day by 2030; construction of Big River Reservoir with a total storage capacity of 24,000 mg and a total safe yield of 36 mgd; development of ground water resources at various locations, primarily for use by Bristol County, with a total safe yield of 9.0 mgd for the study area. The major element of Plan A, Big River Reservoir, would also result in the accrual of benefits for flood control and recreation.

As stated previously, benefits anticipated as a result of implementation of a demand modification program should be based on the unit value of raw water in the study area, best reflected by the current average unit cost of ground water. Implementation of the proposed demand modification program would begin immediately and produce benefits in the form of water savings expected to grow at a uniform rate until 2030, peaking at 15 mgd and remaining constant thereafter (see Figure J-1). Benefits are therefore calculated as follows:

15 mgd x $490.00/mg x 365 days = annual savings
$2,682,750 = annual savings
Average Annual Equivalent Benefit (100 year project life, 50 years of uniform benefit growth @ 7-3/8% interest) = $757,000

The additional ground water development, totaling 9.0 mgd, would occur in stages between the present, 1980, and 2015, as described under Plan Description in Appendix B, Plan Formulation. For the study area as a whole, Plan A calls for development of 3.0 mgd of additional ground water in 1980, 1.5 mgd in 1990, 2.0 mgd in 1995, 1.5 mgd in 2010, and 1.0 mgd in 2015 (see Figure J-2). It has been assumed in this report that this same level of ground water development would occur even in the absence of Federal action. Since the resulting unit value for gound water is applicable to the most likely alternative, it can also be attributed to Plans B and C. Using the average unit value of ground water in the study area, annual benefits are calculated as follows:

1980	3 mgd x $490/mg x 365 days = $536,550
1990	4.5 mgd x $490/mg x 365 days = $804,825
1995	6.5 mgd x $490/mg x 365 days = $1,162,529
2010	8 mgd x $490/mg x 365 days = $1,430,800
2015	9 mgd x $490/mg x 365 days = $1,609,650

Average Annual Equivalent Benefit: $965,000

The major benefit anticipated through the implementation of all three plans would result from the additional surface water supplied through construction of Big River Reservoir, with an expected completion date of 1995. As stated previously, benefits for Big River Reservoir are based on the cost of the most likely alternative in the absence of Federal involvement. Due to the fact that the State of Rhode Island has already acquired the land for construction of a water supply reservoir on Big River and the need for such a facility has been established at the State level, it seems most probable that in the absence of Federal action, Big River Reservoir would be constructed over approximately the same time frame as the Federal proposal, ready for use by 1995. The non-Federal Big River Reservoir would be of similar dimensions and yield as the proposed Federal reservoir, but would be designed as a single purpose facility, eliminating flood control and recreation, with only minimal mitigation measures associated. Estimated first costs for construction and annual costs of the non-Federal alternative are displayed in Table 7. All costs displayed are at January 1979 price levels, present worthed from 1995.

Table 7
First Cost and Annual Cost of Non-Federal, Single Purpose Alternative Reservoir at Big River Site
(1979 Price Levels)

Construction Costs:	
Relocations	$1,108,000
Reservoir Clearing	674,000
Dam Embankment	665,000
Impervious Cutoff	1,135,000
Outlet Works	448,000
Spillway	930,000
Roads	12,000
Buildings, etc.	52,000
Equipment, etc.	34,000
Raw Water Main	294,000
84" Tunnel	5,670,000
55 mgd Water Treatment Plant	9,475,000
55 mgd Sludge Treatment Plant	671,000
Total Reservoir	21,168,000
Mitigation	
Natural Resources	189,000
Cultural Resources	134,000
Sub-total	21,481,000
Contingencies (20%)	4,298,000
Engineering and Design (12%)	3,095,000
Supervision and Administration (8%)	2,063,000
Real Estate	10,838,000
Total Project First Cost	41,785,000
Interest During Construction	6,163,000
Total Investment	$47,948,000
Annual Costs:	
Interest and Amortization (100 yrs. @ 7-3/8%)	$3,539,000
Operations and Maintenance	713,000
Major Replacements	40,000
Total Annual Cost	$4,292,000

For purposes of the economic analysis, these cost estimates are further updated to September, 1980 levels to correspond with the 1980 base year selected for discussion of all other project benefits. These 1980 values are displayed in Table 8. Annual benefits expected to accrue to all three Plans, A, B and C, for Federal construction of Big River Reservoir are therefore equal to total annual cost expressed at 1980 price levels, $4,963,000.

Table 8

Updated First Cost and Annual Cost of Non-Federal, Single Purpose Alternative Reservoir at Big River Site

June 1980 Price Levels

Total Investment	$55,140,000
Annual Costs:	
Interest and Amortization (100 yrs @ 7-3/8%)	$4,070,000
Operations and Maintenance	820,000
Major Replacements	46,000
Total Annual Cost	$4,936,000

Additional benefits expected to accrue to all three reservoir plans through provision of recreational facilities, as described in Appendix H, Recreation and Natural Resources, total $22,000. The derivation of this total is shown in Figure J-3. Benefits will begin to accrue immediately upon completion of the reservoir, and will grow with increased utilization of facilities until 2020, after which it is expected to remain constant throughout the period of analysis.

Flood control benefits for all three Federal plans are derived in the interim report issued in July 1980 by the New England Division, entitled Pawcatuck River and Narragansett Bay Drainage Basins, Water and Related Land Resources Study; Big River Reservoir Project, Rhode Island, Attachment 1 to this report. Benefits for damages prevented to existing structures and expected growth from 1972 to 1990 (much of which has already occurred) are identified in the report as $782,200 at average 1979 price levels (see Table 7-6, Summary of Average Annual Benefits for the Selected Plan). Since the time these benefits were developed, the expected completion date for a Big River project has been changed from 1990 to 1995. Thus, the base year for benefits has been changed to 1995 to correspond with the date that the project will actually become functional. If the total anticipated benefit of $782,200 is updated from average 1979 price levels to June 1980 price levels and discounted to a 1980 base year to correspond with all other project benefits, a total value of $289,000 to be used in the economic justification of the project results.

