



SUDBURY, ASSABET AND CONCORD

WILD AND SCENIC RIVER STUDY

DRAFT REPORT

SEPTEMBER 1996

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SEPTEMBER 1996

Prepared by:

Rivers Program

New England System Support Office

National Park Service

U.S. Department of the Interior



Dick Walton



This report is dedicated to the memory of Allen Morgan.

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SUMMARY OF FINDINGS

ELIGIBILITY

Twenty-nine miles of the Sudbury, Assabet and Concord rivers were found eligible for inclusion in the National Wild and Scenic Rivers System, based on their free-flowing character and the presence of five outstandingly remarkable river-related resources: ecology, history, literature, recreation, and scenery. The eligible segments include 16.6 miles of the Sudbury River, 4.4 miles of the Assabet River, and 8 miles of the Concord River.

CLASSIFICATION

The Wild and Scenic Rivers Act provides for three possible classifications of eligible river segments: "wild," "scenic," or "recreational." These classifications are based on the degree of human modification of the river and adjacent shorelands. The study determined that the upper 14.9 miles of the Sudbury River study segment, starting at the Danforth St. bridge in Framingham and continuing downstream to the Rte. 2 bridge in Concord, should be classified "scenic," while the remainder of the study area, including the 1.7 mile portion of the Sudbury River between the Rte. 2 bridge and Egg Rock in Concord, and all of the Assabet and Concord river study segments, should be classified "recreational." This "recreational" classification was based on the overall development context, though some short stretches within the proposed "recreational" segment could certainly qualify for a "scenic" classification.

SUITABILITY

The entire study area was also found to be suitable for inclusion in the National Wild and Scenic Rivers System, based on:

1) the adequacy of long-term protection afforded to the rivers' free-flowing character and outstanding resources through conservation land ownership, state and local land use controls, and topography. These forms of protection serve to prevent land use changes that would destroy the outstanding resources or be incompatible with existing development along the river.

2) the strong support for designation expressed by the study area communities through Town Meeting votes and through their endorsement of the *Sudbury, Assabet and Concord River Conservation Plan* prepared during the study; and

3) the existence of an appropriate river management framework, the proposed SuAsCo River Stewardship Council, to implement the *River Conservation Plan* and to administer the rivers in partnership with the federal government if designation occurs.

STUDY COMMITTEE RECOMMENDATION

At its February 23rd, 1995 meeting, the Sudbury, Assabet, and Concord Wild and Scenic River Study Committee voted unanimously to recommend designation of the entire 29-mile study area. The Committee also recommended that the rivers be managed in accordance with the *Sudbury, Assabet and Concord River Conservation Plan*. This *Plan*, which describes the administrative framework to be used if the rivers are designated, was endorsed unanimously at the Study Committee's March 16th, 1995 meeting.

RECOMMENDATION

Twenty-nine miles of the Sudbury, Assabet and Concord rivers in eastern Massachusetts are recommended for designation as scenic and recreational rivers under the national Wild and Scenic Rivers Act, to be managed in accordance with the *Sudbury, Assabet and Concord River Conservation Plan* dated March 16th, 1995. The river segments meet the eligibility and suitability criteria for such a designation, and the eight riverfront towns and Commonwealth of Massachusetts have expressed strong support for the designation.



NPS/Roy Crystal



Confluence of Sudbury and Assabet rivers at Egg Rock in Concord.

CHAPTER 1 INTRODUCTION AND STUDY BACKGROUND

This chapter provides an overview of the Wild and Scenic Rivers Act and the Sudbury, Assabet and Concord Rivers Study. It includes a review of the project's history, the study strategy and process, the principal participants, and the major study products and accomplishments.

1.1 THE WILD AND SCENIC RIVERS ACT

The national Wild and Scenic Rivers Act (P.L. 90-542, as amended) was enacted in 1968 to balance long-standing federal policies that promoted the construction of dams, levees, and other river development projects with a program that would permanently preserve selected rivers, or river segments, in their free-flowing condition. Section 1(b) of the Act states:

“It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.”

The original Act designated eight rivers as components of the National Wild and Scenic Rivers System, and specified processes by which other rivers could be added to this system.

As of July, 1996, one hundred fifty-one rivers or river segments totalling almost 11,000 miles had been included in the national system. Only four of these rivers are located in New England: the Allagash in Maine; the Wildcat in New Hampshire; the Westfield in Massachusetts; and the Farmington in Connecticut.

Each designated river receives permanent protection from federally-licensed or assisted dams, diversions, channelizations, and other water resource projects that would have direct and adverse effects on the river's free-flowing condition or outstanding resources. The Wild and Scenic Rivers Act explicitly prohibits new dams or other hydroelectric projects licensed by the Federal Energy Regulatory Commission (FERC) on or directly affecting a designated river segment, and requires that

all other proposed federally-assisted water projects be evaluated for their potential impacts on the river's special features. Projects that would result in adverse impacts on the designated segment are precluded under the Act.

This same protection is provided on a temporary basis for rivers that are under formal, legislatively-authorized study for potential addition to the national system. The interim protection remains in place from the date of study authorization until Congress decides whether to designate the river into the national system, or until three years after the final study report is transmitted to Congress by the President, whichever comes first.

1.1.1 REQUIREMENTS FOR DESIGNATION

Before a river can be added to the National Wild and Scenic Rivers System, it must be found both *eligible* and *suitable*. To be eligible, the river must be i) free-flowing; and ii) possess at least one “outstandingly remarkable” resource value, such as exceptional scenery, recreational opportunities, fisheries and wildlife, historic sites, or cultural resources. These resource values must be directly related to, or dependent upon, the river. The determination of a resource's significance, i.e. the degree to which it fulfills the “outstandingly remarkable” requirement, is based on the professional judgement of the study team.

The suitability determination is based upon several findings. First, there must be evidence of lasting protection for the river's free-flowing character and outstanding resources, either through existing mechanisms (including patterns of conservation land ownership, state and local land use regulations, physical barriers to inappropriate development, etc.), or through a combination of existing and new conservation measures resulting from the wild and scenic study. Second, there must be strong support for designation from the

entities—riverfront landowners, river users, local municipalities, conservation organizations, and state agencies—that will be partners in the long-term protection of the river. Third, a practical management framework must be devised that will allow these interests to work together as effective stewards of the river and its resources. Finally, wild and scenic designation must make sense for the river in question: it must be an appropriate and efficient river conservation tool.

In proposing a river for designation, a recommendation is also made regarding the river's proposed *classification*. The classification—wild, scenic, or recreational—is based solely on the intensity of human presence along the river corridor, in the form of railroads, highways, utility lines, buildings, etc., at the time of classification. A river's classification is principally used to guide future decisions by federal agencies on projects affecting federally-owned lands along the river (e.g., whether the construction of a new boat ramp is appropriate). For rivers that primarily flow through non-federal lands, the classification is less consequential.

The Act defines the three classifications as follows:

“Wild river areas - Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds and shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic river areas - Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational river areas - Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.”

The requirements and criteria for eligibility, suitability, and classification, along with the study findings, are described in more detail in Chapters 3 and 4.

1.1.2 MANAGEMENT ALTERNATIVES

The Wild and Scenic Rivers Act provides a range of approaches to the management of designated rivers. For rivers located within existing federal areas, the federal land managing agency (National Park Service, Bureau of Land Management, Fish and Wildlife Service, or Forest Service) is given responsibility for implementing designation through the protective management of the designated segment and lands within the river's boundaries.¹ In other cases, wild and scenic river designation has resulted in the creation of a new federal area, such as a national park unit, which is administered in the same manner as other national park areas. Federal acquisition of land and scenic easements along the designated segment is authorized in the Act to facilitate the creation of the new federal area.

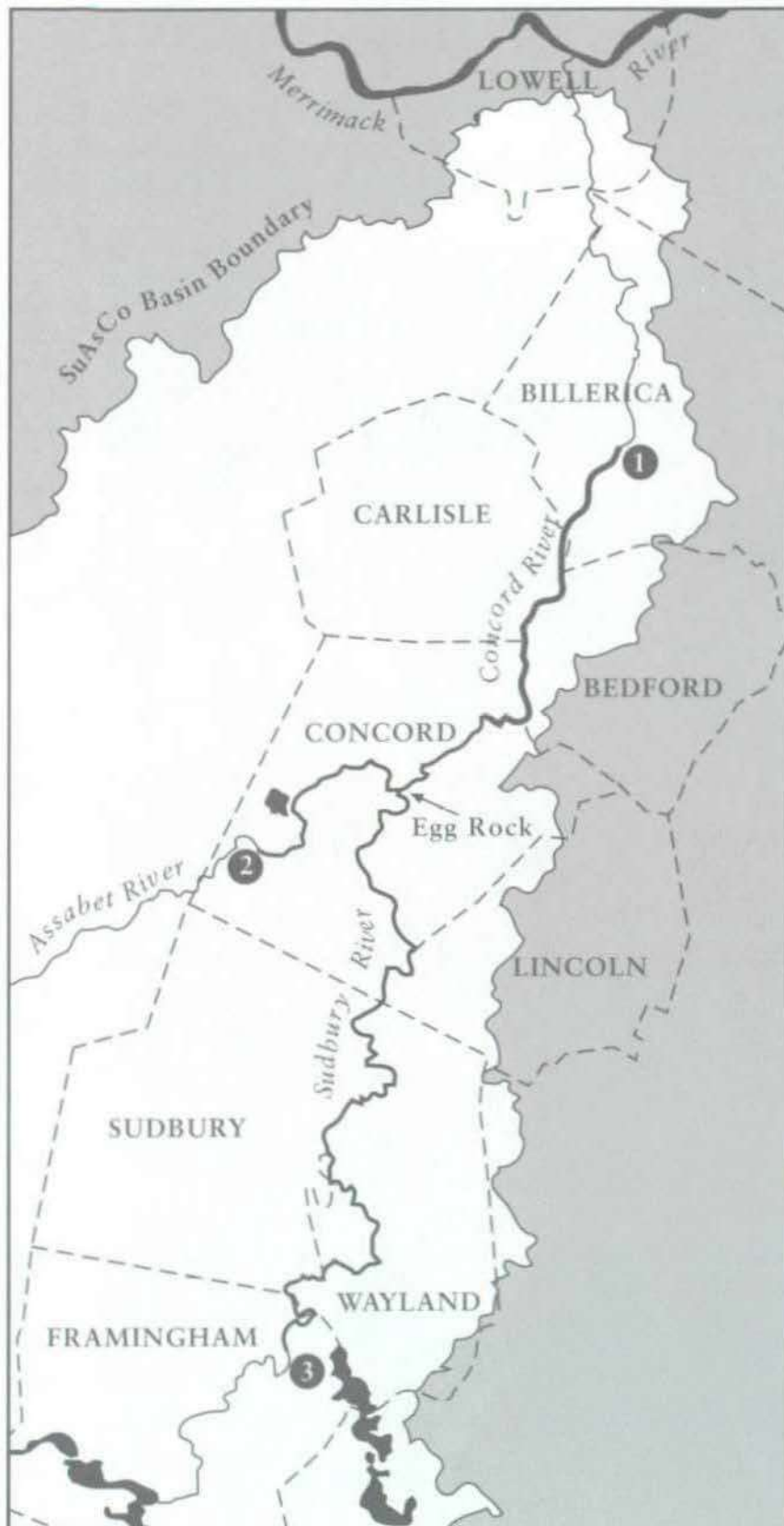
Direct federal management of designated rivers through the ownership of adjacent lands is not the only alternative, however. The Act also provides for state administration of a wild and scenic river in cases where the river has already been protected pursuant to state legislation. On such rivers, the federal government's only role is to ensure that proposed federal water resources projects do not adversely affect the river's free-flowing condition or the resources that made it eligible for designation. Federal land acquisition or any other form of federal expenditure for river protection is expressly prohibited.

A third approach, administration by the federal government in partnership with state and local governments, has been used with increasing frequency to manage so-called “private lands” wild and scenic rivers located in the northeastern states. This strategy combines the advantages of direct federal management—continuing federal assistance in protecting the river's resources—with the advantages of the non-federal approach. Little or no land along the river is acquired by the federal government, federal land use regulations are not imposed, and no strong federal presence is created. Instead, primary responsibility for protecting the river and adjacent lands remains with existing state, county, and local governments, while the federal government

1. Unless otherwise provided in law, such boundaries average 1/4 mile on either side of the designated segment, and are required to be established within one year of designation.

SUASCO WILD & SCENIC RIVERS STUDY AREA

INCLUDING PORTIONS OF THE SUDBURY, ASSABET & CONCORD RIVERS



POINTS DEFINING THE FOCUS AREA

- 1 Route 3 bridge in Billerica
- 2 1000 ft. below the Damon Mill Dam in West Concord
- 3 Danforth Street bridge in Saxonville



Statute Miles



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provides a modest budget for policy coordination and ensures that federal actions are consistent with wild and scenic conservation goals. This approach recognizes that not all wild and scenic rivers are appropriate additions to the national park, national forest, or national wildlife refuge systems. Furthermore, it emphasizes the importance of state and local land use regulations and flow management policies in protecting the river and its resources. By promoting a partnership among all levels of government and private landowners, this cooperative approach to wild and scenic river administration ensures "buy-in" by all the entities which have the power to affect the river in question.

The recommended management approach for the Sudbury, Assabet, and Concord rivers, should they be designated, was made following the eligibility and suitability analyses. It is described in Section 4.3, which presents the proposed River Stewardship Council, and in Chapter 5, which examines alternative study outcomes.

1.2 SUDBURY, ASSABET AND CONCORD RIVERS STUDY BACKGROUND

Local and state interest in a national wild and scenic river study was originally precipitated in the mid-1980s by proposals to reactivate the Sudbury Reservoir, upstream of the Sudbury River study segment, in order to supply water to the Boston metropolitan area. It was feared that withdrawals from the reservoir would create major impacts on downstream areas, including prime wildlife habitat within the wetlands of Great Meadows National Wildlife Refuge. At the same time, surging real estate values in the study area towns triggered concerns about the impacts of accelerating urbanization on the rivers' irreplaceable natural and cultural resources, which had been remarkably well preserved since they were described by Emerson, Hawthorne and Thoreau over a century ago. A wild and scenic river study was proposed to document these resources and to explore protection options.

In the late 1980s an informal study group was organized by the Sudbury Valley Trustees (SVT), the Organization for the Assabet River (OAR), and other local conservation interests. The group requested technical assistance from the North Atlantic Regional Office of the National Park Service (NPS) to evaluate

the potential for a wild and scenic study of certain portions of the rivers, and to determine where these river protection efforts should be focussed.

Two segments of the Sudbury and Concord rivers had been previously identified in the 1982 Nationwide Rivers Inventory (NRI) as being eligible for further study and potential designation as wild and scenic rivers. In the subsequent locally-initiated re-evaluation, the NPS identified four more segments, including one on the Assabet River, which appeared to meet minimum NRI criteria. The resulting study area, encompassing three contiguous segments along the Sudbury, Assabet, and Concord rivers, was the subject of a legislative initiative sponsored by Congressman Chester Atkins in spring of 1988.

For the next two years, the informal study group worked to heighten local awareness of the rivers and associated resources, and succeeded in acquiring votes in favor of the wild and scenic study from each of the eight towns in the proposed study area. Once local support for the study became evident, Congressman Atkins filed the study authorization bill, which was made law on November 28, 1990.

The "Sudbury, Assabet and Concord Wild and Scenic River Study Act" (P.L. 101-628) directed the NPS to study a 29-mile segment of the Sudbury, Assabet and Concord rivers in eastern Massachusetts for potential inclusion in the National Wild and Scenic Rivers System. The Study Act also authorized the establishment of a federal advisory committee, the Sudbury, Assabet and Concord Wild and Scenic Study Committee ("SuAsCo Study Committee") to work with the NPS in conducting the study, in determining whether the rivers were suitable for designation, and in formulating recommendations for their future management.

The study area included eight municipalities in Middlesex County, Massachusetts, extending from Framingham northward to Billerica along the Concord River and its tributaries, the Sudbury and Assabet rivers (see Figure 1). On the Sudbury River, the study segment began at the Danforth Street bridge in Framingham, and extended about 16.6 miles (including mileage along an oxbow) downstream to the confluence with the Assabet River in Concord at Egg Rock, at which point the Concord River originates. Along the Assabet the study

area started 1000 feet downstream of Damon Mill Dam in Concord, extending four and a half miles to the confluence with the Sudbury. The Concord River study segment started at Egg Rock and continued approximately eight miles downstream to the Route 3 bridge in Billerica. The municipalities of Framingham, Wayland, Sudbury, Lincoln, Concord, Carlisle, Bedford, and Billerica were included along the 29-mile long study segment.

1.2.1 STUDY APPROACH

The SuAsCo Study Committee served as the coordinating body for the study, guiding all major study activities. This advisory group included representatives of all the principal study interests, including local and state governments, river conservation organizations, and the U.S. Fish and Wildlife Service, the major federal land-managing agency within the study area. Committee members brought with them a wealth of knowledge and experience in local government, environmental advocacy, water policy, resource protection, and community organizing. These skills, along with the group's willingness to rely on a highly collaborative approach towards the study, ensured the study's success.

The following individuals served on the Study Committee:

Leslee Willitts (Co-chair) <i>representing</i>	Town of Framingham
Sally Newbury	Town of Wayland
Alex Porter	Town of Sudbury
Peter Sprayregen	Town of Lincoln
Bill Sullivan (Chairman)	Town of Concord
Anna Lipofsky/Ruth Ann Valentine ²	Town of Bedford
Wanda Milik	Town of Carlisle
Ralph Bacon	Town of Billerica
Joan Kimball	Governor Weld
Jonathan Yeo	Governor Weld
Ron McAdow (Recording Secretary)	Sudbury Valley Trustees
Betsy Stockey	Organization for the Assabet River
Ed Moses	U.S. Fish and Wildlife Service

2. Ruth Ann Valentine replaced Anna Lipofsky as Bedford's representative in October 1994, and was responsible for her town's involvement in two key aspects of the study: the development of the River Conservation Plan, and the Spring 1995 Town Meeting votes endorsing Wild and Scenic designation.

Several other individuals took active part in the study, providing technical and policy advice and help with special events. These volunteers are among the many people listed in Appendix A of this report. The combination of Study Committee, NPS staff, and volunteers formed a study team.

To increase the effectiveness of the study team's public outreach efforts, and in order to facilitate the compilation of information about the rivers' resources, a cooperative agreement was established between the NPS and the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE). Through the agreement, DFWELE's Riverways Program provided substantial staff assistance for the study in the form of community planning and outreach coordination. The agreement also gave the study team access to the Commonwealth's Geographic Information System (GIS). The GIS contains up-to-date information about the location of many natural and cultural resources statewide, including the study area. GIS maps produced for the project included base maps; wetland, land use, and water resource overlays for each town; and open space maps. Land use analyses were also conducted to provide information for the Water Resources Study.

1.2.2 STUDY GOALS AND STRATEGY

Based on the study background and legislative directive, the NPS had two major goals for the study:

- 1) To determine whether the Sudbury, Assabet and Concord rivers would be an appropriate addition to the National Wild and Scenic Rivers System, and, conversely, whether wild and scenic designation would be an appropriate protection tool for the rivers; and
- 2) To assist local communities in preparing and implementing a river conservation plan that would protect the rivers' special qualities, regardless of whether wild and scenic designation proved to be the recommended outcome of the study.

The NPS was also given some specific direction on the study strategy and goals by the House and Senate committees that reviewed the study authorization legislation. In its report on the Study Act, the House Committee on Interior and Insular Affairs stated that:

“a strategy emphasizing a partnership among Federal, State and local governments and private landowners would enjoy the greatest likelihood of success in protecting the river segments.”

It also emphasized that:

“it believes that . . . concerns [about the possibility that future management of these river segments might unduly emphasize Federal acquisition of lands] can be addressed” and that “acquisition of land or interests in land by the Federal Government should not be necessary to protect these scenic rivers should they be designated.”

The Interior and Insular Affairs Committee further stated that:

“The Committee expects the study to . . . provide an analysis of future use of the rivers for the water or wastewater needs of the towns, consistent with sound water supply and wastewater treatment planning, and appropriate measures to protect the rivers consistent with section 7 of the Wild and Scenic Rivers Act.”

In accordance with these legislative directives, along with the wishes of the study area communities and established NPS policy for wild and scenic studies of “private lands” rivers, the study included the following elements:

- 1) A strong emphasis on grassroots involvement and consensus-building in determining whether the rivers were suitable for designation and how they should be managed.
- 2) Use of a Water Resources Study to help determine the relationship between the rivers’ water supply and wastewater assimilation functions and the protection of their water-dependent resources.
- 3) The development of the “comprehensive river management plan” specified in the Act *during the study* rather than after designation. This plan relied on private, local and state conservation measures rather than federal land acquisition and management to protect the rivers’ outstanding resources, and was the product of close collaboration between NPS, the Study Committee, and local and state governments.
- 4) A commitment to the study area communities that

federal designation of the study segment would be recommended only if strong support was expressed through local Town Meeting votes.

These elements are discussed in more detail below and in subsequent chapters of this report. Additional information can be found in the companion documents to this Report: the *Sudbury, Assabet and Concord Wild and Scenic River Draft Resource Assessment and Eligibility Report*, the *Sudbury, Assabet and Concord Water Resources Study*, and the *Sudbury, Assabet and Concord River Conservation Plan*.

PUBLIC INVOLVEMENT

The Study Committee was the focal point for public involvement, and one of its first tasks was to develop a public involvement plan. This plan included the following:

- the development of a mailing list of over three hundred entries, including key local officials, riparian landowners, and other interested individuals. Those on the list received Study Committee meeting notices, minutes, fact sheets, progress reports, and technical report summaries.
- frequent meetings of the Study Committee at various locations within the eight-town study area. The meetings were advertised through mailings, Federal Register notices, and the local press. Agendas included items and speakers of local interest, with ample opportunity for public comments and questions.
- public forums held during the first few months of the study to identify study-related issues of importance to area residents and river users, and also to identify sources of river-related expertise. Information collected at the forums was used in all phases of the study, particularly during the development of the *River Conservation Plan*.
- several special events to promote public awareness of the rivers’ unique qualities and resource management issues, including a “canoe-in” lobster bake near the confluence of the three rivers at Egg Rock.
- periodic progress report briefings for municipal officials and at spring Town Meetings, presented by town representatives.

- the formation of task-specific subcommittees (e.g. the Public Involvement Subcommittee) with membership open to all, not just Study Committee members.