All benefits expected to accrue to Plans A, B and C are listed in Table 9. Benefit-cost ratio and net benefits are displayed in Table 10.

Table 9

Annual Benefits

	Plans A, B and C
Demand Modification	$757,000
Ground Water	$965,000
Surface Water	4,936,000
Recreation	22,000
Flood Control	289,000
Total Annual Benefits	$6,969,000

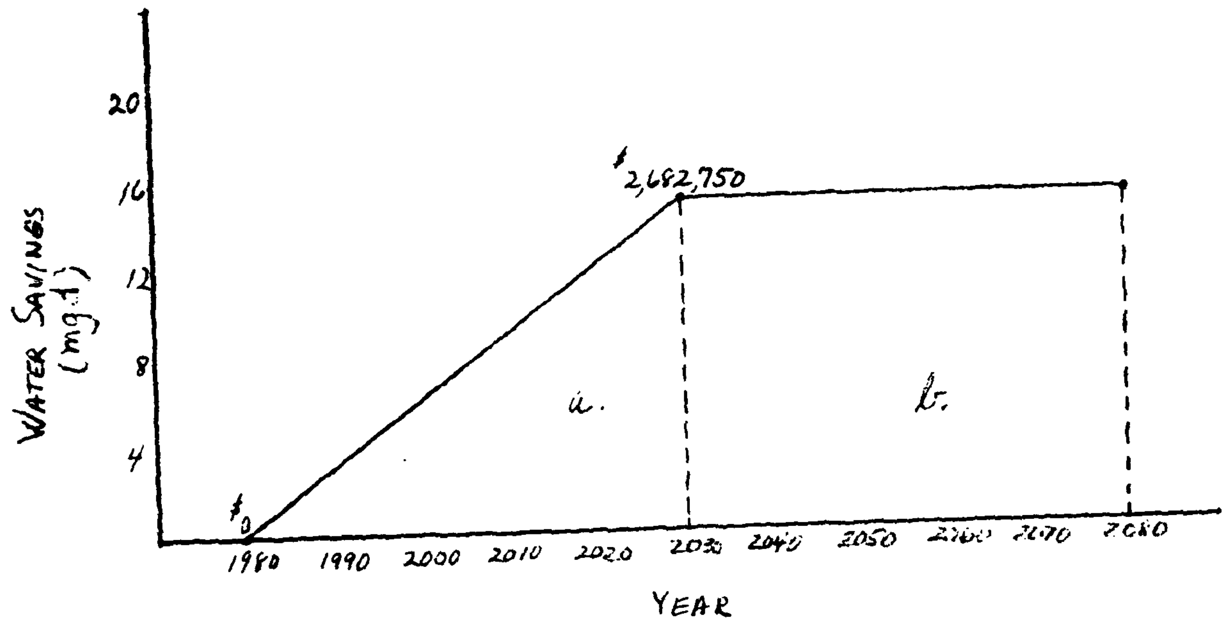
Table 10
Economic Justification

	Benefit-Cost Ratio	Net Benefits
Plan A	$\frac{\$6,969,000}{\$5,608,000} = 1.24$	\$6,969,000 - \$5,608,000 = \$1,361,000
Plan B	$\frac{\$6,969,000}{\$6,217,000} = 1.12$	\$6,969,000 - \$6,217,000 = \$752,000
Plan C	$\frac{\$6,969,000}{\$6,008,000} = 1.16$	\$6,969,000 - \$6,008,000 = \$961,000

As indicated by Table 10, all three Federal plans are justified on the basis of an expected return of greater than one dollar on every dollar invested. Since Plan A maximizes net economic benefits it is designated as the National Economic Development Plan. It should be noted, however, that many of the benefits attributable to Plan B are nonquantifiable but are of significance due to enhancement of the environment, and that while Plan C would not provide a larger capacity of surface water, it would benefit Bristol County by allowing it to draw from the Big River Supply. Selection of a recommended plan must therefore result from a trade-off of all economic, environmental, and technical positive and negative aspects of each plan.

FIGURE J-1

DERIVATION OF DEMAND MODIFICATION BENEFIT



15 mgd. x $490/mg x 365 days = annual savings (2030)

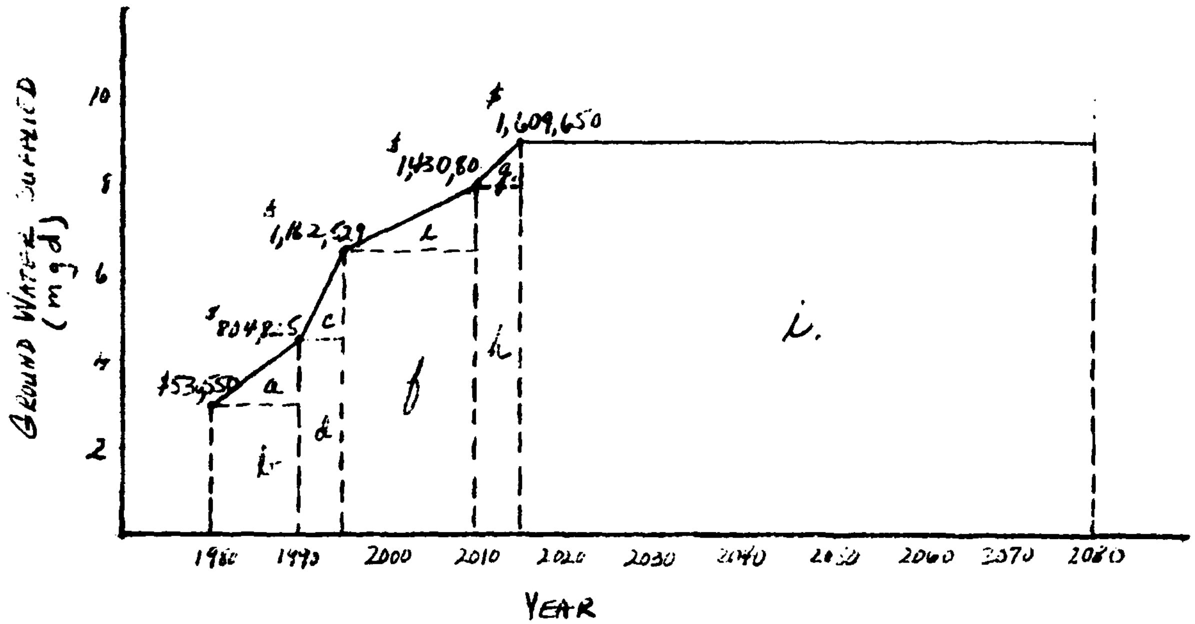
$2,682,750 = annual savings (2030)