WATER RESOURCES STUDY

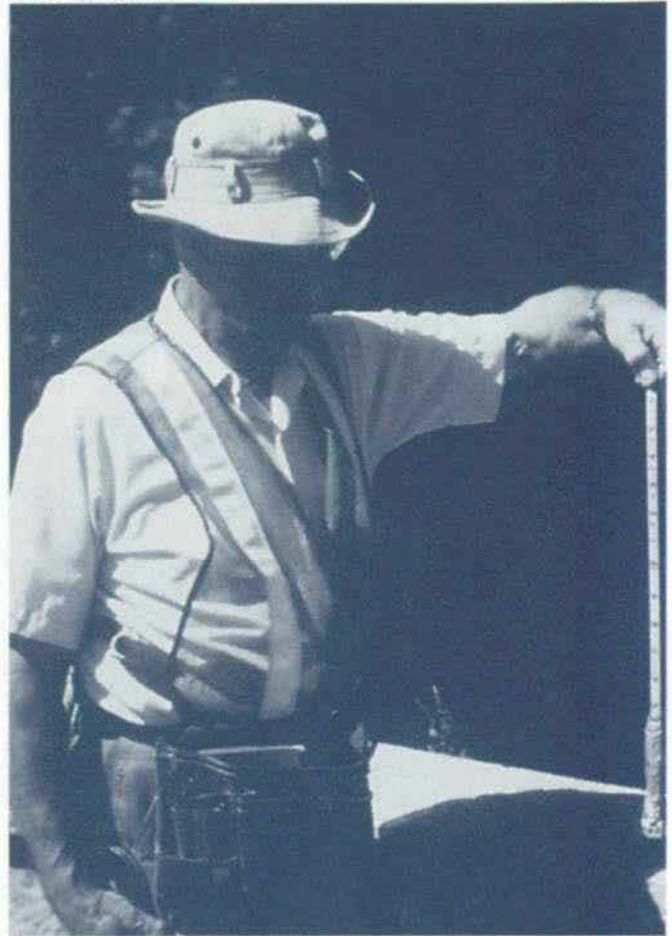
The goals of this study were 1) to identify the seasonal flows needed to protect the rivers' "outstandingly remarkable" flow-dependent resources (recreational, scenic, and ecological values); 2) to predict impacts on flows and water quality that could result from population growth in the area; and 3) to identify any measures that might need to be taken in order to protect the rivers' flows and water quality from unacceptable long term changes.

To conduct this study, the NPS entered into a Cooperative Agreement with the Massachusetts Department of Environmental Management, which in turn hired a consulting firm to perform the research and data analysis. The scope of the Water Resources Study was developed by the Study Committee with the assistance of a technical advisory committee (TAC) of local, state, federal, and academic experts in the fields of hydrology, ecology, and water supply planning. The TAC also assisted in the collection of data and the review of interim and final study reports.

Information about the rivers' existing flow regimes and flow- or water level-dependent resources was collected through field studies, and used in the development of the hydrological model of the study area. To assess the likely impacts on these resources resulting from future population growth and/or drought conditions, the watershed model was used to estimate the flows and changes in water quality that would result from several hypothetical combinations of increased withdrawals and decreased precipitation. This information provided the basis for *River Conservation Plan* provisions regarding the protection of such resources. It will also be used by the NPS to assess the impacts of proposed water resource projects, in accordance with Section 7 of the Act, if the rivers are designated.

The results of the Water Resources Study are more fully described in the *Sudbury, Assabet and Concord Water Resources Study* (two volumes, Goldman Environmental Consultants, 1994). A summary of the study approach and key findings can be found in Appendix D at the end of this report.

NPS/Roy Crystal



Ralph Bacon, Billerica representative, assisted in river stage measurements.

RIVER CONSERVATION PLAN

Although the *Plan* takes its direction from the resource-protection requirements found in the Wild and Scenic Rivers Act, its resource conservation approach relies on the use of measures other than federal land acquisition. Such protection measures include local and state land use regulations (e.g. low density residential zoning, floodplain zoning, and wetlands protection laws) and voluntary private landowner actions (e.g. maintaining a naturally vegetated riparian buffer). Measures to protect and enhance the rivers' flows and water quality (e.g. improving the quality of non-point source runoff by reducing erosion) were also included.

The *Plan* was developed by the NPS and Study Committee after the River Conservation Planning Subcommittee had completed an exhaustive analysis of existing land use and potentially vulnerable areas along the three rivers. The group assessed the effectiveness of existing land ownership patterns and land use regulations in

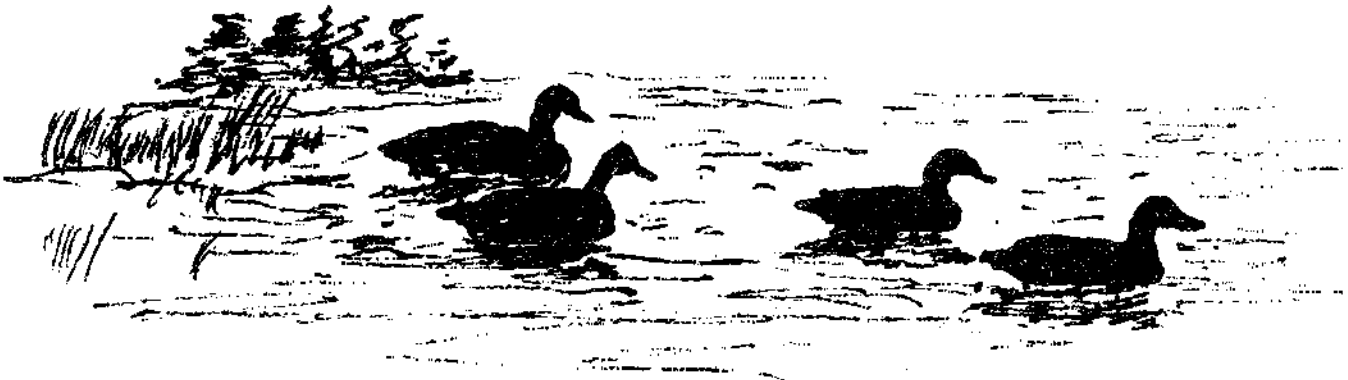
protecting the rivers' outstanding values and riparian integrity. For the most part, the results of this assessment showed that if the towns and state maintained and effectively enforced their existing resource protection controls, the rivers would remain very well protected. Where improvements could be made, the subcommittee advanced them in the form of recommendations for future action by the towns or state government. These recommendations, along with a summary of existing land use controls that should be maintained and enforced, and measures that will protect the rivers' water quality and flows, were used to develop a comprehensive list of resource protection actions in the *Plan*.

TOWN MEETING VOTES

In accordance with commitments made to the study area communities at the outset of the study, and in order to gauge the strength of local support for designation, resolutions on wild and scenic designation of the rivers went to Town Meeting votes in all eight study area towns in Spring 1995. These votes were taken after completion of the *River Conservation Plan* in order to ensure the proposal before the towns was clear.

This proposal included the following elements: if designated, the rivers would be managed by a largely locally-based River Stewardship Council; national Wild and Scenic River designation would not involve any federal land acquisition; and the *River Conservation Plan*, not a management plan written after designation, would guide all private, local, state and federal actions that could affect the rivers or their resources.

All eight towns voted overwhelmingly in favor of designation, several of them unanimously. This was particularly remarkable in the face of the current national and regional "wise use" backlash against governmental involvement in resource conservation, which took the form of vigorous lobbying against the Town Meeting resolutions in several study area communities. The willingness of the vast majority of Town Meeting voters to take the time to learn about the study and the *River Conservation Plan*, and to trust their fellow towns, along with state and federal agencies, to work cooperatively toward mutual river conservation goals, is a strong indication of the likelihood of the *Plan's* success.



BLACKDUCKS

CHAPTER 2 DESCRIPTION OF THE STUDY AREA

This chapter provides an overview of the natural and cultural landscape through which the Sudbury, Assabet and Concord rivers flow. It describes both the regional setting in general and the specific natural, cultural and recreational resources associated with the rivers and their adjacent lands. More detailed information on the study area can be found in the Draft Resource Assessment and Eligibility Report (January 1993) and the Water Resources Study (April, 1994) prepared during the study.

2.1 REGIONAL SETTING

The Sudbury, Assabet and Concord rivers are situated in Middlesex and Worcester counties in eastern Massachusetts, about 20-30 miles west of Boston. They collectively drain an area of 405 square miles, flowing into the Merrimack River at Lowell. Within the study area, the rivers are remarkably undeveloped, providing recreational opportunities in a natural setting less than an hour's drive from several million people living in the Greater Boston metropolitan area. Ten of the river miles along the Sudbury and Concord rivers lie within the boundaries of Great Meadows National Wildlife Refuge, established to protect the outstanding waterfowl habitat associated with extensive riparian wetlands. Historic sites of national importance, including many in Minute Man National Historical Park, are located near the river in the Town of Concord. Included is Old North Bridge, site of the Revolutionary "shot heard round the world." The rivers also feature prominently in the works of nineteenth century authors Hawthorne, Emerson, and Thoreau, and have been the subject of ornithological studies since the early days of field observation techniques.

2.2 NATURAL RESOURCES

2.2.1 GEOLOGY

The Concord River Basin owes its current appearance to glacial activity about 10,000 years ago during the Pleistocene epoch, when Glacial Lake Assabet and Glacial Lake Sudbury formed as a vast ice sheet covering much of North America slowly melted. The basin is characterized by many glacial features, including kames, kettle holes, drumlins, and thick deposits of stratified drift. Within the study area, such features include

Fairhaven Bay, a large kettlehole pond on the Sudbury River; several drumlins which rise abruptly from the generally flat topography along the Sudbury and Concord rivers; and a buried valley aquifer which runs beneath the study segments of the Sudbury and Concord rivers.

Jerry Howard



Sudbury River at Sherman's Bridge, Sudbury and Wayland.

2.2.2 HYDROLOGY

From their adjacent headwaters in Westborough to their confluence at Egg Rock in Concord, the Sudbury and Assabet rivers drop vertically about 155 and 175 feet respectively, resulting in moderate gradients of around 5 to 5.5 feet per mile on average. The Concord River, which originates at Egg Rock, flows north another 15 miles, dropping 70 feet before reaching the Merrimack. The higher gradient reaches of all three rivers were harnessed during the industrial revolution to facilitate operation of the Middlesex Canal between Boston and Billerica, to reduce flooding, or for hydrodynamic power, resulting in numerous dams, millponds, and other alterations. Such structures are concentrated on the upper reaches of the Sudbury River (which also feature an intricate system of water supply reservoirs

built in the late 19th century to supply Boston) and the lower reaches of the Concord River, while the Assabet River's more consistent gradient favored dams along most of its length.

Jerry Howard



Floods frequently submerge Rte. 27 in Wayland and Sudbury.

Within the study area, gradients are gentler—hence the absence of dams and consequent eligibility of these segments for wild and scenic designation. From the upstream end of the Sudbury River study segment in Framingham to Egg Rock in Concord, the Sudbury River drops a little more than an inch per mile, or about 1 1/2 feet. From Egg Rock to the Route 3 bridge, the eight-mile study segment of the Concord River drops only a few inches. Springtime and hurricane-related flooding is common along the Sudbury and Concord rivers, mainly affecting undeveloped floodplains along the Sudbury but also inundating residential areas along the mid-and lower Concord River.

2.2.3 ECOLOGY

The rivers and their floodplains support diverse communities of plants and wildlife in a variety of habitat types, ranging from open water through deep marsh, shallow marsh, scrub-shrub wetlands, and wooded swamps. The water storage capacity of these wetland systems, in combination with the extensive aquifer underlying the rivers, provides sufficient base flows to support river-dependent plants and animals even during low flow periods. Before the construction of a dam on the Concord River at Billerica in the early 1800s, which raised water levels within the study segments of the Concord and Sudbury rivers, vast "fresh meadows" of

marsh grasses were found along major stretches of these rivers. It was this agricultural resource that first attracted European colonists to the area, while the rivers' potential for water power and water supply drove much of the basin's ensuing settlement patterns. Today, average water depths within much of the study area are greater than those of pre-Colonial times, resulting in increased acreages of deep marsh and deepwater habitat types, which are significant for several important animal species.

Despite the study area's long history of human settlement, the nearly 4,800 acres of wetlands along the study segments support 13 state-listed, river-dependent vertebrate, mussel, and amphipod species. Twenty-one species of state-listed plants are found within 0.1 mile of the rivers, and over 221 species of birds have been recorded within Great Meadows National Wildlife Refuge along the Sudbury and Concord river study segments during the past ten years. A single federally-listed river-dependent species, the Bald Eagle, has also been sighted within the refuge, although it is not known to breed in this area.



GREAT BLUE HERON

The rivers are classified as warm water fisheries, supporting populations of largemouth bass, small mouth bass, chain pickerel, brown bullhead, bluegill, pumpkinseed, yellow perch, golden shiners, and black crappie. Largemouth bass are particularly prized by anglers.

Several species of exotic, invasive plants are fairly common along the rivers, including purple loosestrife, glossy buckthorn, and water chestnut. Because these plants crowd out species that provide better wildlife habitat value, or, in the case of water chestnut, reduce the amount of open water available for wildlife and recreational use, they are viewed as undesirable species. Vegetation control campaigns against purple loosestrife and water chestnut are currently being initiated at Great Meadows NWR. The potential effect on these species of possible flow reductions due to increases in consumptive water withdrawals from the rivers was examined during the water resources study. It was found that lower flows, along with reduced seasonal flow variation, would tend to favor the spread of these exotics.

2.3 CULTURAL RESOURCES

2.3.1 HISTORICAL SETTING

Within the Concord River basin are 36 towns and cities, including the eight towns that comprise the wild and scenic study area: Framingham, Wayland, Sudbury, Lincoln, Concord, Bedford, Carlisle, and Billerica. There is evidence of continuous human occupation of the area for at least 8,000 years. Early inhabitants moved through the basin seasonally, using the rivers for transportation and as sources of food. During the Woodland period (from 1000 to 400 years ago), native dwellers began to rely on agriculture (squash, corn and beans) to supplement food supplies. The first European settlement of the Concord River Valley began in the mid-17th century in what are now the towns of Concord and Sudbury. As populations grew, and residents sought to establish local governments, additional settlements grew into towns. The last municipality in the study area to incorporate was Wayland, in 1835.

As inland outposts of the Massachusetts Bay Colony, the towns in the study area, particularly Concord, were less sympathetic to British rule and taxation than many

coastal communities, which relied more directly on England for trade. Consequently, they became involved in early efforts to organize armed resistance, stockpiling weapons and forming a local militia: the Minutemen. A British attempt to confiscate these weapons on April 19th, 1775 was thwarted when, alerted by Paul Revere and William Dawes, a small group of militiamen assembled in Lexington and exchanged shots with the British soldiers. As news of the oncoming British troops reached Concord, the Minutemen organized in earnest, engaging the British at North Bridge on the Concord River, where the first British fatality occurred. Outnumbered and outmaneuvered by the rebels, the loyalist troops withdrew to Boston, suffering major losses during the 20-mile retreat. News of this successful armed resistance sparked widespread revolt throughout the colonies, starting the American Revolution.

Ron McAdow



North Bridge replica, Concord.

During the century following the formation of the new republic, the Concord River basin was transformed, first by agriculture, and then by industry. Farmsteads spread throughout the area. Bog iron from Sudbury was brought by boat down the rivers to Chelmsford for smelting. For a brief time before the advent of railroads, the Middlesex Canal linked Boston and settlements along the Sudbury, Concord and Merrimack rivers in trade. Mills for processing local grain and logs were built wherever the rivers dropped over rocky ledges. Later, the same sites were developed for textile, gunpowder, and paper mills.

In the mid-1800s, the town of Concord became the focal point for an emerging philosophical movement: transcendentalism. Henry David Thoreau's cabin at Walden Pond was less than a mile from the Sudbury River, and his journals reflect the importance of the rivers to him, both in the development of his skills as a naturalist, and as metaphors for a reality beyond conventional society. The poets, novelists, and philosophers Ralph Waldo Emerson, Ellery Channing, and Nathaniel Hawthorne were likewise inspired by the rivers, which feature prominently in their works.

During the late nineteenth century, the Sudbury River basin was pressed into service to help meet Boston's growing water supply needs. Seven small reservoirs located upstream from the study segment along the Sudbury River and its tributaries were constructed between 1875 and 1898, with a total capacity of 13 billion gallons. The water traveled east, by gravity, through aqueducts leading to Boston. This system, together with the Wachusett Reservoir, served as the primary water supply source to the greater Boston area from 1905 until 1943, when a larger reservoir was completed in central Massachusetts. The Sudbury Reservoir system was last used for public water supply in 1974. It is currently managed as an emergency source in case of major failure within the principal supply system.

2.3.2 LAND USE AND OWNERSHIP PATTERNS³

Today, residential uses dominate the towns, or portions of towns, within the study area. Downtown Boston is less than 45 minutes away by train or road, and the major employment centers along Route 128, Boston's high technology highway, are closer still. Framingham is the most urban town, with an economy that is currently shifting from manufacturing to retail and commercial uses. Wayland, Sudbury, Lincoln, and Carlisle are still quite rural in most areas, and are among the wealthiest communities in the country, based on per capita income. Concord has long been a regional hub, but has retained much of its New England village character, with a compact town center. Not surprisingly, tourism is a major part of its economic base.

Land uses in Bedford and Billerica range from small farms to high tech industry. Riverfront areas within Billerica in particular were developed first for seasonal use, but are now occupied year round.

Elsewhere along the study segments, intensive development has been limited due to extensive wetlands and floodplains, and strong state and local wetlands protection and floodplain zoning laws. Much of the riverfront remains wooded or pastoral in character. Large tracts of open space have been protected at Great Meadows NWR, Minute Man NHP, the Pantry Brook state wildlife management area, many town-owned sites, and at locations owned by several land trusts in fee or in the form of conservation restrictions. In addition, there are three private 18-hole golf courses located along the segments.

2.3.3 RECREATIONAL USE

The rivers are highly valued for their recreational opportunities, in particular canoeing and fishing for largemouth bass. The Sudbury and Concord segments provide flatwater boating with over a dozen car top or trailer access points along 25 miles of river. The Sudbury is favored by non-motorized boaters, while the Concord, particularly downstream of Minute Man NHP, is frequented by bass boats. The Assabet River experiences higher flow rates in the upstream part of its study area, and is used heavily in mid-spring by whitewater enthusiasts. The last mile or two of the Assabet, however, provide excellent flatwater canoeing under the shade of a dense floodplain forest.

Jerry Howard



Sudbury River at Fairhaven Bay, Lincoln and Concord.

3. More detail on this subject can be found in Section 4.2 and Appendix C.

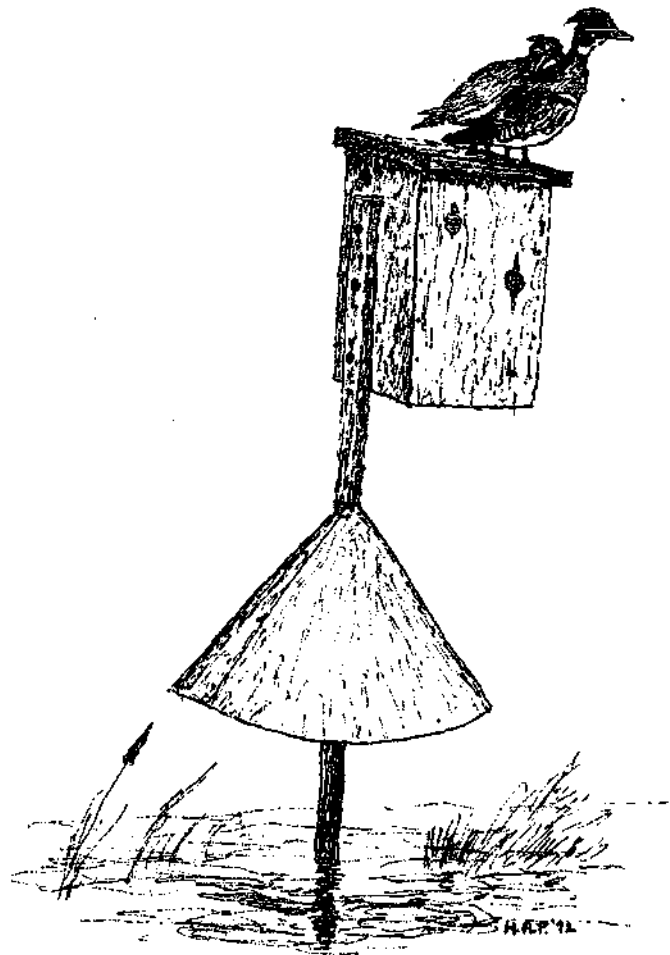
A single canoe livery and one small marina are located within the study area. The canoe livery—Southbridge Boathouse—in particular sees heavy use on summer weekends. Many residents of Greater Boston experience their first canoe ride at Southbridge. Others are initiated to the sport through Appalachian Mountain Club-sponsored trips on the study rivers.

State and local conservation organizations and the FWS organize frequent and very popular nature study programs along the rivers, both on and off the water. At Great Meadows NWR, the emphasis is on community education and school groups. Bird watching and nature photography are particularly popular within the study area towns.

Because of the study area's extensive floodplain, there are no major riverfront walking or biking trails. Conservation lands at several locations, however,

provide access for those who would rather visit the rivers on foot than by boat. Included are the extensive trail network adjacent to the Sudbury River in Lincoln, and the Dike Trail along the Concord River at the Concord Unit of Great Meadows NWR.

The rivers' historic interest attracts many visitors. Every year, thousands of tourists from across the country and around the world visit Minute Man NHP and walk across the North Bridge replica over the Concord River, site of the "shot heard round the world." Others come to the region to visit Thoreau's Walden Pond and follow the path of his ramblings down to Fairhaven Bay on the Sudbury River.



WOOD DUCKS MOVE IN TO NESTING BOX IN MID-MAY

NPS photo



Silver maple, a common riverfront tree.

CHAPTER 3 ELIGIBILITY AND CLASSIFICATION

The purpose of this chapter is to document National Park Service findings relative to: 1) the "free-flowing character" of the Sudbury, Assabet and Concord river study segments; 2) the "outstandingly remarkable" natural and cultural resource values associated with the study segments; and 3) the proposed "classifications" under which the eligible river segments could be included in the National Wild and Scenic Rivers System.

These findings are based on the information contained in the Sudbury, Assabet, and Concord River Study Draft Resource Assessment and Eligibility Report (January, 1993).

3.1 ELIGIBILITY AND CLASSIFICATION METHODOLOGY

The subsections below describe both the relevant eligibility and classification criteria as set forth in the Wild and Scenic Rivers Act and in the USDA/USDI Interagency Guidelines for Eligibility, Classification, and Management of River Areas⁴; and the methodology used to apply these criteria to the Sudbury, Assabet and Concord rivers.

3.1.1 ELIGIBILITY

FREE-FLOWING CONDITION

The Wild and Scenic Rivers Act is intended to protect only "free-flowing" rivers, and such flows must be adequate to support all flow-dependent outstanding resource values. Section 16(b) of the Act defines "free-flowing" as:

"...existing or flowing in natural condition without impoundment, diversion, straightening, riprapping, or other modification of the waterway. The existence, however, of low dams, diversion works, and other minor structures . . . shall not automatically bar . . . consideration for . . . inclusion: *Provided*, That this shall not be construed to authorize, intend, or encourage future construction of such structures within components of the national wild and scenic rivers system."

Federal Guidelines provide the following additional clarification: "The fact that a river segment may flow between large impoundments will not necessarily

preclude its designation. Such segments may qualify if conditions within the segment meet the criteria. . . . Existing dams, diversion works, riprap and other minor structures will not bar recreational classification provided that the waterway remains generally natural and riverine in its appearance."⁵

The study rivers were examined to determine if there were any significant areas of channel or bank modification, or whether portions of the rivers had lost their riverine appearance and function due to impoundments outside the study area. After the rivers' outstandingly remarkable resources had been identified, the Act's free-flowing criterion was used to ascertain whether all such flow-dependent values were adequately supported by the rivers' existing flow regime. This determination was facilitated by information on the relationship between the rivers' existing and potential flows and water-dependent resources that was collected during the Water Resources Study. The extent to which likely future flows and water quality conditions would continue to protect and enhance the rivers' outstanding values was also a part of the suitability analysis conducted for the study. This issue is explored more fully in Chapter 4.

OUTSTANDINGLY REMARKABLE RESOURCES

To be considered eligible for inclusion in the National Wild and Scenic Rivers System, a river segment, together with its adjacent lands, must support one or more "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values..." (Section 1(a) of the Act). The Interagency Guidelines have further clarified that "other

4. As published in the Federal Register on September 7, 1982.

5. 47 Fed. Reg. 39457-58; September 7, 1982.

similar values, such as ecological, if outstandingly remarkable, can justify inclusion of a river in the national system." However, since neither the Act nor the Guidelines provides specific criteria for evaluating outstandingly remarkable resources, this determination is left to the professional judgement of the study team. Such resource values must nonetheless be directly related to, or dependent upon, the river.

For the purposes of the Sudbury, Assabet and Concord Wild and Scenic River Study, river-related resources were determined to be "outstandingly remarkable" if they were found to be either *unique* (the only known example of a specific resource value) or *exemplary* (among the best or most illustrative examples of a resource value) within a national or regional context. The relevant physiographic region was defined as the inland portion of the eastern Massachusetts coastal plain, an area extending from southern New Hampshire to northern Rhode Island. Regionally unique or exemplary resources were judged to qualify as "outstandingly remarkable" by the study team based on the goal of protecting a regional diversity of rivers within the national system.

Although only one outstanding resource is required for a river to be eligible for designation, all major natural and cultural resources within the study area were included in the resource assessment conducted for the study, and several outstanding resource values were documented. Not all river reaches within the study area were found to support all of the rivers' outstanding values, but there were no reaches that did not support at least one of these values, contributing to the viability of the study area as a system of interdependent natural or cultural resources.

Certain kinds of designations flagged the presence of one or more outstanding resources within the study segment. These included recognition of the area's national significance by Congress through creation of Great Meadows National Wildlife Refuge and Minute Man National Historical Park. Other designations of

national importance granted to resources within the study area, such as National Historic Landmark status and National Historic Register status, were also deemed to qualify these resources as "outstandingly remarkable," as did the presence of state-listed endangered species, and the inclusion of some areas as "distinctive" or "noteworthy" in the state's landscape inventory. In addition to the criteria described above, expert opinions were solicited for each resource assessment.

3.1.2 CLASSIFICATION

The Wild and Scenic Rivers Act requires that all eligible or designated river segments be classified as Wild, Scenic, or Recreational. These classifications are based solely on the amount of human impact present at the time of classification. The Act defines them as follows:

Wild river areas - Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic river areas - Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational river areas - Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

The Sudbury, Assabet and Concord river study segments were evaluated to determine which classification(s) best fits existing conditions along the rivers. Based on the Interagency Guidelines, four basic criteria were used in this determination: 1) the extent of any water resources development within the study segments; 2) the nature and extent of shoreline development; 3) the degree of accessibility to the segments by roads or railroads; and 4) the segment's water quality.

3.2 FINDINGS

3.2.1 ELIGIBILITY

The entire 29-mile study area, including all three river segments, was found to be free-flowing. There are no dams, diversions or impoundments within the segments, and no straightened or artificially modified banks.⁶

While the Sudbury, the Concord, and, to a lesser extent, the Assabet River within the study area have long been noted for their low gradient and resulting sluggish flows (there is only a two foot drop in elevation between the start of the Sudbury River study area in Saxonville and the downstream end of the Concord study segment at the Route 3 bridge in Billerica), these flows are presently sufficient to sustain several outstanding resources.

The extensive floodplain and freshwater marsh habitat which support a nationally exemplary diversity and abundance of wildlife would not be present if the rivers had a higher gradient. Likewise, the rivers' boatability, which contributes to the study area's regionally unique recreational value as a flatwater boating resource, is in part due to the absence of dams—a product of its low gradient. In addition, flows in the rivers at present, including seasonal fluctuations, are sufficient to sustain the study area's regionally exemplary scenery. Thus present-day flows can be said to support and complement the outstanding resource values which make the rivers eligible for designation.

It is important to note that while the study rivers are not fast-flowing, the flow-dependent resources identified above still require flows that vary within a normal range. The reduction of average flows in the rivers, or an increase in the frequency or duration of low-flow periods, could cause the degradation of the rivers' ecological, recreational, or scenic resources. The Water Resources Study that was conducted as part of the overall study, to identify the flow needs associated with maintenance of the rivers' outstanding resources, provides guidance for future decision-makers on maintaining the rivers' free-flowing character. This study is described in Chapter 4 and Appendix D of this report.

6. While the North Billerica Dam, located about 5 miles downstream from the terminus of the Concord River study segment, has raised the average water elevation within much of the study area, the study segment remains riverine in appearance.

The following five values were found to be outstandingly remarkable resources associated with the Sudbury, Assabet and Concord river study area. The presence of these resources, along with the rivers' free-flowing condition, makes the entire 29-mile study area eligible for wild and scenic designation.

Ecology. The 29-mile study area of the Sudbury, Assabet, and Concord rivers provides extensive aquatic and riparian habitat for abundant and diverse plants and animals. The wetlands associated with the rivers, especially those within and adjacent to the Great Meadows National Wildlife Refuge, contain excellent vegetative conditions for seed crops and wildlife plant food, as well as dense cover habitat for protection and breeding requirements. Over 15 state-certified vernal pools provide essential breeding habitat for amphibians within the rivers' floodplain. Thirty-two state-listed rare plants and birds have been observed along the study segments since 1980.

The national significance of this area to migratory waterfowl was recognized by Congress with the creation of Great Meadows National Wildlife Refuge along the Sudbury and Concord Rivers. The refuge has recorded sightings of 221 species of birds within the last ten years.

The extensive freshwater habitat, concentration of diverse bird species, and presence of regionally and nationally rare plants and animals along the Sudbury, Assabet and Concord comprise a nationally exemplary ecological resource.

Archaeology and History.

Prehistoric Sites. The Sudbury, Assabet, and Concord river basin possesses one of the highest densities of known prehistoric Native American archaeological sites in Massachusetts. The abundance of aquatic and terrestrial food sources within and alongside the rivers, and the rivers' usefulness as travel corridors, made the study area particularly attractive to Archaic (4000 to 1000 B.C.) and Woodland (1000 to 1600 A.D.) period peoples. The Massachusetts Historical Commission recently noted the presence of "innumerable significant historical and archaeological properties within the study area." The unusually high density of known sites along the rivers suggests that there is a very high probability that additional archaeological sites exist within the

relatively undisturbed river corridor.

The study area is therefore *regionally exemplary* for river-related archaeological resources.

Ron McAdow



Archaeological artifacts, SuAsCo Basin.

Historic Sites. The first successful armed resistance of the American Revolution occurred at North Bridge over the Concord River in Concord, where the Minutemen turned back the British on April 19, 1775. Congress established Minute Man National Historical Park in 1958 to commemorate this important event.

One of the first inland settlements in the region, Concord was founded by farmers attracted by the abundant hay growing in the wet meadows along the Sudbury and Concord rivers. Remote from the colony's coastal communities, Concord was an ideal location to stockpile weapons for those who opposed continued British rule.

The highest concentration of Revolutionary-era sites along the rivers occurs close to the confluence of the rivers at Egg Rock. In addition to North Bridge, Colonel Barrett's farm house still stands along the Assabet River. James Barrett was the regimental commander of the Minutemen and had hidden supplies and munitions in his attics, fields, and carriage house. The Old Manse (on the Concord River), home to many of Concord's most famous writers, also dates back to the Revolutionary era.

The important historical events associated with these river-related sites make them *nationally unique*.

NPS Photo



North Bridge, Concord.

Literary Resources.⁷ The Concord area and its rivers played an extremely important role in the development of both nineteenth-century transcendentalism and our modern environmental ethic. The authors Henry David Thoreau, Nathaniel Hawthorne, and Ralph Waldo Emerson lived in Concord and wrote about the three study rivers.

While the rivers played a symbolic role in Emerson's transcendentalist writings, they played a more active part in the writing of Henry David Thoreau. Thoreau wrote extensively about all three rivers, describing their

7. While four of the five outstandingly remarkable values identified during the study—scenic, recreational, historical, and literary resources—could be properly lumped together as “cultural” resources (in the sense that they are products of human behaviors or beliefs rather than “natural” resources), the study team felt that it was more appropriate to describe them separately. The rivers' literary resources have thus been distinguished from their historical resources because the product of the former is a body of intellectual thought, while the latter is manifest by events.

abundant wildlife, and used them as inspiration for his thoughts on man's relationship to nature. The effects of Thoreau's writing have been far-reaching and long-lasting; today his work can be read in 21 different languages and he is widely considered the father of the modern conservation ethic.

The Sudbury, Assabet and Concord rivers' association with Henry David Thoreau and the other transcendentalist writers is *unique in a national, and possibly international, context*.

Recreation. Three characteristics of the SuAsCo rivers make them unique in the region. These qualities can be summarized as the rivers' attractions, "boatability," and proximity to densely populated areas.

Attractions are what make boating the river an enjoyable experience. These include historic sites visible from the rivers, wildlife observable from the rivers, and the rivers' varied and beautiful scenery. The absence of development along much of the Sudbury and Concord Rivers within Great Meadows NWR is also an attraction.

"Boatability" describes the ease and convenience with which one can boat the rivers. It is possible to canoe 29 miles throughout the study area without a single portage, which is unique among the rivers in the region. The boating season is long, lasting from April through early November. The many launch sites add to the rivers' accessibility and create a variety of possible trip itineraries. In addition, the absence of strong currents

allows canoeists to paddle upstream in most of the study area, avoiding the inconvenience of a car shuttle.

Lastly, the rivers' proximity to densely populated areas, such as Boston, put them within an hour's drive of over three million people, adding greatly to their value as a recreational resource.

The entire study segment is therefore a *regionally unique* outstanding resource for flatwater boating.

Scenery. Most of the study area is remarkably undeveloped, considering the rivers' proximity to densely populated areas. The scenery within the study segment is also highly varied, encompassing many regional types. Consequently, the rivers have received high scores in the Commonwealth's two systematic assessments of scenic beauty in Massachusetts. In 1981, the Massachusetts Department of Environmental Management's Landscape Inventory determined most sections of the Sudbury and Concord rivers to be exceptionally scenic (either "distinctive," comprising the top 4% of the state's land area; or "noteworthy," comprising the next 5%). Another study conducted for DEM's Scenic Rivers Program resulted in classification of the Sudbury and Concord study segments as "scenic cultural rivers," partially based on visual criteria. A user survey conducted by the SuAsCo Watershed Association found "natural beauty" to be the most frequently-cited river characteristic.

Scenic value is, therefore, a *regionally exemplary* outstanding resource.

Ann Ringwood



Peter Sprayregen, Lincoln representative, a frequent river user.

NPS/Roy Crystal



Artist at Sherman's Bridge

3.2.2 PROPOSED CLASSIFICATIONS

Based on the application of the classification criteria to the study rivers, it was determined that the 29-mile study area should be divided into two segments which contrast significantly with regard to shoreline development and accessibility conditions. While short stretches within these two segments could be classified differently, the study team saw no compelling reason to further segment the rivers for classification purposes. The rivers' classification is intended to help guide decisions about water resources projects that could affect their scenic character, increasing the evidence of human activity along the segments. Since these decisions will also be based on the actual development context in the vicinity of the proposed development site, and since there are more gradations of human influence on the river landscape than the two provided by the Wild and Scenic Rivers Act ("wild" is not an appropriate classification for any portion of the study area), the study team felt that it would be counterproductive to overemphasize the classification process.

These segments and the factors which lead to their proposed classifications are as follows:

SEGMENT 1—SUDBURY RIVER:

14.9 miles, from Danforth St. Bridge in Framingham to Route 2 Bridge in Concord.

Proposed Classification:

Scenic

Evaluation Criteria:

Existing characteristics and conditions

Water Resources Development:

The segment is free of impoundments.

Shoreline Development:

Due to this segment's topography, only limited evidence of shoreline development is visible along the river. In Framingham, residential development is screened by vegetation and steep slopes. Elsewhere, low density residential use is set back from the channel due to both topography (floodplain and marshes) and extensive conservation ownership. Thus, the corridor presents an overall natural character.

Accessibility:

While there are eight road or railroad bridges within the 14.9 mile segment, which help to provide scenic and recreational access to the river, between these bridges the river is largely inaccessible, and no roads can be seen from the river.

Water Quality:

Water quality in this segment sometimes fails to meet its Class B goal due to non-point source contamination, and, in particular, mercury contamination originating at a Superfund site upstream. However, as the Guidelines make clear, this does not preclude this segment's classification as "scenic" or "recreational" as long as a water quality improvement plan exists or is being developed. Since both the federal and state Clean Water Acts and hazardous waste clean-up laws mandate such plans, and since recent regulatory changes have tightened controls over non-point source pollution, it is reasonable to assume that water quality will continue to improve.

SEGMENT 2—SUDBURY RIVER:

1.7 miles, from the Route 2 bridge to Egg Rock in Concord.

ASSABET RIVER:

4.4 miles, from 1000 feet below Damon Mill to Egg Rock in Concord.

CONCORD RIVER:

8 miles, from Egg Rock in Concord to the Route 3 bridge in Billerica.

Proposed Classification:

Recreational

Evaluation Criteria:

Existing characteristics and conditions

Water Resources Development:

The segment is free of impoundments. The North Billerica Dam, five miles downstream from the Concord River segment, increased water elevations within the Concord and Sudbury segments by about two feet over the levels that existed prior to 1803. Flows within this naturally low-gradient reach are largely unaffected, however, and the rivers remain riverine in appearance. Furthermore, the freshwater marsh systems along these rivers, including areas within Great Meadows National Wildlife Refuge, are in part a product of these "enhanced" water levels, even though they may differ from the natural communities that existed before the dam was built.

Shoreline Development:

While this segment possesses short stretches of comparatively undeveloped shoreline, substantial evidence of human activity also exists. Residential development associated with suburban Concord is evident along the right bank of the Sudbury River within this segment. Along the Assabet segment, large houses set back from the river alternate with agricultural fields and wooded areas.

Along the Concord River, structures and landscapes associated with Minute Man National Historical Park are readily visible, along with large estates and

cultivated fields along the left bank of the river. While much of the river's banks are in conservation ownership, privately-owned lands show evidence of low density development, with large houses surrounded by lawns set back from the river in Concord, Bedford, and Carlisle. Along the left bank in Billerica, more intensive suburban development along with a commercial marina and restaurant are visible. Near the terminus of the Concord River study segment, an area of riverfront camps and cottages is partially visible within the floodplain forest.

Accessibility:

Along the Sudbury River within this segment there are five road or railway bridges, with ready access to the river at Southbridge Boathouse, Old Calf Pasture, and via residential back yards. Along the Assabet there are also five bridges. While not visible from the river, roads parallel much of this segment within a few hundred feet of its banks. Along the Concord River segment there are six bridges (including the North Bridge replica). Recreational access to the rivers is provided at these bridges, at Southbridge Boathouse in Concord, and at the Center Harbor Marina in Billerica.

Water Quality:

Water quality in this segment sometimes fails to meet its Class B goal due to both point and non-point source contamination. However, as the Guidelines make clear, this does not preclude this segment's classification as "scenic" or "recreational" as long as a water quality improvement plan exists or is being developed. Both the federal and state Clean Water Acts mandate such plans. In accordance with these plans, point sources of pollution along the Assabet and Concord rivers within and upstream of the study segment are being brought into compliance with Class B goals through the NPDES permitting process. Recent regulatory changes have tightened controls over non-point source pollution as well, which should result in improving water quality.

SUMMARY

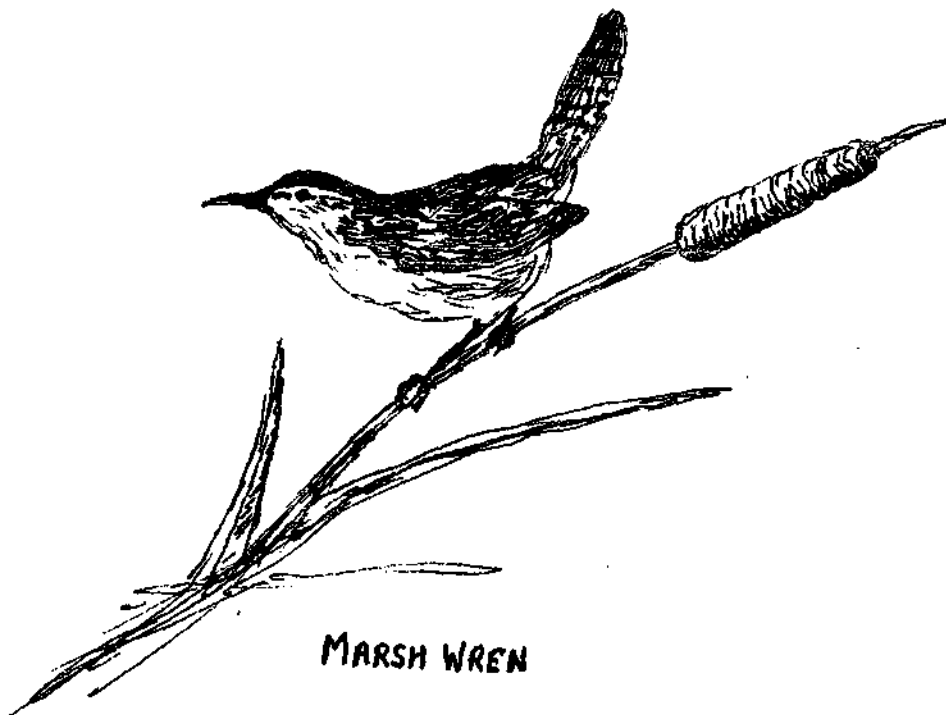
Based on the amount of development and accessibility within the river corridors, the proposed classifications for the study segments are:

The Sudbury River from the Danforth Street Bridge to Route 2: **Scenic**

The Sudbury River from Route 2 to Egg Rock: **Recreational**

The entire Assabet River segment: **Recreational**

The entire Concord River segment: **Recreational**



CHAPTER 4 SUITABILITY

This chapter describes the study's findings relative to Section 4(a) of the Act, which requires the study report to detail the river's suitability or non-suitability for national designation. The chapter also describes the proposed resource management and protection framework for the rivers should they be designated.

4.1 SUITABILITY CRITERIA

A river's "suitability" for wild and scenic designation is based on several factors. Most important, perhaps, suitability is a matter of whether designation can provide lasting protection for the river's outstanding values and free-flowing character. For rivers such as the Sudbury, Assabet, and Concord, that flow through predominantly private lands, and for which federal land acquisition is not an appropriate protective measure, such protection must rely on state, local, and private resource protection provisions. Thus, if designation is to be effective, these non-federal entities must support and be committed to the implementation of any necessary resource protection measures.

Suitability is also a measure of whether national wild and scenic designation is appropriate for the rivers. If it would foreclose other uses of the rivers where there is an overwhelming public interest in such uses, or if other river protection approaches make more sense, then the rivers should not be found suitable for national designation.

For the Sudbury, Assabet and Concord rivers, the criteria used to assess suitability can be summarized as follows:

- 1) How adequate are existing protection measures (including state and local resource protection laws, zoning, and land ownership) in conserving the rivers' outstanding resources and free-flowing character?
- 2) Can a resource protection and management framework be developed that will close any resource protection gaps without relying on additional federal land acquisition or management, and that will facilitate communication and cooperation among the governmental entities and private citizens who bear responsibility for implementing all river protection measures?

- 3) Is there a demonstrated commitment to protect the rivers by the non-federal entities who will be responsible for implementing protective management?

- 4) Is designation appropriate in light of other public needs and alternative river protection approaches?

The manner in which these criteria were applied to the SuAsCo study, along with suitability findings, are described in sections 4.2 through 4.5.

4.2 ANALYSIS OF EXISTING RESOURCE PROTECTION

In order to answer the question "How adequate are existing protection measures in conserving the rivers' outstanding resources and free-flowing character?" a vulnerability analysis was conducted by NPS staff working in cooperation with the Study Committee. The result of this effort was a town-by-town description of existing riverfront topography, land use, land ownership, and regulatory controls for the entire study area.⁸ "Vulnerable" sites identified in this report were those considered inadequately protected, based on either existing land uses or permissible future uses allowable under current zoning and other land use controls. The focus of the analysis was on the integrity of the immediate riparian zone, and on sites associated with the rivers' outstanding resource values.

Once areas of vulnerability had been identified, the study team worked with town zoning and conservation commission staff to determine whether the problem was one of enforcement or inadequate land use controls. Local land trusts, the state Department of Fisheries,

8. The entire text of this analysis can be found in Appendix C.

Wildlife, and Environmental Law Enforcement, and the FWS were also consulted to determine whether vulnerable parcels had already been identified for acquisition. Where enforcement problems were discovered, state and federal regulatory agencies were also contacted, if appropriate.

The immediate results of this effort included the initiation of zoning and wetland enforcement actions on parcels of riverfront land in three of the eight towns. On another site, a proposed subdivision was redesigned, increasing the width of a vegetated buffer, and providing for a car top boat launch and walking trail. During the review of conservation restriction language in another area, the team discovered that early drafters had left loopholes allowing the construction of facilities for active recreation along the river bank. The town board which holds these conservation easements is in the process of renegotiating this language to prohibit the construction of tennis courts, swimming pools, etc., on the grounds that such uses should disqualify the easement donors from the charitable deductions and local property tax reductions they have been enjoying. Model language was provided by the state Division of Conservation Services through the study team to aid in this effort.