average annual equivalency factor = .28230
(50 year uniform growth period, 100 year project life, 7 3/8% interest.)

$2,682,750 x .28230 = $757,340

Average Annual Equivalent Benefit = $757,000

FIGURE J-2
DERIVATION OF GROUND WATER BENEFIT
PLANS A, B, and C



AVERAGE ANNUAL EQUIVALENT BENEFIT = $765,000

1980: 3 mgd x $490/mg x 365 days = $536,550
1990: 4.5 mgd x $490/mg x 365 days = $804,825
1995: 6.5 mgd x $490/mg x 365 days = $1,162,524
2010: 8 mgd x $490/mg x 365 days = $1,430,800
2015: 9 mgd x $490/mg x 365 days = $1,609,650

FIGURE J-2 (CONT.)

a) \$804,825 − \$536,550 = \$268,275

$\frac{\$268,275}{10 \text{ yrs.}}$ = \$26,828/yr. = Average Annual Increase

6.9034 = Present Worth of 1 per period for 10 periods @ 7⅜%

6.9034 x 10 = 69.0340

Where 10 = # of yrs. growth period

35.0840 = Σ Present Worths of 1 per period for n-1 (=9) periods

69.0340 − 35.0840 = 33.9500

\$26,828/yr. x 33.95 x .07380 = \$67,218

Where .07380 = Interest and Amortization factor for 100 yrs @ 7⅜% interest.

b) \$536,550 x 6.9034 x .07380 = \$273,357

c) \$1,162,529 − \$804,825 = \$357,704

$\frac{\$357,704}{5 \text{ yrs.}}$ = \$71,541/yr. = Average Annual Increase

4.0594 = Present worth of 1 per period for 5 periods @ 7⅜%

4.0594 x 5 = 20.2968

Where 5 = # yrs. growth period

8.6951 = Σ Present Worths of 1 per period for n-1 (=4) periods

20.2968 − 8.6951 = 11.6017

\$71,541 x 11.6017 x .07380 x .49087 = \$30,068

Where .49087 = PW of a lump sum for 10 yrs. (1990 − 1980)

d) \$804,825 x 4.0594 x .07380 x .49087 = \$118,353

FIGURE J-2 (cont.)

e.) $1,430,800 - $1,162,529 = $268,271

$$\frac{\$268,271}{15\ yrs.} = \$17,885 = \text{Average Annual Increase}$$

8.8961 = Present Worth of 1 per period for 15 periods @ 7 3/8%

8.8961 x 15 = 133.4408
Where 15 = # yrs. growth period

73.8692 = Σ Present Worths of 1 per period for n-1 (=14) periods.

133.4408 - 73.8692 = 59.5716

$17,885 x 59.5716 x .07380 x .34391 = $27,043
Where .34391 = Present Worth of a Lump Sum for 15 years.
(1995-1980)

f.) $1,162,529 x 8.8961 x .07380 x .34391 = $262,484

g.) $1,609,650 - $1,430,800 = $178,850

$$\frac{\$178,850}{5\ yrs.} = \$35,770/yr = \text{Average Annual Increase}$$

4.0594 x 5 = 20.2968
20.2698 - 8.6951 = 11.6017

$35,770 x 11.6017 x .07380 x .11827 = $3,622
Where .11827 = Present Worth of Lump Sum for 30 yrs. (2010 - 1980)

h.) $1,430,800 x 4.0594 x .07380 x .11827 = $50,695

i.) $1,609,650 x 13.4264 x .07380 x .08286 = $132,139
Where 13.4264 = Present worth 1 per period, 35 periods.
.08286 = Present Worth Lump Sum for 35 yrs
(2015 - 1980)

Summation:
$67,218 + $273,353 + $30,068 + $118,353 + $27,043 + $262,484 + $3,622 + $50,695 + $132,139
= $964,975
Say $965,000