Other findings resulted in the development of a set of recommended actions for each of the eight towns that would ensure the long term protection of the entire 29 miles of riverfront. These actions were incorporated in the *River Conservation Plan* (see Section 4.3.1). They include such measures as the promulgation of sedimentation and erosion control bylaws, the updating of town Open Space Plans to address river conservation more directly, and improvements in some of the towns' floodplain zoning. None of these measures, however, was considered essential to the long term health of the rivers' outstanding resources. Instead, the vulnerability analysis established that the combination of land ownership, topography, and land use regulations along the segments provides sufficient protection for the rivers' riparian integrity and land-based outstanding resource values to meet this suitability criterion.

The prospects for the long-term protection of the rivers' water-dependent resources (such as wildlife habitat, recreation, and scenery) were also evaluated. The study team oversaw a technical Water Resources Study,⁹

which modelled existing and probable future water quality and flows along the segments, based on population growth and land use changes. This investigation determined that, while there is a need to reduce non-point sources of nitrogen and phosphorus (e.g. fertilizer use) within the watershed to protect water quality, there are no known land or water development proposals that would make the rivers unsuitable for designation. Both future flows and future water quality should be sufficient to sustain the rivers' outstanding water-dependent resources.

In summary, the study team determined that the rivers' riparian integrity, water quality, and outstandingly remarkable resources were adequately protected by existing controls, and that the rivers should thus be considered to have met this standard of suitability for wild and scenic designation.

Specific findings relative to this conclusion include the following:

- Over 56% of the 58 miles of river frontage along the study segments is protected from incompatible land uses through ownership by federal, state, or local conservation agencies, or through conservation easements on private land.
- Two key parcels, with about 3/4 of a mile of river frontage, were protected during the study through the cooperative efforts of a land trust, two towns, the county government, and the FWS.
- Much of the remaining undeveloped private land along the rivers is unlikely to be subject to intensive development because is floodprone or has soils considered unsuitable for buildings and septic systems.
- The remainder of the riverfront within the study area is protected from adverse land use changes through a combination of strong local zoning (especially floodplain zoning) and state and local wetlands protection laws.
- The Massachusetts River Protection Act, enacted in July 1996 after the vulnerability analysis was completed, further extended protection for the rivers' water quality, wildlife habitat, fisheries, and flood

9. For more information, see Section 1.2.2 and Appendix D.

Alexander Porter



Sudbury River, Sudbury.

control capacity within a 200 foot setback for all low-density residential and agricultural land not subdivided as of 5/96 or developed as of 1/97. This law affords substantial additional protection for privately-owned open space along the rivers.

- Anticipated land use changes and population growth in the watershed through the year 2010, even in combination with drought conditions, are unlikely to reduce flows to the point where the rivers' outstanding resources are adversely affected. Major new consumptive uses would, however, need to be assessed to determine whether resulting flows, including periodic flushing flows, would be adequate to sustain these resources.
- While the rivers are currently eutrophic—overloaded with nutrients—measures can be taken to reduce both point and non-point sources of nitrogen and phosphorus. These measures have been incorporated in the *River Conservation Plan* (see Section 4.3).
- While sediments within the study segment of the

Sudbury River have been contaminated with mercury as far downstream as Egg Rock, and the EPA advises anglers not to consume fish caught in this area, a Superfund remediation plan is being developed that will address this problem. The segment's value for non-contact recreation, including catch and release fishing, is unimpaired.

4.3 RESOURCE MANAGEMENT FRAMEWORK

This study's second suitability criterion addresses the need for a resource protection and management framework to close any resource protection gaps identified during the vulnerability analysis. Such a framework is also needed to facilitate communication and cooperation among the governmental entities and private citizens who will bear responsibility for implementing the protection measures, should the rivers be designated.

While the Act requires the development of this framework, or "comprehensive river management plan,"

within three years *after* a river is designated, the SuAsCo study team determined that the plan should be developed before the rivers were recommended for designation. The team felt that it would be difficult for town meeting voters to decide whether to support wild and scenic designation if they were uncertain about their town's post-designation role in resource protection. The team also felt it had a responsibility to ensure that the rivers' resources would be adequately protected, without the use of federal land acquisition. By preparing the *Plan* in collaboration with town and state governments before study area residents voted, the study team was able to assess both the voters' support for designation and their commitment towards implementing the *Plan*. The *Plan* thus became a contract between study area residents, their town governments, the state, and the federal government to protect the rivers in a manner that established their suitability for inclusion in the national system.

4.3.1 THE SUDBURY, ASSABET AND CONCORD RIVER CONSERVATION PLAN

The Sudbury, Assabet and Concord *River Conservation Plan* was developed by the study team in collaboration with town boards, town government staff, and state agencies. Work on the *Plan* started following completion of the vulnerability analysis and water resources study, which provided much of the information needed to compile the resource-specific action program that is at the core of the overall *Plan*. The resources addressed in the *Plan* include public and private lands; water quality, quantity, and channel, floodplain, and wetland resources; and the five outstanding resources that make the rivers eligible for designation. For each resource, the *Plan* establishes:

- An objective, or broad vision for future management of the resource.
- A set of standards that describe the minimum criteria by which future management actions will be measured.
- An action program that includes key actions, supporting activities, and additional opportunities. This hierarchy of actions indicates their relative importance in ensuring resource protection goals are met.

- A description of special provisions that would go into effect if the rivers are designated, such as reviews of the impacts of federal water resources projects under Section 7 of the Wild and Scenic Rivers Act.

Entities responsible for implementing the action programs include all levels of government, relevant non-profits, and private citizens. For the most part, the action programs focus on maintaining and enforcing existing resource protection measures, while enhancing education and intergovernmental cooperation. New measures are identified for implementation based on the resource protection gaps discovered through the vulnerability analysis and water resources study.

4.3.2 RIVER STEWARDSHIP COUNCIL

Based on the interest expressed by the Study Committee and local community leaders in maintaining local control over riverfront land use, and based on the positive experience of the Committee in bringing together multiple levels of government and non-profit watershed groups, the study team recommended that a River Stewardship Council be established to implement the *Plan*. This Council would include representatives from each of the study area towns, the state, two non-profit watershed groups, FWS, and NPS. New members (e.g. other watershed groups or other towns in the watershed) could be added by consent of the existing members. The Council would be an advisory rather than a regulatory group.

Should the rivers be designated as components of the national system, the *Plan* proposes they be administered by the Secretary of the Interior in cooperation with the entities that comprise the Council. Through this partnership approach, the federal government would retain responsibility for ensuring federal water resource projects do not impair the rivers' free-flowing character or outstanding resources, while the towns and state would retain their existing land use authorities, along with primary responsibility for recreation management. This arrangement would be formalized and funded through cooperative agreements between the federal government and other members of the Council.

In summary, the resource protection and management framework outlined in the *River Conservation Plan* meets the second suitability criterion described in this report. The *Plan* ensures the continued protection of

the rivers' outstanding values, water quality, and free-flowing character, closing any gaps identified during the exhaustive analysis of potential land use and water resource problems that was conducted during the study. By establishing a River Stewardship Council that includes representatives of all the entities responsible for ongoing resource protection, the *Plan* also ensures that future management decisions will be based on resource protection objectives and standards that satisfy the Wild and Scenic Rivers Act's mandate to protect and enhance the rivers' outstanding values.

4.3.3 NEED FOR FEDERAL LAND ACQUISITION

To clarify study findings relative to the need for a new federal land acquisition and management program, the *Plan* includes specific provisions that address this issue. The *Plan* states that if the rivers are designated, there will be no new federal land acquisition program, that the rivers will not become units of the National Park System, and that there will be no federal management of non-federal lands. Pre-existing land acquisition and management programs at Great Meadows NWR and Minute Man NHP would be unaffected by these provisions.

Based on the analysis of existing protection described in Section 4.2 above, there is no need to establish a new federal land acquisition program should the rivers be added to the National Wild and Scenic Rivers System. The resources that make the rivers eligible for designation are adequately protected without this approach. The few parcels that may be vulnerable to inappropriate development would be better protected through a combination of existing local zoning and existing public and private voluntary land protection programs. A new federal acquisition program would be expensive to administer and would needlessly alienate the communities that have already demonstrated such a sound river conservation ethic.

After careful consideration, the study team determined that in light of ongoing state and local resource protection efforts, federal acquisition for the purposes of wild and scenic designation was unnecessary, and that it would be expensive, slow, and controversial. Instead, it recommended improvements in floodplain zoning consistency in some towns, along with strengthened enforcement of existing laws in others.

4.4 PUBLIC SUPPORT FOR DESIGNATION

Private lands wild and scenic studies such as the study conducted on the SuAsCo rivers frequently engender suspicion and concern in study area communities. In part, this concern is based on the perceived threat of federal condemnation of private lands. Residents and local government officials also worry that decisions about land use, recreational access, and other issues previously subject to local control will be made by a federal bureaucracy that ignores local wishes. They point to a handful of precedents set elsewhere in the country, where some private lands rivers have been designated without benefit of a study or before consensus was reached concerning federal, state, and local resource protection roles. In these instances, the federal government's statutory authority to use condemnation to protect wild and scenic resources has seemed like an ultimatum, making it difficult for local residents to feel like equal partners in river protection. However, since federal acquisition alone cannot serve to protect all of the resources of interest along a designated river, participation by state and local governments is in fact essential to the long term health of the river.

If private landowners and local governments view the federal agency responsible for the river study as an enemy, not to be trusted, the prospects for lasting resource conservation are poor. In several wild and scenic studies of private lands rivers in the northeastern United States during the past decade, the National Park Service has sought to avoid the creation of this "no win" situation by giving local governments the option of saying "no" to designation as a final step in the study process. In New England, this has taken the form of votes at annual Town Meetings, where residents convene to form a temporary local legislature, either directly or through elected representatives. These votes are also used to determine whether those responsible for implementing the river management plan support the plan and pledge their commitment to river protection.

Evidence of support for designation, and a commitment to the long term protection of the rivers, is also needed from the state agencies that share responsibility for the management of water quality, flows, recreation, etc.

The SuAsCo study committee chose to make its position on designation known prior to the spring 1995 town meeting votes. The committee voted unanimously in

February 1995 to recommend designation of all 29 miles of the study rivers, to be managed in accordance with the then draft *River Conservation Plan*, which was completed and approved by the study committee in March 1995. During March, April and May, 1995, the eight towns along the study segments held their annual town meetings. All eight towns used voice votes to express their wishes, and all voted to request Congressional designation in accordance with the *Plan*.

The measure was approved unanimously and enthusiastically by all voters present at several town meetings. In two towns (Billerica and Concord), there was some controversy and confusion about the extent to which designation might affect private property rights and recreational use. These concerns emerged through press articles, statements at pre-vote public hearings, and on the floor of the two town meetings. Much of the "information" provided by designation opponents took the form of questionable legal analyses of the generic Wild and Scenic Rivers Act by groups associated with the Wise Use movement, and out-of-context quotes from the Act, Interagency Guidelines, and even a 1978 GAO Report critical of the very top-down, acquisition-dependent approach the SuAsCo study had so successfully avoided. The overwhelming majority of voters in these two towns found the information provided by the Study Committee and the NPS more trustworthy, however, and approved the designation initiative.

The weeks leading up to the 1995 spring town meetings showed an outpouring of support from local and regional environmental and river user groups. These groups emphasized the high value of the rivers' scenic, natural, and recreational resources to their memberships. They praised the creation of the River Stewardship Council, which would, they felt, ensure future decisions about upstream withdrawals, wastewater permits, and recreational management would be responsible ones.

There were several measures of state support for designation, including the votes by Governor Weld's representatives to the Study Committee, Joan Kimball

and Jonathan Yeo, favoring wild and scenic designation and approving the *River Conservation Plan*. These individuals also worked with state agency staff to ensure their buy-in during the development of the *Plan*.

Governor Weld expressed his direct support for designation in a July 9, 1996 letter to U.S. House Subcommittee Chairman James Hansen, who was leading his subcommittee's review of H.R. 3405, a Bill to Designate The Sudbury, Assabet, and Concord Rivers. State agencies responsible for specific types of resource protection also expressed their support directly; for example, the Massachusetts Historic Commission based its strong support for designation on the fact that this would help to protect important historical and archaeological resources.

In July, 1996, after several years of deliberation, the Massachusetts legislature demonstrated the state's strong commitment to river protection when it enacted the Massachusetts River Protection Act. This law, which applies to most riverfront areas in partially developed or undeveloped areas of the state, creates a 200 foot regulatory setback within which proponents of new development must demonstrate that their project will have no significant effect on several river-related values (e.g. fisheries and wildlife habitat). While not targeted specifically at the study rivers, this law reinforces the existing partnership between Massachusetts cities and towns and state resource agencies in protecting the Commonwealth's wetlands and water resources. It will thus serve to enhance both the implementation of the SuAsCo *River Conservation Plan* and the operation of the River Stewardship Council.

In summary, the study serves as testimony to a confluence of support: the Study Committee's unanimous pro-designation vote; the town meeting votes; and many other expressions of support for designation from the legislature, governor, state agencies, and river user groups. There is a strong commitment to protect the rivers and their resources by the entities that will share this responsibility if the rivers are designated.

TOWN OF WAYLAND
MASSACHUSETTS
 01778



TOWN CLERK
 JUDITH L. ST. CROIX, CMC
 ASSISTANT TOWN CLERK
 LOIS M. TOOMBS

TOWN BUILDING
 41 COCHITUATE ROAD
 TEL. (603) 350-7701
 EXT. 102 OR EXT. 103

SPECIAL TOWN MEETING
CERTIFICATE OF VOTE

At a legal meeting of the qualified voters of the TOWN OF WAYLAND, held May 1, 1995, the following business was transacted under Article 1:

ARTICLE 1 STM. RESOLUTION SUPPORTING NATIONAL WILD AND SCENIC RIVERS SYSTEM

MOVED: That the Town vote to adopt the following resolution:

Whereas:

The Sudbury River flows through the Town of Wayland, Massachusetts, and is a natural resource of great importance to the Town and the Commonwealth of Massachusetts;

Whereas:

The quality and quantity of its water are essential to the maintenance and enhancement of the ecology, recreation, water supplies, and the physical beauty of the landscape;

Whereas:

The National Park Service has determined that portions of the Sudbury, Assabet, and Concord Rivers are eligible for Wild and Scenic River designation based on their outstanding wildlife, recreational, cultural, historical, and scenic values;

Whereas:

The people of Wayland recognize the importance of this irreplaceable natural asset and hereby express a commitment to the protection and preservation of the Sudbury River and its outstanding values;

Whereas:

The Town of Wayland; the Sudbury, Assabet and Concord Rivers Study Committee; and the National Park Service have worked cooperatively to develop an effective locally-based plan that will ensure the necessary protection of the river and its related resources;

Whereas:

The Wild and Scenic River designation would provide further protection of the river and would retain local control and regulation by towns within the designated river segment;

Now, Therefore, be it resolved, that:

1) the people of the Town of Wayland petition the Congress of the United States of America to enact legislation designating the Sudbury River as a Wild and Scenic River in accordance with the locally-developed river Conservation Plan, and to ensure that Wild and Scenic designation shall not authorize federal acquisition or management of nonfederal lands; and

2) the townspeople urge our officials to consider, and wherever appropriate to adopt, additional local measures that will strengthen protection of this critical resource.

VOTED: UNANIMOUSLY IN FAVOR

A true copy, Attest:

Judith L. St. Croix, CMC
 Town Clerk

4.5 SUITABILITY FINDINGS

4.5.1 EFFECTS OF DESIGNATION

This section identifies the effects of designation on the river and its environs, the costs of administering the designated segments, and the public benefits that would accrue. It seeks to answer the question: Is designation appropriate in light of all public needs?

EFFECTS AND PUBLIC BENEFITS

As summarized above, the Sudbury, Assabet and Concord rivers have already been the object of intensive conservation efforts at the state, local, and private level. One of the principal effects of designation would thus be to ensure that the federal government's actions with respect to the rivers would build upon these existing efforts. Without wild and scenic designation, there would be no review of future federal water resources projects to ensure that the rivers' nationally significant, outstanding resources would be protected from the adverse impacts of such projects.

Designation would also have a beneficial effect on resources located within the existing federally-owned areas along the rivers, including water quality, flows, wildlife habitat, scenery, and historical values. While the portions of the rivers within Great Meadows National Wildlife Refuge and Minute Man National Historical Park are unlikely to be adversely affected by land or water-based projects located within the boundaries of these federal areas, regardless of the rivers' wild and scenic status, the same cannot be said for projects located on adjacent non-federal lands. The commitment of the state and local governments to the resource protection standards articulated in the *River Conservation Plan* provides strong assurance that any future state or local decisions and activities will be consistent with the protection of these important resources.

By creating the River Stewardship Council to aid in the implementation of the *Plan*, designation would also serve to improve intergovernmental cooperation in the protection of the rivers. This would increase the efficiency of existing efforts, which are not necessarily coordinated across political boundaries, regardless of the fact that the rivers' resources transcend such boundaries. The modest funding that is expected to be

provided to the Council from both federal and non-federal sources will also heighten public awareness and understanding of the rivers' natural functions, reinforce the ability of local landowners and town governments to act in the rivers' best interests, and avoid the need for expensive, top-down, bureaucratic regulatory programs.

Designation is unlikely to cause significant changes in property values or existing land use and ownership patterns along the 29-mile study segment. Most of the privately-owned, developable land along the rivers has already been built upon at low densities. Land values already reflect the worth of abundant open space and well-preserved natural landscapes along the rivers. Designation would tend to stabilize these values by ensuring that local zoning does not change to allow more intensive land uses, and by protecting the rivers from degradation.

While recreational use of the rivers may increase if they are designated, it is hard to predict how much of an increase might be due the rivers' status as nationally-recognized resources, and how much might come from an increase in regional demand for water-borne recreation. In any case, the *River Conservation Plan* includes recommendations for improving state and local coordination in the recreational management of the rivers. Should demand increase, any carrying capacity problems or use conflicts would be amenable to resolution by the River Stewardship Council.

There are no known public water resources projects that would be prohibited as a result of wild and scenic designation. The rivers' low gradient makes them extremely poor candidates for hydropower development, and likewise makes the use of flood-control dams, dikes, or levees impractical. While studies of the Sudbury Reservoir system's potential for reactivation in the mid-1980s were a major factor in stimulating public interest in the wild and scenic study, there is no current proposal to use the Sudbury River as an active source of water supply. Current operations of the existing MWRA water supply and sewerage system actually result in a net transfer of water into the SuAsCo basin from adjacent basins. Such transfers, along with any future proposals to withdraw 100,000 gallons per day or more from the rivers or associated aquifers, are subject to state regulatory programs that emphasize the protection of instream flows and reliance on

conservation alternatives. If the rivers are designated, any such transfer or withdrawal that required a federal permit (e.g. a Corps Section 404 "dredge and fill" permit) or received federal funds would also be reviewed for direct and adverse impacts on the rivers' free-flow or outstanding resources.

The Water Resources Study addressed the probability that new withdrawals or interbasin transfers will be needed due to likely growth through the year 2010. It indicated that, under its highest predicted levels of water demand combined with severe multi-year drought conditions, aggressive water conservation measures would be needed to avert the temporary loss of habitat for river-dependent wildlife. If the rivers are designated, the impacts of these conditions could be minimized for several reasons. First, the hydrological model of the basin that was developed during the Water Resources Study is expected to be further calibrated and refined as additional flow data are collected, aiding in the prediction and avoidance of low flow events. Second, implementation of the *Plan's* action program with regard to flow maintenance will ensure that the towns, state agencies, and water users will work together to reduce demand and respond to incipient drought conditions to the maximum extent possible. Third, where any federal permits or funding is involved, the federal government will ensure no new water resources projects are authorized that would exacerbate the impacts of drought conditions on the rivers' flows or resources.

Alexander Porter



NPS/Roy Crystal



Distinctive bridges characterize the SuAsCo rivers.

COSTS

The partnership approach adopted for the Sudbury, Assabet and Concord rivers study provides a working model for continued cooperation should the rivers be designated. The National Park Service, Commonwealth, towns, SVT, and OAR have shown a long-term commitment to both river protection and to the joint pursuit of shared goals. Each will contribute time, staff, and other resources to support the work of the Council and the costs of implementing the *Plan*.

In general, the existing costs of river management by the state and local governments should not be significantly affected by designation. Most of the river protection actions described in the *Plan* can be carried out under ongoing public and private programs. Participation on the River Stewardship Council is the most significant new responsibility associated with designation. However, members of the Council are likely to be volunteers or staff from state or local governments working within their current job descriptions, and thus the Council is unlikely to represent a major new financial burden.

Modest federal funding for Council operations and the implementation of the *River Conservation Plan* through cooperative agreements with member organizations will be sought if the rivers are designated. It is estimated that appropriations of \$50,000 to \$100,000 per year will be required during the 3-5 year start-up phase. Approximately half of the annual federal contribution would be spent on staff support and technical assistance from the National Park Service to the RSC. The balance would be distributed through cooperative agreements for specific river protection and

management projects, such as the preparation of a recreation management plan.

After its first few years of operation, the RSC is expected to be less dependent on federal appropriations as alternative sources of funding are identified. Sufficient federal funding to support the National Park Service's mandated Section 7 review of federal water resources projects and its participation on the RSC would continue to be needed, however. These responsibilities are expected to require about 1/2 an FTE ("full time equivalent"—a federal staffing unit).

4.5.2 SUITABILITY RECOMMENDATION

The entire eligible river area has also been found suitable for inclusion in the National Wild and Scenic Rivers System, based on the following factors:

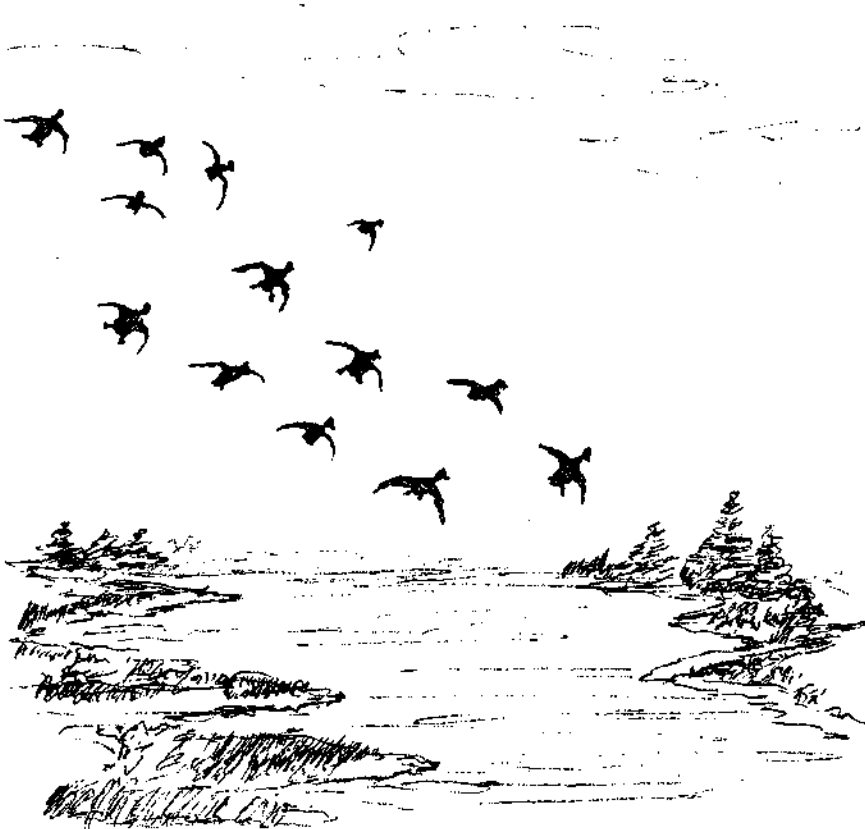
- 1) The adequacy of the long-term resource protection afforded by a combination of existing conservation land ownership, land use controls, and topography along the segments. These factors serve to restrict land use changes that could impair the rivers' free-flowing character or that

would be incompatible with the protection and enhancement of their outstandingly remarkable values.

- 2) The development of an appropriate cooperative framework—the River Stewardship Council—to assist the Secretary of the Interior in the protection and management of the segments, should they be designated.

- 3) The strong support for designation expressed by the study committee, the Commonwealth, user groups, and by study area communities through town meeting votes requesting Congressional designation and endorsing the *Sudbury, Assabet and Concord River Conservation Plan* prepared during the study.

- 4) The major public benefits that would accrue through designation, in comparison with the modest costs associated with its implementation, and the absence of any significant negative effects on property values, local governmental control, or bureaucratic inefficiency.



CHAPTER 5 ANALYSIS OF ALTERNATIVES

This discussion examines the consequences of alternative protective measures for the Sudbury, Assabet, and Concord river study area.

5.1 DESCRIPTION OF ALTERNATIVES

Alternative A. No Action

This alternative would maintain existing state and local provisions for resource protection on the rivers without additional federal oversight on federal water resources projects or federal support for local river protection efforts.

- There would be no review of federal actions for consistency with state and local policies as articulated in the *Sudbury, Assabet, and Concord River Conservation Plan*.
- There would be little if any further assistance from the federal government for *Sudbury, Assabet, and Concord River Conservation Plan* implementation.
- Selection of this alternative would be contrary to the expressed interest of the federal advisory committee, eight study area communities, and Commonwealth of Massachusetts. Town votes evidenced a clear desire for federal designation of the rivers, and for future cooperative management consistent with the *River Conservation Plan*.

Alternative B. Wild and Scenic Designation of Entire Study Area in Accordance with the River Conservation Plan

Under this alternative, 29 miles of the Sudbury, Assabet, and Concord rivers would be added to the National Wild and Scenic Rivers System. A new body, the Sudbury, Assabet and Concord River Stewardship Council, would be established to serve as the local river management committee. Its members would represent a range of interests. The NPS would coordinate its consistency review of federal water resource development projects with the Council. The Council would be the focal point for communication and coordination among local communities, the state, the U.S. Fish and

Wildlife Service, and the NPS.

- Federal water resource development projects affecting outstanding resources, water quality, or flows within the designated reach would be reviewed for consistency with the Wild and Scenic Rivers Act, the *River Conservation Plan*, and state and local policies.
- In cooperation with state and private parties, the NPS would seek funding for the operation of the Council.
- The NPS would support the efforts of the Council to implement the *River Conservation Plan*, including support for voluntary land protection, recreational management, continued water resources research and monitoring, and historical/archaeological research, interpretation, and protection.
- The NPS would seek the cooperation of other federal agencies, especially the EPA, to alleviate water quality problems along the segments.
- By granting national recognition to the rivers' outstanding resources through Congressional action, designation would likely foster greater pride in the rivers and improve long-term support for state and local protection measures.
- Selection of this alternative would achieve the federal designation goal of the *River Conservation Plan* and conform with expressed local desires for federal consistency with state and local plans.

Alternative C. Wild and Scenic Designation with Oversight by the U.S. Fish and Wildlife Service

This alternative is identical to Alternative B, except that the FWS would be the federal entity represented on the Council, and would also be the agency responsible for review of federal water resource development projects.

The study was conducted by the NPS, the agency that customarily studies and manages so-called "private

lands" wild and scenic rivers, and an NPS unit, Minute Man National Historical Park, is located along the Concord River segment. However, the FWS manages a wildlife refuge that encompasses some of the study rivers' most important natural and scenic resources. Consequently, in developing the proposed river management framework, the study team examined the alternative of FWS administration of the segments. This discussion was facilitated by the participation of the FWS refuge manager as a member of the study committee. Based on a comparison of current staff availability and expertise at the wildlife refuge, park, and NPS system support office, the study team concluded that NPS was in a better position to provide the technical assistance described in the *Plan*, and to ensure that the management of the proposed segments is consistent with the administration of other private lands wild and scenic rivers in the northeast.

5.2 RECOMMENDED ALTERNATIVE

Alternative B, designating the entire 29-mile study area for administration by the National Park Service in partnership with a River Stewardship Council, is the

preferred alternative for these rivers. Selection of this alternative is based in part on the findings that the rivers meet wild and scenic eligibility and suitability requirements. It is also based on the expressed wishes of the state and local governments to have federal representation on the River Stewardship Council, and federal support for implementation of the *River Conservation Plan*.

The Study Committee considered Alternative C, designation with FWS as the federal managing agency, at length during preparation of the *Plan*. Its recommendation that the NPS be the federal managing agency was based on the fact that the NPS is studying or managing several other wild and scenic rivers in the northeast and thus possesses staff with the technical knowledge that will be needed by the River Stewardship Council. In contrast, the FWS manages only a handful of wild and scenic rivers nationally—all west of the Mississippi—and has limited staff with expertise in working with local communities to protect resources outside the national refuge system. The Study Committee felt that NPS management would thus be more efficient: a better use of scarce federal staff and funds.



APPENDIX A: STUDY PARTICIPANTS

THE SUDBURY, ASSABET AND CONCORD WILD AND SCENIC RIVER STUDY COMMITTEE

Bill Sullivan, Town of Concord, Chair
 Leslee Willitts, Town of Framingham, Co-Chair
 Ron McAdow, Sudbury Valley Trustees, Recording Secretary
 Sally Newbury, Town of Wayland
 Alex Porter, Town of Sudbury
 Peter Sprayregen, Town of Lincoln
 Wanda Milik, Town of Carlisle
 Ruth Ann Valentine, Town of Bedford (11/94-7-95)
 Anna Lipofsky, Town of Bedford (4/92-10/94)
 Ralph Bacon, Town of Billerica
 Betsy Stokey, Organization for the Assabet River
 Joan Kimball, DFWELE Riverways, Commonwealth of Massachusetts
 Jonathan Yeo, Massachusetts Water Resources Authority, Commonwealth of Massachusetts
 Ed Moses, Great Meadows NWR, U. S. Fish & Wildlife Service

STUDY STAFF

Cassie Thomas, Project Manager, New England System Support Office, National Park Service
 Drew Parkin, National Park Service (former staff)
 Julia Blatt, SuAsCo Project Coordinator, Massachusetts DFWELE Riverways Program

STUDY REPORT GRAPHICS AND LAYOUT

Victoria Bass, New England System Support Office, National Park Service

ILLUSTRATIONS

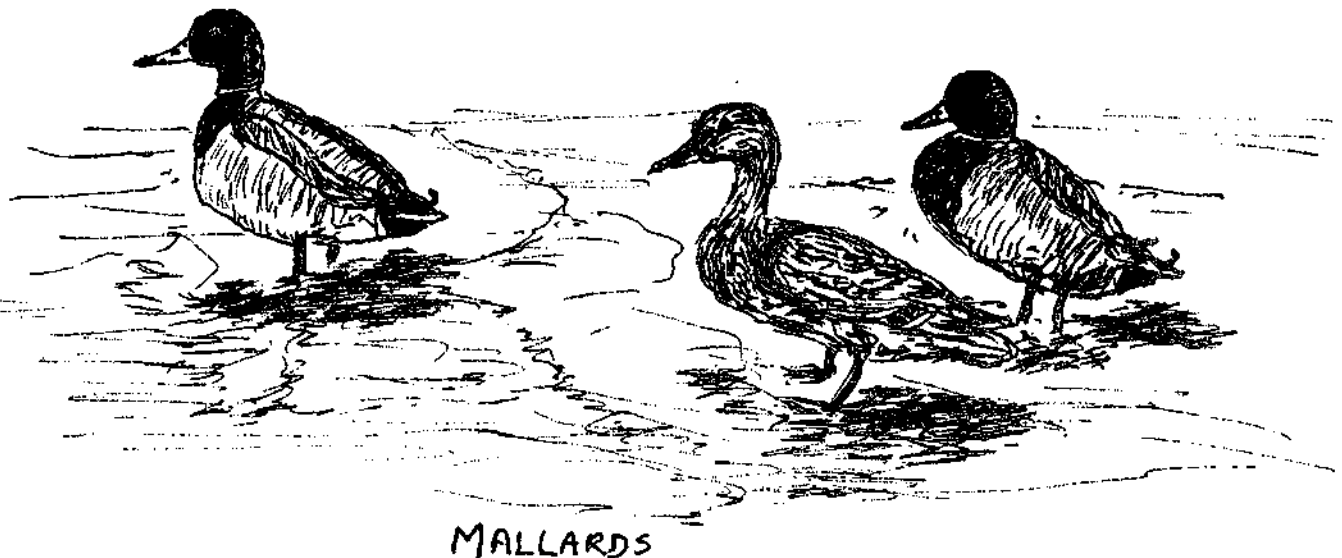
All pen and ink drawings are by Alexander Porter, Sudbury's Study Committee representative.

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 Sandy Bane, Town of Carlisle
 Whitney Beals, Sudbury Valley Trustees
 Shirley Blancke, Concord Antiquarian Museum
 Thomas Blanding, Historian
 Lisa Bratton, U.S. Geological Survey
 Crystal Card, Billerica Conservation Commission
 Chris Chisholm, Town of Carlisle
 Betsy Colburn, Massachusetts Audubon Society
 Dave Comstock, Sierra Club
 Roy Crystal, Goldman Environmental Consultants
 David Cutner, Town of Framingham
 Dan Dattilio, Minute Man National Historical Park
 Peter Donahue, Appalachian Mountain Club
 Bill Elliott, Water Supply CAC
 George Ellmore, Botanist, Tufts University
 Chuck Enright, Concord
 Ann Forbes, Preservation Consultant
 Dave Frisque, Great Meadows National Wildlife Refuge (former staff)
 Larry Gall, National Park Service
 Whit Garberson
 Mike Gildesgame, MA Dept. of Environmental Management
 Dorothy Graaskamp, MA Dept. of Fisheries, Wildlife, and Environmental Law Enforcement

Carol Gumbart, Town of Wayland
 John Haubert, National Park Service
 George Holmes, Town of Framingham
 Jerry Howard, Wayland
 Phil Huffman, National Park Service (former staff)
 Dick Hsu, National Park Service
 Steve Johnson, Sudbury Valley Trustees
 Jody Kablack, Town of Sudbury
 Janet Kennedy, Great Meadows National Wildlife Refuge
 Al Lima, Town of Concord
 Ursula Lyons, Hop Brook Protection Association
 Judy Mack, Sudbury Valley Trustees
 Geoff McGean, Town of Lincoln
 Bob McIntosh, National Park Service
 Steve McRae, MA Dept. of Fisheries, Wildlife, and Environmental Law Enforcement
 Mike Meixsell, SuAsCo Watershed Association
 Dan Monahan, Town of Concord
 Ken Moon, Wayland Conservation Commission
 Barbara Mudd, SuAsCo Watershed Association

Richard Murray, MA Dept. of Fisheries, Wildlife, and Environmental Law Enforcement
 Nancy Nelson, Minute Man National Historical Park
 John Organ, U.S. Fish & Wildlife Service
 Marcia Rasmussen, Town of Concord
 Karen Pelto, DFWELE Riverways Program
 Joe Piantedosi, Town of Bedford
 Shirley Rohan, Southbridge Boathouse
 Arthur Screpetis, MA Dept. of Environmental Protection
 Pam Shields, U.S. Environmental Protection Agency
 Ken Simmons, MA Dept. of Fisheries, Wildlife, and Environmental Law Enforcement
 Gordon Shaw, Concord
 Gary Smillie, National Park Service
 Chris Soller, National Park Service
 Budd Titlow, Southborough
 Judy Walpole, Town of Concord
 Matt Zettek, Framingham Advocates for the Sudbury River
 John Zupkus, Bedford Conservation Commission



APPENDIX B: SUDBURY, ASSABET AND CONCORD
WILD AND SCENIC RIVER STUDY ACT

NOVEMBER 28, 1990

TITLE VII—SUDBURY, ASSABET, AND CONCORD RIVERS STUDY

Sudbury, Assabet, and Concord Wild and Scenic River Study Act. Massachusetts. 16 USC 1271 note.

SEC. 701. SHORT TITLE.

This title may be cited as the "Sudbury, Assabet, and Concord Wild and Scenic River Study Act".

SEC. 702. FINDINGS.

The Congress finds that—

(1) The Sudbury, Assabet, and Concord Rivers in the Commonwealth of Massachusetts possess resource values of national significance, including outstanding wildlife and ecological values, historic sites, and a cultural past important to America's literary heritage.

(2) Portions of this study segment have been listed on the Nationwide Rivers Inventory by the National Park Service.

(3) There is strong support among State and local officials and area residents and river users for a cooperative wild and scenic river study of the area.

(4) In view of the longstanding Federal practice of assisting States and local governments in protecting, conserving, and enhancing rivers of national significance, the United States has an interest in assisting the Commonwealth of Massachusetts and the appropriate local governments in studying and developing a resource conservation and management plan for the river, consistent with the Wild and Scenic Rivers Act.

SEC. 703. WILD AND SCENIC RIVER STUDY.

(a) LISTING FOR STUDY.—Section 5(a) of the Wild and Scenic Rivers Act (16 U.S.C. 1276(a)) is amended by adding the following new paragraph at the end thereof:

"() SUDBURY, ASSABET, AND CONCORD, MASSACHUSSETS.—The segment of the Sudbury from the Danforth Street Bridge in the town of Framingham, to its confluence with the Assabet, the Assabet from 1,000 feet downstream of the Damon Mill Dam in Concord to its confluence with the Sudbury and the Concord from the confluence of the Sudbury and Assabet downstream to the Route 3 Bridge in the town of Billerica. The study of such river segments shall be completed and the report submitted thereon not later than at the end of the third fiscal year beginning after the date of enactment of this paragraph."

Reports.

SEC. 704. ADVISORY COMMITTEE.

(a) APPOINTMENT.—At the earliest practicable date following the enactment of this Act, but not later than forty-five days after enactment, the Secretary of the Interior (hereinafter referred to as the "Secretary") shall establish the Sudbury, Assabet, and Concord Rivers Study Committee (hereinafter referred to as the "Committee"). The Secretary shall consult with the Committee on a regular basis during the conduct of the study required by section 3 of this Act (hereafter "the study") and the preparation and submission, pursuant to section 4 of the Wild and Scenic Rivers Act, of a report with respect to the river segments covered by the study.

(b) MEMBERSHIP AND PROCEDURES.—

(1) Membership on the Committee shall consist of 13 members appointed by the Secretary as follows:

(A) One member shall be appointed by the Secretary from the Fish and Wildlife Service.

(B) Two members shall be appointed by the Secretary from a list of candidates supplied to the Secretary by the Governor of the Commonwealth of Massachusetts.

(C) One member shall be appointed by the Secretary from a list of candidates supplied to the Secretary by the Sudbury Valley Trustees.

(D) One member shall be appointed by the Secretary from a list of candidates supplied to the Secretary by the Organization for the Assabet River.

(E) One member each shall be appointed by the Secretary from lists of candidates supplied to the Secretary by the Board of Selectmen or equivalent local governing body of each of the eight towns located within the area covered by the study.

(2) The members of the Committee shall elect a chairman, vice chairman, and recording secretary from the membership at the first official meeting of the Committee. Official minutes shall be kept of each regular and special meeting of the Committee and shall be open for public inspection.

(3) Any vacancy on the Committee shall be filled in the same manner in which the original appointment was made. Any member appointed to fill a vacancy occurring before the expiration of the term for which his predecessor was appointed shall be appointed only for the remainder of such term. Vacancies in the membership of the Committee shall not affect its power to function if there remain sufficient members to constitute a quorum under paragraph (4) of this subsection.

(4) A majority of the members of the Committee shall constitute a quorum for all meetings.

(5) The Committee shall advise the Secretary in conducting the study and concerning management alternatives should some or all of the river segments studied be included in the National Wild and Scenic Rivers System.

(6) Members of the Committee shall serve without compensation but may be reimbursed by the Secretary for reasonable and necessary expenses incurred by them in the performance of their duties as members of the Committee.

(7) The Committee may accept and utilize the services of voluntary, uncompensated personnel.

(8) The Committee shall terminate upon the submission to the President, pursuant to section 4 of the Wild and Scenic Rivers Act, of the report with respect to the river segments covered by the study.

Appropriation
authorization.

SEC. 705. AUTHORIZATION.

There are hereby authorized to be appropriated such sums as may be necessary to carry out the purposes of this title.

TITLE VIII—PRIVATE RELIEF PROVISIONS

Leroy W.
Shebal.

SEC. 801. (a) Notwithstanding any other provision of law, including but not limited to section 8 of the Wild and Scenic Rivers Act (16 U.S.C. 1279) or any provision of the public land laws of the United States, the Secretary of the Interior (hereinafter in this title referred to as the "Secretary") shall survey and convey all right, title,

APPENDIX C: ANALYSIS OF EXISTING RESOURCE PROTECTION
SUDBURY, ASSABET AND CONCORD WILD AND SCENIC RIVER STUDY

JULY 1994

This summary focuses on the protection of the land-based portion of the outstanding resources identified in the Eligibility Report. Included are riparian and terrestrial ecosystems possessing high river-dependent wildlife habitat value; historical sites as described in the Eligibility Report; upland scenery within the river corridor; and recreational access points. The protection of flow-dependent resources (such as aquatic habitat and water-based recreation) is addressed by the Water Resources Study and River Conservation Plan.

Resources to be Protected

In order for the SuAsCo River study area to be considered suitable for designation, the long term protection of certain resources within the river corridor must be assured. These resources include the outstanding resources identified in the *Resource Assessment and Eligibility Report* and the immediate riverfront throughout the 29-mile study area. The outstanding resources must be protected if the rivers are designated because their preservation is one of the primary goals of the Wild and Scenic Rivers Act (see § 1(b) of the Act¹). In addition, regardless of the location of the resources which make the rivers eligible for designation, protection of the riparian corridor, i.e. the lands immediately adjacent to the rivers' banks, is needed to maintain the ecological and scenic integrity of these waterways.

Forms of Protection

There are three principal forms of protection for lands within the SuAsCo river corridor: 1) physical constraints to development; 2) land ownership for conservation purposes; and 3) local and state land use laws.

1) Physical constraints are those topographic or access conditions which serve to restrict new development of lands along the rivers. Examples are steep slopes, which render areas undevelopable without costly feats of engineering; unsuitable soils (mucks or extensive bedrock outcrops) which have poor structural bearing characteristics or require expensive blasting; and natural hazard areas such as floodways. Landlocked areas—undeveloped parcels which do not front on public roadways, and particularly those that are bounded by waterways and/or railroads, utility lines, etc. on all sides—are also considered to be subject to physical constraints due to the expense of providing physical access.

2) Under the land ownership category, all lands which are either owned in fee for qualified conservation purposes or which are subject to permanent conservation restrictions are considered to be protected from additional development. Qualified conservation lands include those purchased by the federal government pursuant to authorizations for the establishment of national parks and wildlife refuges. Such lands cannot be converted to other uses except through federal legislation, and also receive protection from certain forms of federally-authorized land use changes such as federal highways (Section 4(f) of Highway Act). Lands subject to the protection of Article 97 of the Massachusetts Constitution, which requires a 2/3rds vote of both houses of the state legislature for the disposition or change in use of said lands, are also considered to be permanently protected, as are areas subject to development restrictions under the state's Wetlands Conservancy Program. In addition, lands or interests in land held by private charitable organizations for conservation purposes, or which are held in trust for, or otherwise restricted by deed to, such purposes are considered to be permanently protected.

Not included are lands owned by municipalities, road commissions, water commissions, etc., which are not subject to long term conservation use restrictions. Examples are town DPW and school department lands and lands under the care and control of water departments and commissions, because these lands could be sold to private purchasers or developed by the towns. Also not included are lands subject to preferential tax assessments, i.e. Massachusetts G.L.

¹P.L. 90-542 as amended (16 U.S.C. 1271 *et seq.*), Section 1(b) states: "It is hereby declared to be the policy of the United States that certain selected rivers ... which, ... with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values ... shall be protected for the benefit and enjoyment of present and future generations."

Chapter 61, 61A, and 61B lands, since these open space incentives apply only against current property taxes with no penalty (apart from rollback taxes) for future changes in use. Lands subject to state Agricultural Preservation Restrictions, however, are considered to be permanently protected since these restrictions were bought by the state using public funds and can only be repurchased by the landowner at significant cost.

3) Local and state land use laws and regulations include zoning and non-zoning bylaws and regulations, along with state designations and restrictions, that protect natural resources or reduce permissible development densities. Examples of local protection include large lot zoning, resource protection overlay districts (e.g. floodplain zoning), wetlands bylaws or overlay zones, Board of Health septic system setback requirements (particularly those more stringent than state-mandated Title V minimums), TDR (transfer of development rights) programs, cluster development authorizations, and lands subject to PUD or PRD (planned unit or planned re-use development) requirements which include resource protection incentives. It is important to note that where local resource protection programs are more stringent than state-mandated minimums, state agency projects, including projects which alter wetlands or require wastewater treatment permits, are only required to meet the state standards.

Examples of state protection include areas protected under the Wetlands Protection Act, and designated Areas of Critical Environmental Concern, within which the review of projects which trigger MEPA (the Massachusetts Environmental Policy Act, which requires a project's environmental impacts to be assessed before state permits are issued) is more stringent than elsewhere. Should the proposed Massachusetts River Protection Act be passed, this form of state-imposed and locally enforced zoning would also be considered to be a major form of regulatory protection for the SuAsCo rivers.