FIGURE J-3

DERIVATION OF RECREATIONAL BENEFIT

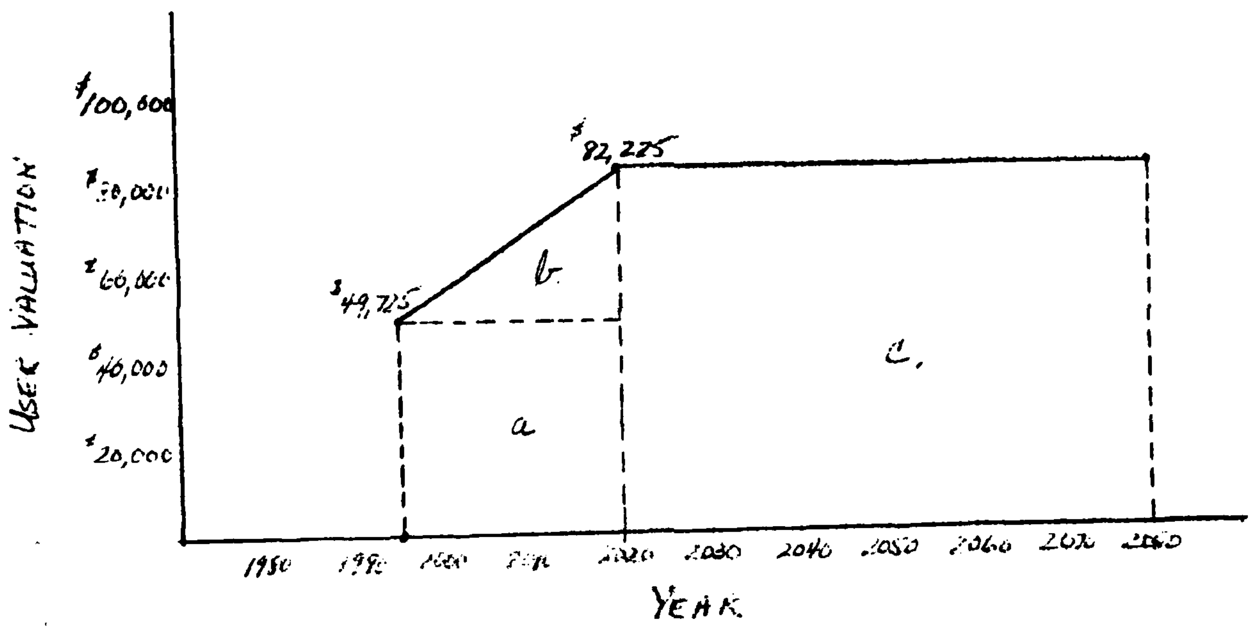


FIGURE J-3 (cont.)

a) $49,725 X 11.2703 X .07380 X .34391 = $14,224

Where: 11.2703 = Present Worth of 1 per period for 25 Periods at 7 3/8 % interest

.07380 = Interest and Amortization factor for 100 years at 7 3/8 %.

.34391 = Present worth of 1, 15 periods at 7 3/8 %.

b) $82,225 − $49,725 = $32,500

$\frac{\$32,500}{25 \text{ yrs.}}$ = $1,300 = Average annual increase.

11.2703 x 25 yrs. = 281.7575

174.8957 = Σ Present worths of 1 per period, n-1 (=24) periods.

281.7575 − 174.8957 = 106.8618

$1,300 X 106.8618 X .07380 X .34391 = $3,526

c.) $82,225 X 13.36963 X .07380 X .05806 = $4,710

Where: 13.36963 = Present Worth of 1 per period for 60 periods at 7 3/8 % interest

.05806 = Present Worth of 1, 40 periods at 7 3/8 %

Summation: $14,224 + $3,526 + $4,710 = $22,460

Say $22,000

Pawcatuck River and Narragansett Bay Drainage Basins

Water and Related Land Resources Study

BIG RIVER RESERVOIR PROJECT

APPENDIX K

INSTITUTIONAL ANALYSIS

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

July 1981

APPENDIX K

INSTITUTIONAL ANALYSIS

TABLE OF CONTENTS

I. EXISTING INSTITUTIONAL ARRANGEMENTS

A number of local, State and Federal agencies possess various powers related to the provision and protection of water and related land resources in the study area.

A. Local Agencies

1. Organization and Powers

Local agencies with water supply functions are, for the most part, the locally-managed suppliers who hold the primary responsibility for the development, operation and protection of water supply systems.

In Rhode Island these local water systems usually assume one of the following three organizational structures.

a. Municipal Departments. Cities and towns in Rhode Island may create and operate municipal water departments. Most municipal water departments have been established by special legislation, defining their service areas, management, structure and powers.

Municipal water departments are, in most communities, managed by an elected board of water commissioners, although in a few communities the water department is run by the Board of Selectmen or the Mayor through appointed public works officials. Day to day operation of municipal systems is managed by an appointed superintendent.

Once established, these departments operate under home rule and may be altered by the decision of the municipality. Municipal departments possess the following general powers:

- acquire by eminent domain, or by lease or purchase, all water and lands located within the municipality needed to develop and protect water supply sources.
- to construct water supply facilities.
- to set reasonable rates.
- to make assessments against property owners for capital improvements.
- to issue bonds for capital expenditures upon approval of the electorate.
- to sue and be sued.
- to set rules and regulations for the management and operation of its system.

- to make intermunicipal agreements with other water systems to supply and receive water.

Under special enabling acts, communities may, subject to approval and the holding of a hearing, take by eminent domain or acquire by purchase, lands outside the community needed to protect a watershed or collect and store water. Also, a board of water commissioners may, after a formal declaration of emergency, "restrain the use of water." This "restraint" may range from a public appeal to voluntarily limit the use of water for certain purposes to an absolute ban on new construction.

b. Water Districts. Water districts are public agencies created to provide water supply services to a legally defined area. This area may consist of a portion of a town or towns, or it may encompass entirely one or more towns.

Districts are usually administered by a board of water commissioners elected by users within the district and operated by an appointed water superintendent. Districts usually possess the same powers as a municipal water department; they differ from departments only in their right to borrow money.

c. Water Companies. Private water companies are defined as: every person, partnership, association, or corporation, other than a municipal corporation, or landlord supplying water to his tenant, engaged in the distribution and sale of water in the State and occupying public streets with its pipes and mains. Water companies are organized and operated as private, profit-making businesses and must pay taxes on their property holdings. They are under the immediate supervision of the Public Utilities Commission, which is primarily interested in capitalization, rate structures, and franchise territories. Any water company or corporation having franchise rights encompassing an entire municipality or district may, subject to State approval, take by eminent domain or acquire by purchase, all waters and lands needed to develop and protect water supply sources.

In Rhode Island, local supplies consist of 16 municipal departments, 7 water districts, and 2 water companies. These local supplies are subject to the requirement that all new supply sources receive Department of Health approval. It is also required that all new supply sources and distribution systems must be reviewed and approved by the State's Water Resources Board for compliance with the State's water resources development plan.

Of the 39 communities in Rhode Island, only 3 communities have municipal water departments that serve their entire community only. The remaining communities are served by combinations of water districts, large municipal departments with intermunicipal agreements and regional supply systems.