Level of Protection/Goal

For the outstanding resources which make the rivers within the SuAsCo study area eligible for designation, the acceptable level of protection is that level which ensures the resource will be protected and enhanced over the long term. Thus the goal of designation, at a minimum, is to maintain the resource values which create strong public interest in the river system. Maintenance means the resource will continue to exist without measurable degradation for the foreseeable future. For ecological resources associated with terrestrial areas, this means no net loss of species diversity, distribution, or population will occur. For scenic values, major alterations in the river corridor landscape, such as the loss of forested hillsides or the construction of conspicuous houses in upland meadows, would be considered a degradation, as would other forms of development incompatible with existing land use patterns (e.g. shopping malls or other intensive land uses at the river's edge).

Enhancement of the resources, where possible within the recommended management framework for the rivers, is an additional goal of designation. For instance, where recreational conflicts exist along the river, a management strategy designed to reduce such conflicts without resulting in a loss of access to the river by existing user groups would be considered an enhancement of this important resource category. Programs intended to improve the stewardship of riparian lands, e.g. voluntary implementation of "best management practices" for lawn and garden care, would also be considered to enhance the riparian habitat resource. Other examples of resource enhancement could include the development of educational and interpretive materials associated with the rivers' history, literary heritage, and ecological values.

Town-by-town Summary

Described below are three categories of existing protection for land-based resources located in each of the eight study area towns. These summaries are organized as follows: first, the town's riverfront character is described (length of frontage on study rivers, topographic features, major landforms and land uses, etc.) along with the presence of outstanding resources as identified in the *Eligibility Report*. Next, the town's basic land use requirements (such as riverfront zoning districts) are described, and resource protection zones or bylaws are summarized. Finally, likely future development patterns in the town's riparian areas are assessed, with a focus on the potential for significant new or incompatible development. From this description, areas of concern can be identified for further discussion with the River Conservation Planning Subcommittee, town representatives, and town officials. Information about the effective enforcement of local protection requirements will also be sought. Recommendations for additional local protection or improved enforcement (where needed) will be formulated pursuant to these discussions. Where the need for new forms of protection is not indicated, the focus of these discussions will be on enhancement opportunities.

Please note that in the town-by-town analyses, features are located within the river corridor using "left bank" and "right bank" convention. This convention always refers to the left or right bank as viewed while looking downstream. It is preferable to the use of compass points (e.g. "west bank" or "north bank") because the rivers' meanders make compass directions confusing.

Framingham

1) Riverfront Character

The study segment of the Sudbury River begins in Framingham at the Danforth Street bridge, just downstream of Saxonville, a 19th century mill village sited on the last impoundment along the Sudbury. The portion of the river immediately upstream of the bridge is considered ineligible for designation due to bank and channel alterations—straightening and riprapping—performed by the U.S. Army Corps of Engineers for flood and erosion control. Once past Danforth Street, however, the river's natural character is restored as it flows along steep, hemlock-shaded banks and on past an oxbow.

While at first glance there appears to be only about one linear mile of the Sudbury River under study in Framingham, this distance is deceiving. If the oxbow is counted in addition to the main stem of the river, another mile is added to the total distance. Because some of the frontage along the right bank of the oxbow is within the town of Wayland, however, total frontages along the Framingham study segment's left and right banks differ: the right bank frontage totals about 6200 feet, or 1.17 miles, while the left bank frontage totals 11,300 feet, or 2.14 miles, counting frontage both on the main stem and the oxbow.

Immediately downstream from the Danforth Street bridge, a historic iron structure which has been closed to vehicular traffic, the river runs north for about half a mile between steep wooded slopes. Once past Danforth Street, no development is visible from the river due to topography and the dense vegetation, although a school and a cemetery in fact flank the river along the left bank. On the right bank, a large area of glacial sand and gravel deposits between the river and Pod Meadow Brook is owned by the New England Sand and Gravel company. Except where there have been recent extraction operations, this site is naturally vegetated in mature hardwoods and softwoods, particularly along the riverbank.

An oxbow branches off the river to the right, downstream from the upland portion of the sand and gravel site. Land within the oxbow, although wet and low-lying, has also been subject to sand and gravel extraction, but there are no structures on this site. Land along the right bank (upland side) of the oxbow is undeveloped, due to topography (extensive wetlands along the New England Sand and Gravel land and at the mouth of Pod Meadow Brook) and the land-locking effect of an aqueduct right-of-way along the northern (downstream) bank. Wayland borders Framingham along this downstream half of the oxbow.

Along the main stem of the river, most of the current follows a channel which short-circuits the oxbow, flowing in riffles across a ledgy outcrop where Little Farms Road dead ends on the left bank. From here downstream past Stone Bridge Road to the Sudbury border, a distance of about 2500 feet, a well-screened, low density neighborhood stretches along the left bank. Some river frontage, including a canoe access area with parking for a few cars at the end of Little Farms Road, is owned by the Conservation Commission. Lot sizes range from about 20,000 square feet to an acre or more. The right bank is in Wayland. This reach is also spanned by the Weston Aqueduct and the ruins of an earlier Stone Bridge. Except where the aqueduct follows a steep spur as it crosses the river from the west, the riverside topography is gentle with a well-defined, largely forested bank.

Within the Framingham study segment, outstanding river-related resources include riparian and aquatic wildlife habitat in the vicinity of the oxbow; archaeological and historical sites such as the Weston Aqueduct "siphon," the Danforth Street Bridge, and Stone's Bridge at the town border with Wayland; and recreational and scenic values, particularly from the oxbow downstream. Of these resources, the habitat, archaeological, scenic and recreational values at the New England Sand and Gravel site, including the oxbow, would be most vulnerable to inappropriate changes in land use.

2) Local Land Use Requirements

There are several residential and commercial zoning districts along the Sudbury River in Framingham, ranging in density from the 8000 square foot R1 one and two-family zone, to the 20,000 square foot R3 and PRD one and two-family zones. Building heights within residential districts are limited to 40 feet.

At the start of the study segment at Danforth St., zoning on both sides of the river is R1. Farther downstream along the left bank, the Planned Re-use District (encompassing the town-owned school property) serves to protect "open space, trees, planting, and other natural features" and requires 20,000 square feet minimum lots.

On the right bank, the upland portion of the New England Sand and Gravel site is zoned General Manufacturing, subject to a temporary PUD/Cluster overlay. Residential development on this site, while allowed during the term of the PUD, would require a special permit. Among the objectives of the PUD designation are the preservation of open space and the protection of wetlands, woodlands, fields, natural habitats, significant vegetation, and water bodies. The oxbow portion of the NE S&G site along with the left bank from Little Farms Rd. downstream, is zoned R3.

Framingham's floodplain zoning meets National Flood Insurance Program (NFIP) minimum standards. A Special Permit from the ZBA is required for construction within zones A1-A10, but such construction is not prohibited outright. There appears to be no prohibition on downstream impacts associated with new construction. Such projects are merely required to be designed to minimize the loss of life and property.

Framingham's Wetlands Bylaw extends the buffer zone to 125 feet from wetlands and vernal pools, and protects agriculture, recreation, and aesthetics, functions not covered under the state act. In defining agriculture and spelling out permissible activities within and near wetlands under this definition, the bylaw also regulates vegetative cutting along rivers and streams. This is a particularly significant form of protection for riparian habitat and aesthetics along the study segment of the Sudbury River.

Existing areas of residential development along the study segment in Framingham are fully sewered. Any new development which would not be served by sewers would have to comply with the town's septic system regulations. Included in these regulations are minimum setbacks of 75 feet from watercourses (not including wetlands) for systems with a design flow of 1000 gallons per day or less, and 100 feet for those with flows exceeding 1000 gpd. (Based on a 110 gpd/bedroom rule of thumb, virtually all single family residences would have systems with design flows less than 1000 gpd.) No leach field may be sited less than 2 vertical feet above the 100-year floodplain, and compensatory flood storage is required if raised systems are used to meet this elevation requirement.

3) Riverfront Development Potential

Despite the fairly intensive pattern of existing development along the lower Sudbury River in Framingham, the river corridor is quite natural in appearance, with mature trees and large areas of riparian vegetation providing both ecological and aesthetic benefits. With the exception of the Sudbury Landing and New England Sand and Gravel sites, there is virtually no developable land along the study segment of the Sudbury River in Framingham, barring a change in use of municipal land currently used for the school and the Edwards Cemetery, or the release of MWRA aqueduct lands. Thus conditions within the existing residential neighborhood are unlikely to change.

The proposed Sudbury Landing development site is located on the left bank just downstream of the Danforth St. bridge. Conceptual plans for an 18-lot subdivision at this site have been under discussion for several years. The Planning Board has not received a final plan, however, nor has a curb cut permit been issued for access from Danforth St. A retaining wall separating buildable upland from the 100-year floodplain has already been constructed. The development of this site could cause water quality and aesthetic impacts on the river, especially if existing woody shrubs were to be removed and replaced by lawns. If the site is developed, the town's regulatory agencies (particularly the Conservation Commission) should work with the developer to encourage the preservation of a naturally-vegetated buffer strip along the riverfront in order to reduce non-point source pollution, mitigate scenic impacts, and provide riparian wildlife habitat.

At the Sand and Gravel site, a number of factors would serve to reduce impacts on the river (both mainstem and oxbow) should new uses be proposed. These factors fall into three general categories: topography, compatibility with existing uses, and zoning requirements.

Topographically, much of the riverfront at this site is wetlands, subject to protection under state and local law. It would be difficult (but not impossible, given the town's rather weak floodplain zoning and "limited project" provisions under state wetlands regulations) to develop the land within the oxbow, for example. Bridging the river would be expensive, as would be bringing in a sewer line to serve the site. Use of a septic system would not be allowed because the oxbow is entirely below the 100-year floodplain.

Existing or proposed uses on the Sand and Gravel property, such as the re-activation of town wells, a yard waste composting facility, and the siting of a working shaft for the construction of a new deep rock aqueduct by the MWRA, make the development of adjacent land difficult. Under state law, no development will be allowed within a 400 foot radius of the water supply well, for instance, and land uses within the "Zone 2," which affects much of the site, would also be subject to scrutiny, especially if a proposed aquifer protection bylaw is passed. The composting operation has unfortunately generated complaints about odor, so it appears unlikely that new residential uses in particular would be desirable in the vicinity of this facility. The MWRA project will tie up another area of the site for several years, and even after the aqueduct is complete, the MWRA will presumably need to maintain access to the shaft site for maintenance, reducing the amount of developable area.

Finally, given the strong incentives for protecting natural features such as wetlands and riparian habitats under the PUD regulations, it is likely that any new non-industrial development at the site would result in the permanent preservation of the river frontage and oxbow as public open space.

If the Sudbury Landing development receives town approval, this portion of river frontage will someday be flanked by houses on 8000 square foot lots. However, the Conservation Commission will still have the opportunity to condition activities on the site which could affect nearby resources areas, and thus could help to ensure that portions of the buffer zone be left in natural vegetation. Framingham may also want to consider strengthening its floodplain regulations so that existing structures cannot be enlarged or rebuilt in such a manner as to harm the river's resources.

Whether or not the Sand and Gravel site is redeveloped, the permanent protection of the significant oasis of natural riverfront on this site should be a high priority. Particular priority should be given to identifying and protecting rare and endangered species habitat and archaeological sites. The town may also want to consider undertaking a public

education program to encourage the voluntary conservation of riparian vegetation by riverfront landowners. Finally, the town could formalize the protection of the riparian corridor on town-owned lands (cemetery and school) by transferring these areas to the Conservation Commission to be managed for conservation purposes.

Wayland

1) Riverfront Character

Wayland's frontage within the study area is second only to Concord's, with a total of 14.7 miles of shoreline along the Sudbury River. The town has 10.6 miles (56,160') of frontage on the right bank, and 4.1 miles (21,600') of frontage along the Sudbury's left bank. The majority (10.9 miles) of river frontage is in protected ownership, with about 9.5 miles within Great Meadows National Wildlife Refuge and the remaining 1.4 miles protected by the town and county.

The study segment begins just downstream of Pod Meadow Brook, on the right bank of the Sudbury River opposite the oxbow. The first half mile of frontage is under public ownership for water supply purposes (Weston Aqueduct) or is land-locked, and therefore undeveloped. The land-locked area is cut off from access along Stonebridge Road by the Weston Aqueduct and a high tension power line easement, is within the 100-year floodplain, and is also taxed under the Chapter 61 B open space program.

Below Stonebridge Road, the slopes of a drumlin along the right bank have been subdivided into relatively small parcels. Four or five of the houses in this older development are within 100 feet of the river. Awareness of the importance of the river seems to run fairly high in this community, which sponsored a riverbank cleanup day last spring.

Downstream, the river turns abruptly to the east and enters the Broad Meadows, now part of Great Meadows NWR. Wayland's frontage along the left bank begins just upstream of Heard Pond. The main channel of the river bypasses this embayment to the south, meandering through wide emergent and shrub wetlands. Wayland High School and a subdivision are located along the right bank, about 1000 feet from the river. The subdivision is almost completely shielded from the river by mature trees. To the north, along the left bank, is Pelham Island, an area of low density residential development and conservation land. The open fields of town-owned Heard Farm conservation area are Pelham Island's principal landscape feature. The Heard Farm frontage includes two canoe landing sites, where boats launched elsewhere can be brought to shore. Pelham Island's houses are all several hundred feet or more from the river, out of the extensive floodplain which makes this area a true island during times of high water. Most of this floodplain frontage is owned by the federal government as part of the wildlife refuge².

As the river turns north, it passes a large undeveloped country property (the Paine Estate) with almost a half mile of river frontage on the right bank, including a private canoe landing. Sandy Burr Country Club is farther downstream on the right bank, across from the eastern side of Pelham Island on the left. The golf course fairways, framed by weeping willows, are a prominent landscape feature. Pine Brook enters the river downstream from the right, just upstream of Pelham Island Road bridge, an attractive humpbacked structure. This section of the road floods frequently. The nearest developed land on the right bank is about 600 feet from the river, within Wayland's "downtown" commercial district, and is virtually invisible to the canoeist.

Downstream of the Pelham Island Rd. bridge the river skirts the eastern side of Pelham Island before entering the broad marshes at the mouth of Wash Brook, flowing in from the west. A few houses are located 400 feet or more from the river's left bank on Pelham Island. On the right bank a garden supply and nursery business owns land within

² While federal land along the rivers is technically owned by the "U.S. Government" rather than the U.S. Fish & Wildlife Service or National Park Service, for the purposes of this summary federal ownership is occasionally attributed directly to the agencies involved.

the floodplain which is officially in agricultural use. At present the riverfront portion of this site remains naturally vegetated.

At the mouth of Wash Brook the Boston and Maine Railroad and Rte. 20 span the river. The town's old (now closed) landfill occupies a sliver of land between the and highway. An informal boat launch is located on the right bank downstream of the Rte. 20 bridge, on land owned by the state highway department and a private landowner. The Raytheon site, which includes a light industrial building situated far back from the river and radio testing towers closer to the waterway, is on the right bank just downstream from the private frontage. Beyond Rte. 20 the river enters the so-called Sedge Meadows, which extend downstream for approximately three and a half miles.

Immediately downstream of Rte. 20 on the left bank, Wayland owns an extensive area which includes a fifty-foot high sand and gravel drumlin known as the Lord parcel. Beyond this hill to the west lie Wayland's and Sudbury's municipal landfills and the Wayland Highway Department's work/storage area, all of which are shielded from view from the river by the drumlin. The FWS is eager to buy the Lord parcel, including several hundred feet of river frontage, but some additional sand and gravel extraction may occur on the landward side of the hill, away from the river.

Farther downstream, the river passes historic farmhouses along the left bank 500 feet or so from the channel. Hidden by vegetation, River Road runs along a causeway on the left bank just upstream of the Rte. 27 bridge. On the right bank, low topography and conservation land holdings by the town and FWS, extending to the nearest road about half a mile away, obscure any sign of human presence.

Downstream of the Rte. 27 bridge (a mile below Rte. 20), the Sedge Meadow wetlands broaden, stretching a half mile or more laterally from the river channel. Despite its name this extensive wetland system includes woody shrubs such as buttonbush in addition to emergent plants. The boater's view across the wide floodplain is dependent on the river's elevation: at times of low water, the low wooded hills which line the floodplain may be barely visible over the tops of the wetland vegetation. Apart from the low bridges which are soon lost to sight around the river's meanders, there are virtually no signs of human activity along this reach of the river.

Wayland's frontage on the left bank ends just below Rte. 27 at its border with Sudbury. Along the right bank, Wayland extends downstream for several more miles. The fairways of another golf course give way to more town and federal conservation land, extending 800 feet or more landward from the channel, as the river continues through the Sedge Meadows for two miles before narrowing to skirt low drumlins on both sides. At this point, just upstream of Sherman's Bridge, several houses situated on the slopes of the right bank are partially visible. All but about 260 feet of the right bank in this area is within the wildlife refuge.

Sherman's Bridge has recently been reconstructed. Its low, narrow, and timber pile-supported design has been retained through the aid of the U.S. Forest Service's Timber Bridge program, and contrasts favorably with generic I-beam steel and concrete highway bridges.

Downstream of the bridge the floodplain widens through an area known as the Broad Meadows, narrows as the river threads its way between two more hills, and then widens again before reaching the boundary with Lincoln and Concord. Few signs of human habitation are visible along the Wayland shoreline, which is heavily wooded. Most of the frontage is within the national wildlife refuge except for about 600 feet which is privately owned by a seasonal nursery operator who raises plants in containers.

Outstanding river-related resources in Wayland include riparian and aquatic wildlife habitat, especially in the vicinity of Heard Pond, the Sedge Meadows, Broad Meadows, and where tributaries enter the river. Historic resources include archaeological sites, the Stone Bridge, and the Four-Arched Bridge (also known as the Old Town Bridge, on the National Register) over the river just below Rte. 27. Scenic and recreational resources are associated with natural landscapes such as Heard Pond and the Broad and Sedge Meadows, and visual and physical access points such as the Pelham Island Road bridge, Rte. 20 bridge, River Road at the Rte. 27 bridge, Four-Arched Bridge, and Sherman's

Bridge. Another important aesthetic feature in Wayland is the view of hills along the skyline from the river. Of these outstanding resources the most vulnerable are privately-owned undeveloped uplands, boating access points adjacent to town or state-owned bridges, and aesthetic values associated with the bridges themselves. Elsewhere extensive federal refuge ownership serves to protect most wildlife habitat and other resources from inappropriate uses.

2) Local Land Use Requirements

Much of the town's riverfront area is zoned for residential use. The area along the right bank upstream of Heard Pond requires 30,000 square foot lots. Most of the remainder requires 40,000 square foot lots, except for the riverfront in the vicinity of the town center, where 30,000 square feet are required, and the area downstream of Sherman's Bridge where 60,000 square foot lots are required. The Raytheon site, zoned "limited commercial," is the only non-residential district along the river. Within both the residential and limited commercial districts, building heights are limited to 35 feet.

Within the residential districts, conservation clusters are allowed by special permit on parcels ten acres or more in size. Allowable densities for such developments are based on a formula which excludes wetland and floodplain areas from the total developable area. The resulting "open land" is required to be used for conservation, recreation, or agriculture, and to be conveyed in fee to the town, a land trust such as the Sudbury Valley Trustees (SVT), or the residential association.

On parcels at least 40 acres in size, "planned developments" are allowed by special permit. Such developments must conserve scenic, historic, and environmental features. At least 35% of the development area is required to be conveyed to the public, and a total of at least 70% must be open space. Structures within the development must be sited at least 100 feet from waterways.

Wayland has stringent floodplain protection requirements. The town has two different floodplain overlay districts: one is the locally-defined flood plain, including all of the area below 124 MSL; while the other is based on the federal FIRM and Floodways maps, including Zones A and A1-A30 which define the 100-year floodplain. In general, the local definition, which is used by the Planning Board and the Board of Appeals, is more stringent. The federally-defined 100-year floodplain (which is more conservative than the town's 124-foot district only in extreme upstream areas and along some of the river's tributaries) is used by the Conservation Commission to define "lands subject to flooding" under the state Wetlands Protection Act.

Within the town-defined floodplain, no new structures or filling are allowed unless the proponent can prove to the Board of Appeals' satisfaction that no pollution or reduction in flood storage would result. Since the town's Board of Health regulations require new houses to have their basement floors at least two feet higher than the FIRM 100-year flood elevation, substantial filling would be needed to build a house in the floodplain, and compensation for this volume of fill could be hard to come by.

The town also has a Watershed Protection (overlay) District. Areas within this district along the main stem of the Sudbury River include the wetlands associated with Pod Meadow Brook, across from the oxbow, and at the mouth of Pine Brook, along Pelham Island Road near the town center. Within the district, no buildings may be erected or enlarged, and no filling is allowed, unless the Board of Appeals finds such activities compatible with the purpose of the district and issues a special permit. The district predates the state Wetlands Protection Act and is thus largely superseded by it, but in some cases (e.g. "limited projects" such as the bridging of wetlands by driveways) activities which might be allowed by the Conservation Commission or DEP under the Wetlands Act could be prohibited by the Board of Appeals.

The town's septic system regulations require at least 75 feet between leach fields and wetlands and waterways for leaching systems having up to 1000 gallons per day flow capacity (which would serve single family houses). For larger systems the setback is 100 feet. In addition, leaching fields for both new construction and replacement systems

must be above the 100-year floodplain. Raised or mounded systems are allowed, but compensatory flood storage must be provided.

Wayland's Board of Health has taken the unusual step of adopting regulations for subdivision approval. Developments of 20 lots or more require a hydrogeological evaluation for the purposes of sewage disposal system design. Increases in off-site stormwater discharges are not allowed, while detention basins and artificial wetlands are encouraged. For smaller developments outside of wetland buffer zones, however, sedimentation control is dependent on good management by the developer during the stripping and excavation phases. Such developments could affect the river where buildable sites abut tributaries or the river proper.

3) Riverfront Development Potential

There is little undeveloped private land along the river in Wayland. The only remaining large tracts are the Paine Estate, Raytheon property, and two golf courses.

The 160-odd acre Paine Estate is currently the subject of a joint proposal by the town, SVT, and the FWS to purchase the property from the estate of the late Virginia Paine. The town's share of the purchase price was recently approved at 1994 town meeting. Should the Paine Estate trustees turn down the proposal, however, it is possible that the entire estate will be sold to a developer, allowing as many as 62 lots to be developed under conventional subdivision provisions. While much of the site's frontage is within the town's 100-year floodplain, there is a small hill near the river's edge which might make an attractive house site, or even be used for the clustering of several houses by special permit. It would be desirable to ensure that any future development on this site be unobtrusive. Should the site be developed under the town's conservation cluster or planned development provisions, the riverfront areas would be particularly appropriate for use as permanent passive recreational or conservation open space. Under the planned development regulations, a buffer of at least 100 feet between the river and any structure would be ensured. Open space areas preserved under these development provisions would not necessarily provide public access, except that in the case of PUDs at least 35% of the open space must be public.