2. Operations

All water suppliers in the study area are single purpose entities. To meet the cash requirements of providing services, two methods are employed -- the wholesale or retail approach. The wholesale approach is used by water systems serving more than one community or district, and it entails the billing of each individual community or district connected with the system for its share. The retail approach involves billing each individual user.

3. Finance

a. Local Financing

(1) Major construction projects. At a local level, public water agencies may obtain funds for major construction projects using the following financing mechanisms:

(a) general obligation bonds - Municipal water departments and districts may issue general obligation bonds which are backed by the full fiscal resources of the community, including property taxes. Repayment of these bonds is guaranteed by taxes levied on all real property. These bonds have low interest rates due to their low risk and are easily marketable due to their standardized marketing procedure. To issue general obligation bonds, an agency must have the power to levy taxes. Issuance usually requires prior approval by qualified voters in an election.

(b) revenue bonds - Revenue bonds may also be used to finance major construction projects. Money for their repayment is raised from charges levied for services performed by the issuing unit. They are often used by revenue producing agencies and are quite popular because:

- legal limits do not exist.
- many agencies do not have the power to tax.
- voter approval isn't necessary.
- they can be used to finance projects extending beyond municipal boundaries.

These bonds have higher interest rates, but they are usually accepted as par with general obligation bonds in terms of risk.

(c) special assessment bonds - Special assessment bonds may also be used to finance project. Repayment of these bonds is accomplished through special assessments against benefited property owners. Their interest rates and finance charge is higher than other bonding methods. They are often issued in connucnction with general obligation bonds. In such cases, construction of facilities which benefit the general community are funded by general obligation bonds and laterals, mains, and submains, which abut and service properties, are funded by special assessment bonds. Special assessment bonds are usually short term, thus reducint the long term debt of the community.

(2) Cash requirements. Revenues are needed to enable an agency to meet the cash requirements of operation and maintenance, annual debt service, and repairs. These revenues are usually obtained through service charges, installation charges, and general taxation. As previously mentioned, there are two common approaches to billing for services rendered: the wholesale approach and the retail approach. Users are usually billed according to water consumption. Most water systems charge a flat fee for a minimum level of water use. However, billing practices for use over the minimum level vary among different water systems. Some systems charge a constant rate for all units of water used above the minimum level. Other systems employ a sliding scale for increased water -- as the water use increases, the cost of units of water decreases.

All excess revenue from the operation of municipal water departments go to a community's general fund and the funds used by the department come directly out of the general fund. Thus, a water department cannot apply its income towards improvements as private water companies and districts do. Although most municipal water departments prepare their own budgets, the budget must be approved by town meeting members or a city council.

b. <u>Federal Financing</u>. Federal assistance is availble, in some cases for the financing of major construction projects.

(1) Economic Development Administration (EDA) grants. The Economic Development Administration, an agency of the Department of Commerce, provides funding in the field of water supply. EDA will contribute as much as 80 percent to the cost of local public works in towns where the economy is depressed, and it "can be shown that the project tends to improve the opportunities for the successful establishment or expansion of industrial or commercial plants or otherwise assist in the creation of additional long-term employment opportunities."

(2) Farmer's Home Administration (FHA) funding. The FHA makes loans and grants to public bodies and non-profit organizations for the construction of rural and community water and waste disposal systems. Under this program grants up to 50 percent of the construction of water facilities may be made. Eligible projects must serve residents living in open country or in rural towns with a maximum population of 10,000.

(3) Housing and Urban Development (HUD) grants. Under the Housing and Community Development Act of 1974, the Department of Housing and Urban Development may make block grants to communities for improvements. These grants may be applied to water department expenses and water facility construction costs.

(4) Programs of the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and Soil Conservation Service (SCS). The Army Corps of Engineers and the Bureau of Reclamation, under the Water Supply Act of 1958, and the SCS, under Public Law 566, may provide for additional capacity for other purposes. The Army Corps of Engineers and the Bureau of Reclamation require the non-Federal interests to pay costs allocable to the provision of such water at Federally subsidized interest rates. The SCS required such repayment up until the passage of the Rural Development Act of 1972, which authorizes the Secretary of Agriculture to bear up to one-half the costs of reservoir storage capacity for present municipal and industrial water supply needs.

B. Regional Agencies

1. Regional Water Suppliers

Rhode Island contains regional water systems created by special acts of the legislature which provide water supply services on an areawide basis. Membership in these systems is mandatory in some cases and discretionary in others. In general, the regional supplier is responsible for the development, operation and maintenance of the water supply source and related facilities, while the community or districts supplied are responsible for the distribution to the individual consumer. A description of some of the regional suppliers in the study area is provided below.

a. Kent County Water Authority

(1) Organization. Rhode Island's Kent County Water Authority is a political subdivision whose boundaries are conterminous with the boundaries of Kent County. It is administered by the board consisting of five members (four members appointed by the town or city councils of the four municipalities within the country, and one member appointed by the council of the town or city with the greatest number of inhabitants). It currently serves parts of two communities outside Kent County through contractual arrangements.

(2) Powers. As stated in its enabling legislation, the Kent County Water Authority has the following major powers:

- to produce, distribute, and sell water within or out of the limits of the district.
- to acquire by purchase, own, operate, maintain sell, lease, or otherwise dispose of property involved in the provision and protection of water supply.
- to fix rates and collect charges.
- to make by-laws for management.
- to issue bonds.
- to sue and be sued.
- to enter into cooperative agreements with cities, counties, towns or water companies for interconnection of facilities.

(3) Operations. The Authority supplies water on a retail basis to towns within the district and on a wholesale basis to towns outside the district.

(4) Financing. Major construction projects are financed by the issuance of revenue bonds. Operations and maintenance costs are met through water usage charges.

b. The Providence Water Supply Board.

(1) Organization. The Providence Water Supply Board, the largest water system in Rhode Island is managed by a board of water commissioners consisting of a finance director, ex officio, and six other members, four of whom are appointed by the Mayor subject to the approval of the city council, and two of whom are members of the city council.

(2) Powers. The Act establishing the Board authorizes it to acquire by purchase or eminent domain all waters, lands, and flowage rights within a specified area of the watershed of the North Branch of the Pawtuxet River, as are necessary to provide its users with adequate and safe drinking water. A 1967 amendment to the Act designates communities and districts currently served and sets a maximum limit of a monthly average of 150 gallons per capita per day on the quantity of water to be supplied to each community or district. The board is also empowered to construct facilities, set rates, determine billing methods, lease its lands, set rules and regulations for users of the system, and regulate the amount and use of water in times of emergency.

(3) Operations. Currently, the Providence Water Supply Board supplies five communities on a retail basis and six water systems on a wholesale basis.

(4) Finance. Major construction projects are financed by bonds issued by the city of Providence. Operation and maintenance costs are covered by water use charges.

2. Regional Planning Agencies

In Rhode Island, the Statewide Planning Program, a state agency, conduct locally oriented planning and is involved in 208 planning. Today, the major responsibility in the area of water supply is the review of water supply projects where Federal programs of assistance to local communities require regional planning agency review prior to approval.

C. State Agencies

1. Department of Environmental Management (DEM)

The Department of Environmental Management in Rhode Island is involved with all key environmental issues which affect the State. The DEM has wide ranging jurisdiction encompassing protection, regulation and management of air, land and water resources in Rhode Island. The major activities of DEM are:

- control and abatement of sources of water pollution.
- improvement and preservation of air quality.
- preservation of Rhode Island's lands, especially wetlands from pollution and unnecessary encroachment.
- administration of Rhode Island's forest resources and natural areas.
- operation and maintenance of State parks and beaches as well as protection of Rhode Island's natural resources and all visitors to State recreation areas.
- preservation and management of Rhode Island's fish and wildlife resources.
- enforcement of boating laws throughout the state while promoting safe boating practices.
- development and improvement of the state's navigable waters and coastal zone.

2. <u>Water Resources Board</u>

The Rhode Island Water Resources Board was created in 1967 to coordinate the development, conservation, and apportionment of water resources in the State. The Board consists of nine members as follows:

- five representatives of the public who are appointed by the Governor. At least two of these members shall be affilitated with public water systems.

- the Director of the Department of Natural Resources.

- the Director of the Department of Community Affairs.

- the Chairman of the joint legislative committee on water resources.

The representatives of the state government all serve ex officio. The major powers and duties of the Board are:

- to acquire sites and other related property, other than property already owned by an agency for water supply purposes, for reservoirs by either purchase or eminent domain.

- to construct or purchase water supply facilities and lease these facilities to a public agency willing to construct and administer such facilities.

- to formulate and maintain a long-range water resources guide plan and implementation program.

- to provide for cooperative development, conservation, and use of water resources by water systems.

As part of its coordination responsibilities, the Water Resources Board has the power to allocate water resources, review and approve all new water supply sources and facilities, and insist that certain supply syst[illegible] provide transmission lines to communities that may later need wat[illegible] the source being developed. As for funding, the Board does maintain a water development fund. This fund is a special revolving fund established from rents on reservoir sites and other income from the sale of properties on sites to make loans to public water agencies for all projects related to water resources with the exception of the purchase of reservoir sites.

The purchase of reservoir sites requires the approval of the issuance of general obligation bonds by the General Assembly and the electorate. The Water Resources Board is not empowered to issue revenue bonds, which require no public or legislative consent.

3. Department of Health

The Rhode Island Department of Health has the power to approve the quality and adequacy of water supply sources and treatment works, set water quality standards, and enforce rules and regulations established by the Department.

4. Public Utilities Commission

The Public Utilities Commission's major responsibilities for water supply are to hold hearings and make decisions on requests for rate changes. It also decides on requests for variances from its minimum and maximum service connection pressure regulations of 20 psi and 120 psi gage pressure, respectively. It does not yet have jurisdiction over a few of the small private water companies in the State.

5. Rhode Island Statewide Planning Program

The Statewide Planning Program is a division of the Rhode Island Department of Administration. It is the central planning agency of the state and is guided by the state planning council, comprised of State, Federal and local representatives. Its function is to plan the development of the state, coordinate activities of government agencies and private individuals and groups, and provide planning assistance to the state government, the General Assembly, and government agencies.

6. The General Assembly

The Rhode Island General Assembly approves all local requests for development of water supplies outside of local jurisdiction and for diversions out of watersheds.

D. Federal Agencies

1. The U.S. Environmental Protection Agency (EPA)

Under provisions of the Safe Drinking-Water Act of 1974, the U.S. Environmental Protection Agency has the primary responsibility for establishing and enforcing drinking water standards and otherwise supervising public water supply systems and sources of drinking water. Interim primary drinking-water standards have been established by EPA and became effective 24 June 1977.

It is the intent of the Act to transfer the EPA's enforcement responsibilities for protecting drinking water to the states. To assume this responsibility, states must have drinking-water regulations no less stringent than the Federal regulations as prescribed in the Act and should have a plan for providing safe drinking water in emergency situations. They must also have monitoring programs that comply with Federal requirements and sufficient enforcement authority.

EPA is currently working with the states to assist them in the development of laws and regulations necessary to carry out their enforcement responsibilities. Whenever a state does not force a public water system's compliance with drinking water regulations or a schedule imposed with a variance or exemption, EPA is directed to begin enforcement action.

EPA also has the responsibility of developing requirements for underground injection control. Primary responsibility for carrying out these requirements falls to the states where underground source protection programs are designated to be needed. If the state fails to assume such a program within a specified period of time, EPA is required to prescribe a control program for that state.

2. U.S. Army Corps of Engineers

The Corps is involved in various aspects of water supply planning and development.

The Water Supply Act of 1958 authorized the Corps to provide for excess capacity for municipal and industrial water supply in reservoirs to be constructed primarily for other purposes on condition that non-Federal interests agree to pay the cost allocable to such water.