Additions to the Raytheon site's existing buildings would require a special permit under existing zoning requirements, since the site is fully built-out according to floor area ratio (FAR) requirements. Also, since the first several hundred feet of river frontage on this site is within the town's floodplain, development along the river is unlikely. Should changes or additions to the existing structures be proposed, however, the Board of Appeals would require a site plan review, at which there would be the opportunity to advocate for riverfront and wetland protection.

Portions of the river frontage at both golf courses are owned by Great Meadows, and both are currently taxed under the provisions of Chapter 61 B. This offers no assurance of permanent protection, however, and Sandy Burr in particular has uplands suitable for development close to the river. Inasmuch as this golf course land is largely open at present, such development might be obtrusive unless it were screened through careful landscaping. The protections offered through the town's conservation cluster and planned development regulations would also apply to developments at the golf courses, if these options were to be selected by the developer.

Russell's Garden Center owns a small amount of frontage on the right bank between Pelham Island Road and Rte. 20. Since this land is considered to be in agricultural use, it is not subject to many of the provisions of the Wetlands Protection Act, making the riverfront in particular vulnerable to inappropriate vegetative cutting. A conservation restriction on the immediate riverfront portions of this parcel could serve to protect its flood storage and habitat functions.

Undeveloped, non-conservation public land along the river in Wayland includes the area behind the high school; the former landfill along Wash Brook; and a large tract owned by the Board of Road Commissioners on the left bank, downstream of Rte. 20 (the Lord parcel).

At the high school, although GMNWR owns a thin sliver of riverfront, protection from inappropriate uses for the nearby uplands (which are not wetlands but may be below the 124 foot contour) would also be beneficial. The town may wish to consider transferring at least the riverfront portion of this site to the Conservation Commission as conservation land, making it subject to Article 97 restrictions on future changes in use.

The site of the closed landfill between Rte. 20 and the railway has a significant amount of road frontage and could conceivably be developed or used for purposes which could have physical or aesthetic impacts on the Wash Brook wetlands, which are contiguous with the main stem of the river. The town may want to consider placing a restriction on such future uses (e.g. use as a materials transfer station) in order to maintain the scenic buffer between Wash Brook and Rte. 20 that this site provides.

While much of the Lord parcel site is within the floodplain, a peninsula of upland extends north towards the river. The sand on this parcel represents a significant financial asset to the town's Road Commissioners, and because of this, no agreement has been reached to protect the site for its archaeological, wildlife habitat, and aesthetic values. While the 1993 Town Meeting voted to approve the sale of the parcel to the FWS, the Board of Road Commissioners have so far rejected the refuge's offers because they feel the appraised value is lower than the value of the sand on the site. Should FWS fail to acquire the riverfront portions of the site, sand and gravel mining could destroy important riverine values.

Some of Wayland's existing riverfront developments are within its 100-year floodplain, which presumably would make the expansion of associated structures difficult. Such areas include the river side of Shore Road and Riverview Circle, backyards along Charena Road, and the end of Alpine Road.

In summary, it appears that the vast majority of Wayland's river frontage is well-protected from changes in use which would alter its existing character. At the Paine Estate, golf courses, and Raytheon property consideration should be given to the protection of riverfront areas should additional development be proposed in the future. The town should also consider clarifying its intentions regarding the future use of river frontage at the high school, and at the Road Commissioners' site if this is not added to Great Meadows NWR.

It would be useful to inventory the status of the various informal boat launch sites within the town, determine whether there are management problems (i.e. littering, problem parking, erosion, etc.) at these sites, and work with the owners of the sites to secure formal protection for boating access where appropriate. Sites which should be investigated include Pelham Island Rd. (FWS property), River Rd. (FWS), Rte. 20 (state Highway Dept. and a private owner), Rte. 27 (County land), and Sherman's Bridge (FWS).

Sudbury

1) Riverfront Character

Sudbury has 5.4 miles (28,640 feet) of river frontage along the left bank of the Sudbury River. Of this, about 4.4 miles are in public ownership, including over 21,300 feet (4.1 miles) within Great Meadows NWR, 160 feet of tax-delinquent frontage (most likely soon to be owned by the town, and then to be transferred to FWS), a few hundred feet owned jointly by the town and DEM, and about 1700 feet owned by DFWELE.

The Sudbury River first enters the town of Sudbury from Framingham, just downstream of Stone Bridge Road. For the next half mile or so, the river forms the boundary between Sudbury and Wayland (on the right bank) until Wayland's left bank frontage commences upstream of Heard Pond. Several miles downstream the river emerges from Wayland to form the border between Sudbury (on the left bank) and Wayland once again until the four-way boundary with Concord and Lincoln is reached.

The upstream section of river frontage in Sudbury is less than 3/4 of a mile long. A steep, wooded bank rises about

40 feet above the narrow floodplain, making houses on the small residential lots along this reach invisible from the river. Right before the Wayland town line, high tension wires cross the river and the bank slopes down as a small tributary enters from the left.

Most of the downstream section of the Sudbury River within Sudbury meanders through the wide marshes known as the Sedge and Broad Meadows. At its widest, just below the point at which the river re-enters Sudbury downstream of the Rte. 27 bridge, this marshy area extends for almost 4000 feet on both sides of the river. There is virtually no development and little privately-owned land between the river and Water Row, a winding country lane that parallels the river over 1000 feet back from the bank. Only the wooded slopes of the low hillocks along the distant western shore of the marsh are visible to the canoeist. A forested wetland system associated with Bridge Brook, entering from the Sudbury side, adds to the sense of the river's isolation in a vast expanse of marsh "grasses," shrubs and trees.

A few houses, set well back from the river beyond the marshes and partially concealed by mature trees, come into view along the left bank about a half mile upstream of Sherman's Bridge, where the floodplain narrows as the river threads between two hills. Downstream of this bridge the headquarters building for the wildlife refuge is visible during the colder months on the southern hillside of Weir Hill, about 700 feet from the river.

Downstream of Weir Hill, Pantry Brook enters the river from the west. The Massachusetts DFWLE owns a large area of wetlands along this tributary, extending almost to the bank of the river.

A small, steep-sided drumlin (Rice Hill) about 400 feet from the river is the most prominent landscape feature along the final half-mile of the river in Sudbury. The hill's dense stands of white pine provide habitat diversity and add variety to the scenery. As the border with Concord is reached, the Nashawtuc Country Club golf course appears along the left bank. The fairways are several hundred feet from the river but within the floodplain, and a portion of the river frontage is owned by the golf course rather than the wildlife refuge.

Outstanding river-related resources include aquatic and riparian wildlife habitat along most of the town's riverfront and extending up tributaries such as Bridge and Pantry Brooks. Historic resources include archaeological sites throughout the river corridor and the Haynes Garrison house and battleground site on Water Row. Recreational and aesthetic values include boating access points (e.g. Sherman's Bridge), visual access points (Rte. 27 Bridge and Sherman's Bridge), and views of undeveloped uplands from the river (e.g. Round Hill, Weir Hill, and Rice Hill [as named in Thoreau's journal]). The latter are probably the resources which would be most vulnerable to inappropriate land use changes. This degree of vulnerability is described below in Section 3.

2) Local Land Use Requirements

All land along the river in Sudbury is zoned A-1, with minimum lot sizes of 40,000 square feet. Many existing, developed lots are smaller than this.

The town has both a Floodplain District and a Water Resources Protection District, although no areas within the latter overlay district are near the river. The floodplain includes 100-year floodplain, all land lower than 125 feet above sea level, and floodplains delineated on several other maps. Due to higher-than-predicted flooding in the vicinity of Rte. 27 in the spring of 1993 (a 50-year storm), the town will be conducting a Flood Insurance Restudy in 1994, which could result in proposals for changes in the floodplain district boundaries at the 1995 Town Meeting.

Virtually no new building or expansion of existing structures is allowed within the floodplain. Dumping and filling are likewise prohibited. The Board of Appeals may grant permits for certain accessory uses if the use would not pollute water bodies, raise flood levels, etc.

Sudbury voters approved a local wetlands bylaw at the 1994 spring Town Meeting. This bylaw addresses the use of pesticides and herbicides, beefs up enforcement, expands jurisdiction over vernal pools, adds sedimentation and

erosion control requirements, and rules out post-development increases in runoff. It relies on both the vegetative definition for wetlands found in the state WPA and the soils and hydrology definitions used to define wetlands for federal Clean Water Act § 404 permits.

Sudbury has increased the protection afforded by the state's Title V regulations, requiring leaching fields to be 100 feet from surface watercourses (where water is present for at least three months). The setback from wetlands is the same as the state minimum—50 feet.

The town's subdivision regulations were not examined in detail since there appears to be no subdividable land along the river. Sudbury does have cluster development provisions and the Planning Board is quite proactive in encouraging this form of development.

3) Riverfront Development Potential

Almost all of the privately-owned riverfront land in Sudbury appears to be fully built out. At a couple of locations, however, privately-owned uplands close to the river could be subject to residential development. Such locations include a hillside parcel off Lincoln Lane near Sherman's Bridge and Rice Hill, overlooking the river just upstream from the Concord border.

The two acre hillside lot at the corner of Lincoln Road and Lincoln Lane has been excavated for gravel in the past and presumably awaits residential development. One or two houses could be built at this site, but it is likely that any development would be landscaped and screened from the river by trees, since this is the character of the surrounding neighborhood. In the vicinity of Rice Hill, the drumlin downstream of Pantry Brook, several development proposals could significantly alter the riparian landscape. A 10-acre parcel, including the drumlin and frontage on Concord Road, was recently acquired by the Sudbury Water District, with the intent of exchanging it for land on the adjacent 27-acre riverfront parcel to allow the development of a water supply well. The waterfront lot is lowlying and has about 320 feet of frontage on the river. The land is primarily used for agricultural and residential purposes (single house), but is also used to stockpile gravel and store earth-moving equipment. The uncovered stockpiles are of particular concern due to their impacts on water quality and aesthetics.

Development of Rice Hill could pose a threat to both wildlife habitat and scenery along the river if such development involved the removal of white pines from the top of this drumlin, and especially if the hill were to be regraded to reduce its height. Unless new houses on this hillside were to be carefully sited and landscaped, they could be quite obtrusive. The owner's current proposal, should he and the Water District complete the swap, is to build two houses on the northeastern corner of the lot (i.e. the part closest to the river), to excavate gravel from the top of the drumlin, and to terrace the remaining hillside to enable Christmas trees to be cultivated.

It would be advisable for the town to investigate forms of protection for this site, especially if it is developed as a town well. In addition to the 400 foot radius of protected, undeveloped land required by state law for a public water supply well; the town, state DFWELE, or non-profit such as SVT may want to discuss the donation or purchase of a conservation restriction to protect the more environmentally sensitive portions of this site.

Lincoln

1) Riverfront Character

Lincoln has 1.7 miles of frontage on the right bank of the Sudbury River. Of this, all but a few hundred feet of frontage on Fairhaven Bay are in some form of conservation ownership. Fee simple owners include the federal government and the town. Most of the river frontage of the remaining, privately-owned land is subject to conservation restrictions.

From Boundary Rock (where Sudbury, Wayland, Concord and Lincoln meet) the river flows past a wooded hill and Farrar Pond before passing under Lee's Bridge, an arched granite structure along Rte. 117. One or two houses on the hill are visible from the river.

Beyond the bridge the river turns east, running between Concord's scenic hillsides on the left bank and lowlying marshes and woods on the Lincoln side before entering Fairhaven Bay. Lincoln's public canoe landing, accessed via Rte. 117, is at the head of a slough which runs south from the river towards tall stands of white pine. The Lincoln side of the river in this area is naturally vegetated, with abundant wildlife.

At Fairhaven Bay the river widens between gentle hillsides fringed with marshes. One or two large houses located several hundred feet from the river are barely visible through gaps in mature trees. Ahead, at the downstream end of Lincoln's frontage, lies Well Meadow, an extensive marsh.

Lincoln's outstanding river-related resources, including scenery, recreation, literary values, and wildlife habitat, are concentrated in the vicinity of Fairhaven Bay. This area's scenery was rated "distinctive" (among the top 4% of the state's land area) in DEM's 1979 Landscape Inventory. Fairhaven Bay also figured prominently in many of Thoreau's accounts of his time spent living at Walden Pond. To protect these resources, it is essential that the uplands surrounding Fairhaven Bay be managed in a way which preserves the existing landscape features of meadows and mature woodlands. This landscape would be vulnerable to intrusive new development within open areas, and to insensitive tree cutting if this would increase the prominence of buildings which are currently well-shielded from view.

2) Local Land Use Requirements

The hillside overlooking Farrar Pond and the river in Lincoln is zoned R-3, Open Space Residential. The remainder of Lincoln's frontage is within the R-1 Single Family Residential district. Within the R-3 district, developments on parcels 25 acres or larger can be clustered on a portion of the site to allow the preservation of the remainder as open space. Overall site development densities for such R-3 clusters are permitted to be double that which would be allowed within a R-1 district (i.e. about one acre per dwelling unit), although resulting population densities are not allowed to be significantly higher than for an R-1 development. Multi-family structures are allowed along with traditional detached single-family units. Such developments are subject to site plan approval and require a special permit from the ZBA.

Within the R-1 zone, lot sizes are a minimum of 80,000 square feet. Parcels 160,000 square feet or more in size may be developed using clustering. The maximum building height in both the R-1 and R-3 zones is 36 feet.

Lincoln's floodplain zoning follows NFIP minimum standards. The town's Board of Health has increased the setback for septic system leach fields from the state-mandated 50 feet to 100 feet from all watercourses, including wetlands.

The local wetlands bylaw discourages activities within the first 50 feet of the buffer zone by creating a presumption of "significant adverse effect" for such activities. Unlike the state Wetlands Protection Act, this bylaw permits no "limited project" performance standard exemptions for certain kinds of wetlands alterations, and also protects wetlands which do not border or touch waterways. Thus there is no exemption for private developments³ which involve the filling of wetlands in order to provide driveway access to upland building sites, making the development of wet parcels problematic. The town's Water Board is exempted from the local bylaw's permit requirements, so the development of new wells in wetland areas would be regulated only under the state Act.

³ As opposed to state agency projects which are subject only to the requirements of the state Act rather than the more stringent town bylaw.

3) Riverfront Development Potential

Except for two privately-owned undeveloped lots totalling about 440 feet on Fairhaven Bay, all of Lincoln's Sudbury River frontage is protected from future development through fee ownership or conservation restrictions. The two narrow lots in question are in the same ownership and are almost 100% wetlands. About 1.1 of the town's 1.7 mile total is in public conservation ownership. This includes both federally-owned wildlife refuge land and the town's own extensive holdings in the vicinity of Rte. 117 and Mt. Misery. Conservation restrictions held by the town or the Lincoln Land Conservation Trust protect the remaining 2700 feet or so of frontage.

Even where these forms of protection are at their narrowest (about 100 feet) within the river corridor, existing landward development in the form of single family houses is already at the maximum density permitted by zoning. As noted above, the result is that few of these houses are even visible from the river. In addition, due to the effect of conservation restrictions, actual densities are far lower than one house per 80,000 square feet.

While there have been questions raised about possible loopholes in the language of some of the conservation restrictions (particularly the older ones), and there is no active monitoring program to ensure that restricted land is not being used for prohibited purposes, so far problems such as the development of intensive "recreational" uses and/or extensive vegetative cutting have been infrequent. Still, it would be advisable for the town and LLCT to examine the terms and language of the conservation restrictions they hold, and to develop an active annual monitoring and new owner education program to minimize the likelihood of future problems.

In summary, it appears that existing land uses within the river corridor in Lincoln are unlikely to change to the detriment of scenery or wildlife habitat. In addition, the town has the best-protected recreational access (both for boating and riverfront walking) within its network of conservation lands. Based on this analysis, it appears that Lincoln's Sudbury River frontage is more than adequately protected by existing regulations and ownership, and that additional measures would not be required in order to establish the river's suitability for designation.

Concord

Concord has extensive frontage on both banks of all three rivers, totalling 23.7 miles—more frontage than any other town in our study. Because of the complexities involved in reviewing riverfront character and analyzing development potential in Concord, we have decided to describe the situation separately along each of the three river segments. Local land use requirements, which apply town-wide, are thus described first in this section on Concord.

1) Local Land Use Requirements

The residential zoning density along the three rivers in Concord ranges from AA (minimum lot size 80,000 square feet) along most of the Sudbury and the left bank of the Concord, down to C (10,000 square feet) along parts of the Assabet and Sudbury. The two intermediate residential zoning densities, A and B, have 40,000 and 20,000 square feet lot size requirements respectively. Both banks of the Assabet River, from about a half mile below the Rte. 2 bridge to Egg Rock, and the entire right bank of the Concord River, are zoned A. The first half mile of the Assabet's riverfront downstream from Route 2 and a short stretch of the Sudbury just above the confluence are zoned B.

All residentially-zoned areas have a maximum height allowance of 35 feet above grade on all four sides. Since 1991, new lots in Concord are required to have a minimum of 50% upland.

Non-residential zoning along the rivers consists of a small business district along the Assabet in West Concord Center; an area zoned Industrial Park along both banks of the Assabet from the Boston and Maine railroad line to Route 2 (the site of GenRad and MCI-Concord); an area of Limited Business along the right bank of the Assabet downstream from Rte. 2; and Medical Professional and Limited Business zoning on the left bank of the Sudbury at Route 2 (Emerson Hospital and the New England Deaconess facility). There is no non-residential zoning along the

Concord River in Concord.

Density requirements in these non-residential zones are: Business—no minimum lot area; Industrial Park—4-acre minimum; Medical Professional at Emerson Hospital—80,000 square ft.; and Limited Business—no minimum.

In accordance with the current provisions of the state's zoning enabling law (Chapter 40A), Concord allows residential cluster development by special permit only, but requires that at least 50% (rather than the state-mandated 30% minimum) of the site be reserved as open space.

Overlay zoning districts in Concord include a Floodplain Conservancy District, a Wetlands Conservancy District, and a Groundwater Conservancy District. The floodplain zone requirements meet NFIP minimum standards, with the Floodplain Conservancy District consisting of the area within the 100-year floodplain. Septic systems within this district may be repaired but may not be expanded beyond Board of Health minimum design requirements. New construction must have the lowest floor elevated to or above the base flood elevation and requires a special permit from the ZBA. While the focus of these provisions is primarily to protect against loss of life and property rather than pollution and downstream flooding,⁴ the town's enforcement of its floodplain zoning has been very strong. The town's Natural Resources Commission (which also serves as the town's Conservation Commission) thinks that the 100-year floodplain delineation may not be conservative enough, i.e. that it may not include areas which on average flood at least once every 100 years.

The Wetlands Conservancy District consists of wetlands within Concord, defined by either soils or vegetation, making the area covered broader than that considered to be bordering vegetated wetlands under the state Act, although this district affords no protection to wetlands buffer zones. Many passive land uses and minor construction projects are permitted within this district without review by Concord's ZBA, although of course the state Act continues to apply so that project review by the Natural Resources Commission is still required. Special permits from the ZBA are required for filling and building construction within this zoning district. In applying for a special permit, proponents are required to provide detailed site evaluation information. The special permit process provides for input from both the NRC and Planning Board, increasing the likelihood that the ZBA will base its decision on the proper consideration of environmental impacts.

Concord's NRC is in the process of drafting a local non-zoning wetlands bylaw for possible vote at the '96 Town Meeting. The local bylaw would probably add more explicit language regulating vegetative cutting in and near wetlands, and would create a rebuttable "no build" setback within the portions of the buffer zone closest to the edge of the wetlands.

Concord's subdivision regulations state that property should be developed so as to maximize stormwater recharge and minimize direct overland run-off into adjoining streets and watercourses. Peak flows and total site runoff can be no greater following development than before development. Storm runoff should follow natural drainage patterns. Permission from the town's Natural Resources Commission (which also serves as Concord's Conservation Commission) is required to close watercourses. These regulations thus encourage the use of "soft," or natural stormwater control facilities such as drainage swales and retention/detention areas, as opposed to closed drainage systems. Such natural systems usually result in lower concentrations of suspended sediments, oil, and heavy metals in the runoff, and also serve to reduce thermal impacts on nearby watercourses due to high summertime temperatures. Concord's stormwater regulations may provide a useful model for other study area communities interested in reducing local flooding and non-point source pollution.

Concord's Board of Health regulations require all new septic system leach fields to be located at least 75 feet from

⁴C.f. Wayland's, Bedford's, and Carlisle's "no new construction" approach, placing the burden on the applicant of proving that the proposed construction site is outside the 100-year floodplain or that no impacts will result. Carlisle also bans new paving.

wetlands and watercourses.

2) Sudbury River

a) Riverfront Character

Above Fairhaven Bay, Concord's river frontage lies along the left bank only (1.7 miles). The town line bisects the golf course at Nashawtuc Country Club, most of which is within the 100-year floodplain. The Clubhouse and associated structures are 300-400 feet from the riverbank. A network of small ponds and streams drain into a large wetland just south of Rte. 117 by the golf course. Much of the river frontage and some of this wetland is owned by FWS.

Downstream of Rte. 117 at Lee's Bridge, Conantum ridge rises steeply from the lowlying Nine Acre Corner area, forming the western shore of Fairhaven Bay. Except where there has been extensive tree cutting along the slopes immediately downstream of the bridge, the mature hardwood and pine forest along the top of the ridge conceals the handful of large houses which have been built along the crest of the ridge, 500 feet or more from the river. The lower slopes of the ridge are in open meadows, while a fringe of native vegetation softens the river's banks, creating the distinctive scenery that is among the most favored in the entire study area. Much of the left bank along Fairhaven Bay, including these distinctive meadows, has been protected through conservation restrictions. The small island along this shoreline is owned by the Concord Land Conservation Trust.

Concord's town line on the river's right bank begins near the downstream end of Fairhaven Bay, just below Well Meadow. Here steep slopes on both shores force the river to narrow. These slopes are mostly forested by mature pines and hardwoods. A few houses are located within 100 feet or so of the river along the right bank on landscaped grounds, while along the left bank, several large houses are set back 100-200 feet from the river on sloping lawns.

Past Conantum and Fairhaven hills, the riverside topography softens again. A wide floodplain with extensive marshy fringes characterizes most of the remaining Sudbury River corridor. Human activity becomes increasingly evident: Emerson Hospital and the New England Deaconess complex rise high above the river on the left bank just upstream of Rte. 2, and between Rte. 2 and Egg Rock, the back yards of suburban Concord neighborhoods are visible from time to time. However, although densely settled downtown Concord is quite nearby, the riverfront character remains pastoral rather than urban. Many structures are completely concealed by thick vegetation, while others are set back on sloping lawns, out of the floodplain.