Title I of of the 1965 Flood Control Act authorized the Corps to undertake the Northeast Water Supply Study (NEWS). The purpose of this study was to prepare a regional water supply plan that would address the long range water supply needs of the northeastern United States. This study was scheduled for completion in FY 1977. The study proposed single purpose water supply projects; the costs of these projects are to be reimbursed by non-Federal interests under the same conditions stipulated in the Water Supply Act of 1958.

3. Soil Conservation Service

The Soil Conservation Service of the Department of Agriculture is a technical agency created to develop and carry out a national soil and water conservation program, including the provision of technical aid for planning and installing conservation farming systems on farm lands, and for projects for the conservation and development of land and water resources in the upstream watersheds. This assistance is currently being provided primarily under three authorities: 1) the Soil Conservation Act of 1935, 2) the Flood Control Act of 1944, and 3) the Watershed Protection and Flood Prevention Act of 1954.

4. The Water Resources Council

The Water Resources Council was established by the Water Resources Planning Act of 1965 to encourage conservation, development and utilization of water and related land resources on a comprehensive coordinated basis.

5. Other Federal Agencies

As previously mentioned, the Department of Housing and Urban Development (HUD), the Farmer's Home Administration (FHA), the Economic Development Administration (EDA), and the Bureau of Reclamation administer programs which provide assistance to communities for the development of water supply systems.

II. EXISTING LEGAL FRAMEWORK

A. Water Rights

In Rhode Island, each town's rights are defined by special Acts of the State Legislature. Since cities and towns are chartered by the state, their rights are subject to the state's wishes. This means the state can pre-empt rights to various water bodies (including groundwater) or give one community the complete authority over a body of water lying in another community. The water body may not be jointly used by another public water supplier without the permission of the first user.

Public suppliers must petition the state for new sources and petitions may be challenged by other suppliers. Such conflicts are resolved by state legislation.

The State of Rhode Island has exercised its power to pre-empt water rights. Chapter 1278 of the Rhode Island General Laws grants the Providence Water Supply Board rights to waters of the North Branch of the Pawtuxet River and waters flowing into the Scituate Reservoir complex provided that the city shall forever discharge from its reservoir sufficient quantities of water to maintain a flow of not less than 500,000 gallons per day in the North Branch of the Pawtuxet River below the lowest dam built by the city on the Branch. The Act also provides that the city shall discharge further quantities of water, when necessary, to maintain a flow of not less than 6 million gallons each day, except Sunday, into a pond formed by Arkwright Dam of Interlaken Mills in Coventry and to maintain a flow of not exceeding 72 million gallons each week at the Clyde Bleachery and Print Works in West Warwick.

Apart from water rights granted by Special Acts, water rights are determined by the doctrine of "riparian rights of reasonable use:" a landowner is entitled to make reasonable use of water flowing on his land or contiguous to it. The doctrine of riparian rights is a common law doctrine which has evolved over time through judicial decisions.

B. Protection of Water Supply

In Rhode Island, various enabling acts give municipalities the power to take by eminent domain, lands needed to protect a watershed or to collect and store water.

In addition to their power of eminent domain, municipalities have, through wetlands legislation, the power to issue protective orders to restrict alterations of wetlands where sites are significant to water supply and, through zoning legislation, the authority to use zoning to protect areas important to water supply.

The Rhode Island Department of Health has the authority to take action to preserve the quality of water used as sources of public supplies.

III. INSTITUTIONAL ALTERNATIVES

This section discusses several alternative institutional structures for the management of water supply. These alternatives are not portrayed here in complete detail. Rather, it is the purpose of this presentation to outline alternative institutional frameworks upon which details can be built after alternatives for water supply have been formulated. Further, the alternatives described here are not meant to be mutually exclusive as certain characteristics of one alternative may be incorporated into a number of options and combinations of various alternatives may be required to address both short and long term needs. The institutional options discussed fall into five categories based on the level of government most responsible for the alternative's implementation. These categories are local, regional, state, interstate and federal.

A. Local Options

Publicly and privately owned water utilities shall continue to provide water supply services on a local basis within the framework of each state's existing laws, regulations, and institutional arrangements. Individual communities or supply systems would be responsible for planning, financing, construction, and operation of their own water supply facilities. They would have powers of eminent domain, they would be responsible for setting rates and managing their water system by their own choice of administrative arrangements. State-level programs could be implemented to strengthen state responsibilities in the area of water supply management, however, these programs as now would cause minimum interference with local management responsibilities.

B. Regional Options

1. Single Purpose Regional District

a. Organization. Single purpose districts, similar to the Kent County Water Authority, could be established by special legislation which would assign specific responsibilities for water supply functions. Membership in these districts could be either voluntary or compulsory. They could be administered by an advisory board consisting of elected representatives from member municipalities could be based on equal representation of each municipality or proportional representation by population. The advisory board would be responsible for formulating policy, approving budgets, and employing personnel. It would appoint a board of trustees or water commissioners to provide daily management and supervision. Staff would consist of an executive director, an engineering section, an accounting section, and a legal advisor.

b. Powers. Each district would have the power of eminent domain. They would have the right to purchase all water rights and facilities of member municipalities with a guarantee to former owners of protection against future water shortages. All previous statutes concerning local water rights in the district would be repealed and former owners would receive equitable compensation for former property accredited to their account for services. These districts would also have the power to set rates, make rules and regulations for the operation of the system, make assessments against property owners for capital improvements and issue bonds.

c. Operational Features. Construction, operation and maintenance activities would be a district level responsibility. Planning, monitoring, and enforcement would also be carried out at a district level, but would be subject to state programs and standards. Daily service functions would be provided by the central district, or through a series of sub-districts. Billing for services would be accomplished by either retail or wholesale approach.

d. Finance. Special legislation would be required to allow districts to issue bonds pledging the full faith and credit of member municipalities as one separate entity. Thus, the debt limitation of each single municipality would not be affected. As previously stated, operation and maintenance costs would be provided through assessments against member municipalities or charges to individual users. Yearly budgets would be prepared by the board of trustees and approved by the advisory board.

2. A Multi-Purpose Regional District

Multi-purpose districts could be created by enabling legislation. These districts would have responsibility for water supply management along with responsibilities for other aspects of water and related land resources management. The organizational structure, operational procedures, powers and financing capabilities of these districts could be similar to those of the Single Purpose Regional District Alternative, however, water supply would be only one of the ongoing divisions or departments administered by the advisory board.

The outcome of the State's 208 plan is expected to determine the feasibility of the creation of regional districts with water supply and wastewater management responsibilities. In some areas, the recommended 208 management structure may conflict with the multi-purpose district structure discussed earlier.

C. State Options

1. A Single Purpose Statewide Agency

a. Organization. State agencies responsible for providing water supply services on a statewide basis could be established. These agencies could be administered by a single commissioner or a board of commissioners, responsible for day-to-day supervision. Services could be provided through a series of operating districts determined by the st[illegible]s.

b. Powers

These statewide agencies would have powers to:

- formulate state water supply management plans.
- construct, operate and maintain regional water supply facilities.
- take water and lands by eminent domain for water supply services.
- set rates for water supply services and wholesale water.
- monitor all supply sources and facilities.
- issue bonds.

Such agencies could also have the power to acquire existing local water supply systems or all existing local supplies could remain a local responsibility. However, local supplies would require state agency approval for all improvements and extensions.

c. Operations. Planning, financing and construction of new water supply projects would be carried on at the state level. District level offices would carry on day-to-day operation, maintenance, and monitoring functions for all water supply systems over which they have jurisdiction. These districts would also be responsibile for billing users of the system.

Establishment and enforcement of rules and regulations for system operation and water quality standards would remain the responsibility of state agencies separate from these statewide water supply agencies, thus, allowing objectivity in enforcement actions.

d. Finance. These state water supply agencies could finance major construction projects through the state legislature as contingent debt. Debt would be repaid through assessments against municipalities benefiting. General obligation bonds could be issued pledging the full faith and credit of the state.

2. A Multi-Purpose Statewide Agency

State agencies with responsibility for providing water supply services in combination with services in other water and related land resources areas could be established. Organization powers operation and financing capabilities of these agencies would be similar to that of the single purpose statewide agency described above. At the state level, the agency would be departmentalized into the various areas of water resource management over which it has jusisdiction.

D. Interstate Options

1. A Single Purpose River Basin Commission

a. Organization. In areas where river basins encompass more than one state, a river basin commission, responsible for water supply management could be established. Establishment of such an institution would require special legislation by participating states and interstate agreements. The commission could be administered by a board of commissioners consisting of members appointed by the governors of each state.

b. Powers. The commission could be empowered with various combinations of the following responsibilities.

- resolution of problems of water rights and interstate allocation and diversion of water.
- development of basin-wide water supply management plans.
- review and approval of all projects with impacts on the basin's water supply.
- finance, construct and operate new large-scale interstate water supply projects.
- development of cost sharing arrangements and assumption of reimbursement obligations if projects are federally funded.

c. Operations. Existing local water supply agencies would continue to operate as they do today, however, new projects would be subject to review and approval of the basin commission.

If vested with powers to construct and maintain interstate water supply systems, the river basin commission would be responsible for operation of new interstate systems, and they would have the power to set rates for water use and bill water users.

d. Finance. Major constructon projects could be financed through the issuance of revenue bonds, the revenue obtained from user charges, earmarked taxes levied by state or local governments, and federal loans. Day-to-day operation and maintenance of interstate water systems managed by the commission could be financed through user charges.

2. A Multi-Purpose River Basin Commission

A river basin commission with responsibilities for water supply management and various other aspects of water and related land resources management could be established by special legislation in participating states and interstate agreements. The commission could be organized much the same as a single purpose river basin commission except that it would be departmentalized according to its various water resources management responsibilities. Powers, operations and financing mechanisms would also be similar to those of the single purpose entity, however, the commission's multi-purpose functions would require a more intricate structure of interstate agreements.

E. Federal Options

The history of federal involvement in water supply management has been limited; most direct federal involvement in this area has consisted of construction projects for flood control and reclamation purposes with water supply components fully reimbursable by states and localities to be served. Indirect involvement has consisted of a grant and loan program for water supply planning, the preparation of water supply plans in conjunction with state and local entities, the setting of drinking water regulations, technical assistance, and research.

The Water Supply Act of 1958 clearly stated that it is the policy of the federal government to recognize the primary responsibility of state and local interests in the development of water supply for domestic municipal, industrial, and other purposes, and that the federal government should cooperate with states and local interests in the development of water supplies in connection with federal navigation flood control, irrigation of multi purpose projects, The Rivers and Harbors Act of 1965, which authorized the NEWS Study, places greater emphasis on a direct federal role in planning and possibly construction and management of water supply systems. However, the feasibility of federal takeover of water supply and distribution functions is quite low due to the heterogenity of sources, requirements, and existing institutions and local preference for home rule.

Therefore, future options for federal participation in water supply management consist of limited direct roles and indirect or simulatory roles.

Direct federal participation could consist of federal provision of water supply facilities to supplement existing systems. Either a federal corporation could be established to finance, construct and possibly manage these facilities, or an existing federal line agency could assume one or more of these functions.

Indirect federal options could consist of:

- federal assistance in resolution of water allocation problems.

- increased federal participation in water supply planning through membership in various interstate and state water resources planning agencies.

- stronger federal programs to provide funds and technical assistance for state and local planning. Such programs could provide non-reimbursable grants for demonstration projects.

- establishment of a federal agency to coordinate applications for water supply grant and loans programs.

- federal establishment of research institutes to study new technologies, water conservation techniques, store data, and disseminate information.

- formation of a permanent federal agency, provide technical assistance to state and local interests in areas of planning and design and project evaluation.

Several of the above options could be implemented, along with the various local, state, and interstate alternatives discussed here to provide better integration of water supply planning and management between federal and non-federal agencies.