The only canoe livery within the study area, Southbridge Boathouse, is located on the left bank of the Sudbury about a mile above the confluence with the Assabet at Egg Rock. This wooden structure is a reminder of boating's heyday at the turn of the century, and provides vital access to the river for those who do not own canoes. It also provides river tours on a pontoon boat, making the rivers accessible even to the non-canoeist.

The last half mile upstream of Egg Rock is particularly natural in appearance, due in part to the public and land trust ownership patterns but also because this area is especially flood-prone.

Outstanding river-related resources along the Sudbury River in Concord include wildlife habitat, recreation, and literary resources; and in particular, scenic values in the Fairhaven Bay area. This area was rated "distinctive" (among the top 4% of the state's land area) in DEM's 1979 Landscape Inventory. It also figured prominently in many of Thoreau's accounts of his time spent living at Walden Pond. To protect these resources, it is essential that the uplands surrounding Fairhaven Bay be managed in a way which preserves the existing landscape features of meadows and mature woodlands. This landscape would be vulnerable to intrusive new development within open areas, and to insensitive tree cutting if this would increase the prominence of buildings which are currently well-shielded from view.

Southbridge Boathouse, where non-rental canoes can be launched for a fee, is the only practical boating access on the Sudbury River within Concord (although Lincoln's canoe launch provides access to the Fairhaven Bay area). Should

the town-owned portion of the riverbank behind the Keyes Road DPW site ever be improved for use as a park, free cartop boat access could be provided here and might help reduce demand at Old Calf Pasture, just downstream on the Concord River.

b) Riverfront Development Potential — Sudbury River

Extensive marshy floodplains along either side of the Sudbury in Concord preclude additional development along much of the river. The riparian zone is further protected through conservation restrictions⁵ on some parcels overlooking Fairhaven Bay and by conservation ownership (FWS and Concord Land Conservation Trust). However, a few large, potentially subdividable parcels remain in this section.

Nashawtic Country Club owns a large parcel at the Concord/Sudbury border along the left bank of the Sudbury River. The parcel is currently used as a golf course and lies within two zoning districts: A and AA, which require lot size minimums of 40,000 square feet and 80,000 square feet respectively. Although much of this land is in the 100-year floodplain and/or wetlands zoning district, the low hill north of the clubhouse, about 400 feet from the river, appears developable. While the golf course is currently on the U.S. Master's circuit and the club has no plans to go out of business, should this land ever be sold in the future there is nothing to prevent it from being developed in accordance with Concord's various bylaws.

Downstream of Lee's Bridge on Fairhaven Bay, most of the river frontage is protected through conservation restrictions or as permanent open space as the result of cluster development. Two lots between the river, Rte. 117, and Tanglewood Drive lack formal protection of their river frontage. On one of these, extensive tree removal (which occurred without the required review by the Natural Resources Commission) has left a scar of thinly-vegetated hillside stretching down to the river. This situation illustrates the need for continuing public education about the existence of local and state regulatory programs, and also points to the desirability of private, voluntary land protection programs such as those conducted by CLCT and SVT.

At the mouth of Fairhaven Bay, an undeveloped 20 acre "pork chop" lot located on the river's left bank is the subject of a previously-approved subdivision plan. Should this lot be developed in accordance with the plan, houses on the site would likely be visible from the river. However, a permanent conservation restriction protects a 200-foot wide buffer along the Sudbury River and the northernmost portion of the site is within the floodplain, so its post-development character would likely remain consistent with existing land uses in the area.

Across the river downstream, on the slopes of Fairhaven Hill, another large (49 acre) irregularly-shaped lot appears to have enough frontage on Fairhaven Rd. to allow at least some development. While the upstream portion of the site's river frontage is within the floodplain, it also contains steep uplands which, if developed and particularly if cleared, would alter the existing natural landscape in this area. Adjacent to this parcel on the downstream side, two other large lots—one with a house and the other apparently undeveloped—could accommodate further riverfront development if they were to be subdivided.

Just upstream of Heath's Bridge on the right bank, a large undeveloped parcel is probably not vulnerable to development. This 41-acre parcel contains extensive floodplain and a potential town well site. Given these constraints, none of the area within several hundred feet of the river appears developable.

Below Sudbury Rd. on the left bank there are two long, narrow parcels along the immediate riverfront. Both are

⁵ According to town experts, it would be desirable to renegotiate some of these existing CRs to ensure that extensive vegetative cutting and the construction of recreational facilities such as swimming pools and tennis courts is not allowed. Otherwise, there is no assurance that land which appears to be protected under a CR will actually be managed in such a way as to minimize aesthetic, wildlife habitat, and water quality impacts.

entirely within the 100-year floodplain, and one is landlocked, so they are likely unbuildable. While the large parcels upslope of these riverfront lots are also either undeveloped or developed at much lower densities than would be allowed by the underlying AA zoning, they too have extensive areas of floodplain. The nearest buildable uplands are several hundred feet from the river.

Farther downstream, the town owns a 29.5-acre parcel, almost completely within the floodplain/wetland zone, for water supply purposes. The state's water supply regulations require that the land within a 400 foot radius of the well be protected from development, although of course this protection is in effect only as long as the town chooses to use the well. Should the town ever abandon the well and wish to develop the land, only the immediate road frontage—far from the river—would presumably be buildable.

On the right bank the extensive floodplain precludes additional housing development on the large parcel immediately downstream from the bridge. The Soutter land, with a half mile of river frontage upstream of Rte. 2, has recently been protected by the CLCT. Thus its river frontage and pastoral landscape will remain unchanged in the future.

Emerson Hospital and the New England Deaconess Association facility occupy the Sudbury's left bank between the waterworks site and Route 2. The intensity of riverfront development at this location makes it an anomaly within the study area. Zoned medical/professional with a minimum lot requirement of 80,000 square feet, there is a maximum lot coverage allowance of 25% at the site (for impervious surfaces including roofs and paving), and buildings are limited to 110 feet in height. While Emerson Hospital's parcel has been fully built-out, especially with the recent addition of a helipad on the riverfront, NEDA has not yet reached this percentage. In addition, since parking remains an issue at the hospital it is possible that a variance could be requested to add to the garage.

From Route 2 to the confluence, remaining riverfront land along the Sudbury lies within the wetland/floodplain zone, is protected through conservation ownership, or is fully developed. There is a possibility that there will be a request to rezone the parcel immediately below Rte. 2 on the left bank in order to allow the construction of retirement housing. If this occurs, due regard should be given to the protection of a riparian buffer strip. Otherwise, the construction of accessory buildings and the removal of vegetation within the extensive floodplain, either of which could affect water quality, wildlife habitat, and recreation along this segment, are probably the greatest threats within this densely-developed residential area.

3) Assabet River

a) Riverfront Character

The Assabet River study segment begins 1000 feet below the dam at Damondale in West Concord. The river corridor in this area is characterized by a narrow channel running between steep wooded slopes. About 30-40 feet above the river, the slopes level off into a broad terrace. Much of this resulting level upland has been developed for residential purposes. Lot sizes range from 1/4 to 1 acre or more. Most of the houses cannot be seen from the river, however, due both to topography (the structures are above the crest of the slope, as seen from the river) and vegetation, including mature trees. Within the first half mile of the study segment, there are the town-owned Marshall Farm and Harrington Park on the right bank, and a small area of town conservation land (Cousins Park), a public school (Thoreau School), and the Lapham conservation land on the left bank.

At West Concord Center the river passes under Rte. 62 and a railway bridge. Commercial uses along Rte. 62, including a former gas station, car wash, equipment rental business and small strip malls, are briefly visible from the river. Below this urbanized area, land owned by Boston Gas along the left bank near the outlet from Warner's Pond remains partially undeveloped. Farther downstream, the Massachusetts Correctional Institute-Concord facility occupies about 2000 feet along the left bank. Most of the prison buildings are 500 feet or more from the river. Reconstruction of MCI-Concord's sewage treatment facility, in order to bring its discharge into compliance with state and federal water quality standards, is nearing completion.

On the right bank, light industrial and office park complexes are sited 400-500 feet from the river, just above the 100-year floodplain. Much of the floodplain in this area is naturally-vegetated and undeveloped, although it lacks formal protection. Portions of the floodplain are used for playing fields and employee parking.

Immediately downstream of the Rte. 2 highway crossing, commercial development in the form of restaurants and a motel on the right bank, and older residential development along Assabet Ave. on the left bank, is briefly visible. Farther downstream, the river begins to meander within a wider, marshier floodplain. Some houses, set well back on sloping lawns, are visible along the right bank upstream of an abandoned railroad grade. The left bank is also sparsely developed in this area, due in part to the wetlands associated with Spencer and Dakins Brooks. Near the mouth of Dakins Brook are Willow Island and Dove Rock. The Assabet River joins with the Sudbury River about a half mile downstream at the town-owned Egg Rock .

Outstanding river-related resources along the Assabet River in Concord include historic sites (Barrett's Farm); diverse wildlife habitat associated with wetlands and woodlands along the river corridor; recreation and aesthetics along the length of the study segment; and literary values. A reduction in the amount or diversity of riverfront vegetation—mature hemlock, white pine, and silver and red maples in particular—would reduce the river's habitat value and harm its recreational, scenic, and literary values.

Boating access to the Assabet River in Concord river is informal. Put-in sites within the study segment include the Pine Street bridge, near the Thoreau School, and the Main Street/Rte. 62 bridge in West Concord.

b) Riverfront Development Potential — Assabet River

While relatively little of the Assabet's study segment frontage (1.7 miles) is in protected ownership, much of the riverfront land has been fully built out or faces natural barriers to further development. A handful of parcels along the river, including some in public ownership, could be subject to future development.

The study segment starts in a residential area which appears to be fully built-out. Existing parcels larger than the 10,000 to 20,000 square foot minimums required for Residential C and B development are generally not subdividable, due to the town's minimum upland area requirements for new lots. As noted above, much of the existing development along the river upstream of Rte. 62 is buffered from the river by steep slopes and a band of trees. On the left bank, Cousins Park is managed by the town for open space, recreation, conservation, and community gardens. The town-owned 15-acre Marshall Farm parcel along the right bank has been leased to a farmer, protecting both open space and the town's traditional agricultural base. However, this is municipal, not conservation land, meaning that the town could decide to use the site for non-agricultural or conservation purposes after the farmer's 20-year lease expires.

Portions of the Thoreau School site, occupying 15.5 acres along the Assabet's left bank, with 1730 feet of river frontage, could be developed by the town for school or other purposes. Existing school buildings are set back on a ridge and are not visible from the river, but theoretically additional buildings could be constructed on southwestern portions of the site, out of the floodplain.

One undeveloped, subdividable parcel is located just downstream on the right bank above the former railway bridge. Houses on this parcel would likely be out of sight of the river due to the steep bank in this area.

Between the former railway bridge and the Main St./Rte. 62 bridge, a school bus livery occupies a site along the right bank. It is alleged by the town that the pavement at this site extends illegally into the floodplain. Should the town prevail in its current enforcement action, the business may be required to remove some of the existing pavement and allow a natural buffer to establish itself along the river.

Downstream of the West Concord business district, both banks of the Assabet could be developed at higher than present intensities. A small parcel on the right bank which was formerly used to handle pesticides (the "Smith"

parcel), while fairly wet, has some developable areas on its Baker Ave. side, away from the river. The site's topography makes it extremely unlikely that any development would take place within several hundred feet of the river.

GenRad Corporation owns a 74.5-acre parcel just below Route 62, with 3410 feet of frontage along the river's right bank. The main building is set back several hundred feet from the river on higher land above the wide floodplain. Most of the open space on this site (including parking lots and a playing field) lies in the floodplain/wetland zone, but there may be room for some additional development within uplands, away from the river. While this site has been developed at the maximum density allowed by Concord's current zoning, the incentive would be strong to issue a variance should the company's (or its successor's) fortunes improve to the point where more building space was needed.

On the left bank lies largely undeveloped land of high conservation interest at the mouth of Nashoba Brook, owned by Boston Gas. This area has been considered by the town for development of a park and affordable housing, which would require development under a comprehensive permit or rezoning.

The MCI Concord facility, across the river from GenRad, sits on a 64-acre parcel with 2320 feet of left bank river frontage. The floodplain is narrow here and there is some potentially developable riverfront adjacent to the prison wastewater treatment plant, behind the prison. A railroad line bounding the parcel on the south limits possible access routes to this area. Along Rte. 2, disused buildings (the "Green Ladies") which formerly housed correction officers are slated for relocation or demolition by MCI, freeing their site for re-use, possibly as a parking lot. The parcel is zoned Industrial Park, but development by the Commonwealth's Department of Corrections is not subject to the town's zoning requirements.

Just downstream of Rte. 2 on the left bank is a small parcel owned by the State Highways Department and used for maintenance purposes. The storm drains on this site lead directly to the river.

The bed of the abandoned B&M Railway lies between the river and road frontage of several seemingly-developable parcels farther downstream on both banks. While presumably any new development on these sites would be landward of this right-of-way, ownership of the railway right-of-way remains a mystery to local landowners and the town Planning Department—i.e., it may be owned in fee by the railroad or its successor, it may merely be an easement over the residential land, or the railroad's property rights may have reverted to the adjacent landowner. If the latter is the case, the construction of new houses on the banks of the river could be possible.

Downstream on the right bank, across from Dakins Brook, a large low-lying parcel within Thoreau's Azalea Swamp is currently undeveloped. This site is partly wetlands and mostly in the floodplain, but does appear to have some developable land. The parcel is bounded by the river to the north and the old railroad bed to the south, making access difficult. Its riverfront could be developed only if the small upland areas within the site are at least 40,000 square feet in size, and the railroad bed could be crossed by a private drive.

Just upstream of Egg Rock there are several undeveloped parcels along the river, on the slopes of Nashawtuc Hill. The riverfront portions of these parcels are all bounded by the old railroad bed, making it necessary to resolve the railroad's ownership rights in order to determine whether new riverfront development would be possible. The CLCT is currently working to try to protect these parcels.

(Note: The 1986 Assabet Riverway Plan includes the following recommendations for the study area: 1) protect open space at Thoreau School and MCI; 2) use conservation restrictions to protect the GenRad floodplain. The latter would not be needed if the town's floodplain zoning were stronger, i.e. if it contained outright prohibitions against new buildings in the 100-year floodplain.)

4) Concord River

a) Riverfront Character

Concord has a little over six miles of frontage on the Concord River, with 2.3 miles along both banks and an additional 1.6 miles along the left bank only. Riverfront topography is varied, including extensive floodplains and associated wetlands, interspersed with ponds and steep-sided, rounded hills which cause the river to meander somewhat. Concord's historic land use patterns are well-preserved along the Concord River, with little evidence of twentieth century subdivisions.

Proceeding downstream from the start of the Concord at Egg Rock, the river passes Old Calf Pasture on the right bank. This conservation area provides ample boating access to the river, and its mixture of mature trees and open meadows creates a pleasing landscape. The first structures that come into view just downstream of the Lowell Road bridge are the Buttrick Mansion and Old North Bridge replica, both of which are located within Minute Man National Historical Park. The park's riverfront grounds, originally part of the Buttrick Estate, are naturally landscaped. Mature specimen trees, lawns, and hedges occupy upland areas, while native shrubs are found along low-lying portions of the river's banks. Farther downstream, at Flint's bridge, well-preserved historic buildings line the bridge approach along Monument St. on the river's left bank.

Continuing downstream, the river widens somewhat. A fringe of silver maples hugs the right bank along the Dike Trail, which runs much of the 1.4 mile length of FWS's holdings. Beyond the dike are ponds within which water levels are managed by the FWS to enhance their waterfowl habitat value. Concord's wastewater treatment plant is located on uplands behind the wildlife refuge, well back from the river. On the left bank, open fields along with the occasional farmhouse can be seen through gaps in the vegetation. Structures are generally a thousand feet or more from the river's banks.

On the left bank, opposite the Bedford town line, a series of hills (Buttricks, Balls and Davis Hills), forested in oak and white pine, cause the river to meander to the east before turning north again. For the last mile along the river in Concord, the left bank is bordered by a floodplain which is generally several hundred feet wide. Beyond the floodplain, open fields, wooded low hills, and the occasional house can be seen.

Outstanding river-related resources along the Concord River in Concord include historical sites such as the North Bridge and the Old Manse; archaeological sites; wildlife habitat within the wetlands and ponds along the Dike Trail area of Great Meadows NWR; recreation; and aesthetic values, particularly at Egg Rock and downstream along Davis, Balls, and Buttricks Hills. The Concord River in Concord is also significant for its literary values, having figured prominently in the writings of the transcendentalists and early field ornithologists.

The most vulnerable resources are probably the open meadows and undeveloped hills along the left bank. The alteration of this landscape by intrusive, intensive development or by insensitive tree cutting could impair the river's aesthetic values and reduce habitat for riparian species which depend on the cover and roosting sites associated with mature stands of white pine and other trees. Such alteration would also destroy a landscape which would probably look familiar to Thoreau or Emerson and which is associated with their accounts of the river over a century ago.

Access to the Concord River in Concord is provided at Old Calf Pasture. Canoeists are permitted to land their vessels at the North Bridge replica within Minute Man NHP, but this site is not really practical as a put-in or take-out point.

b) Riverfront Development Potential — Concord River

While much of the land along the Concord River is protected through conservation ownership (town, FWS, and NPS), several hills visible from both sides of the river still contain developable land. Intensive new development, especially if coupled with the removal of mature oak and pine trees, could impair the area's highly scenic qualities.

Downstream of the North Bridge replica lie Flint's Bridge and Poplar Hill, the first of these hills. At Flint's Bridge on the left bank a cluster of historic houses on small lots line Monument St. While built close to the river and within the floodplain (and served by on-site septic systems), these historic structures add character to the area. One 14.7 acre parcel with frontage both on Monument St. and 1200 feet along the river is not fully built out, but is mostly within the floodplain. Any future construction would most likely occur well away from the river bank.

Poplar Hill rises on the right bank. A couple of large lots located along Great Meadow Rd. on this hill appear to be subdividable, although there are existing houses on these sites. This area is zoned Residential A, with a 40,000 square foot minimum lot requirement and a frontage requirement of 150 feet. The parcels in question appear to be largely upland, with only a narrow fringe of floodplain along the river. Another 20-acre parcel just downstream is probably not developable due to large areas of open water. Farther downstream on the right bank is the outfall from the town's wastewater treatment plant, located on uplands behind the Concord Unit of Great Meadows NWR. The refuge land extends downstream to the border with Bedford.

On the left bank are Punkatasset Hill, Buttrick's Hill, Balls Hill, and Davis Hill. This area is all zoned Residential AA, which means there is a minimum lot size requirement of 80,000 square feet and a minimum frontage requirement of 200 feet. While the highest part of Punkatasset Hill (about 325 feet above sea level) lies across Monument Street and almost 1500 feet from the river, the hill slopes gradually down to the river, and structures on its presently open lower slopes would be visible from the river. However, there is an APR on the 67-acre Hutchins Farm parcel which fronts on the river below this hill.

Buttrick's Hill overlooks the river just across from Great Meadows' Dike Trail area. Two newer houses have been built at the end of Buttrick's Hill Road. While these houses are well-screened from the river by mature trees, development on the adjacent 32 acre parcel, which has extensive road frontage, could be more obtrusive. The CLCT has sought a CR on this land in the past.

Continuing downstream on the left bank, the river meanders around Ball's Hill. Small and steep sloped, Ball's Hill rises abruptly from the edge of the river. A large (109-acre) undeveloped parcel on the hill with over a mile of river frontage (6,570 feet) appears to have substantial developable capacity. The parcel includes both Ball's Hill and the adjacent Davis Hill. While the site contains extensive wetlands and floodplain areas, it also includes uplands along the currently forested slopes of the hills. Any future development which resulted in the removal of trees from these slopes would cause a marked alteration in their visual qualities. Much of this area is within the acquisition boundary for Great Meadows NWR. (Note: this area is considered by both the town and the MA Natural Heritage Program to be an area of ecological significance. Ball's Hill was also home to William Brewster, a famous nineteenth-century ornithologist. The area is privately-owned and is a town priority for preservation [see Open Space Plan].)

Carlisle

1) Riverfront Character

Carlisle has about two miles (10,400 feet) of frontage on the left bank of the Concord River. Of this, only about 15% (1600 feet) is in private ownership. Most of the remainder (8530 feet) is owned in fee by FWS and the town's Conservation Commission, with an additional 270 feet protected by a conservation restriction held by the Conservation Commission (Rolando/Riverloft Trust property).

Upstream of the Rte. 225 bridge, the floodplain is comparatively narrow where two low hills border the river. Despite the attractiveness of these hills as housing sites, they retain their rural character—open fields at the high points with natural vegetation elsewhere. One or two houses nestle in the trees, several hundred feet from the river. A shallow strip of floodplain along the riverfront is owned by FWS, and a conservation restriction protects an otherwise developable parcel adjacent to a single existing house on the Concord town border.

Downstream of Rte. 225, the floodplain widens to a half mile or more, and most of this river frontage is under FWS ownership. Cleared agricultural land is barely visible from the river.

Existing public access sites along the river include a town-owned car-top boat launching area with parking for several cars on the downstream side of the Route 225 bridge, and a trail along the river (no boating access) on the town's Greenough property, located at the Billerica town line.

Outstanding river-related resources along the Concord River in Carlisle include wildlife habitat, recreation, and aesthetics. These values are vulnerable to alterations of the riparian zone resulting in loss of vegetative cover.

2) Local Land Use Requirements

Privately-owned land along Carlisle's riverfront is zoned General Residence B, which allows the construction of single family houses on lots 80,000 square feet or larger, inclusive of areas within the floodplain and wetland districts. The maximum building height is 45 feet. Cluster developments are allowed by special permit, with a minimum of 30% of the land within such a development required to be preserved as open space. Wetlands can only be used to satisfy 50% of the open space requirement or 15% of the total site area, whichever is less. Special permits for cluster development are granted only if there is a strong public interest in protecting the reserved open space. Developers must demonstrate that valued resources which might otherwise be destroyed will be protected by this form of development.

Site plan review is not required for residential developments. The Planning Board allows the use of common driveways to serve multiple house lots in order to reduce the number of curb cuts and amount of paving associated with residential development. At the request of the Conservation Commission, driveways can be required to be left unpaved in order to protect nearby wetlands.

Carlisle's resource protection zones include a stringently regulated Wetland/Flood Hazard District. Within the 100-year floodplain, no new structures or paving are allowed, although existing structures may be enlarged and accessory structures may be built by special permit. Proponents are given the opportunity of trying to demonstrate that the floodplain maps are inaccurate, but the burden of proof is on them if they seek to develop areas with the Wetland/Flood Hazard District. Carlisle's floodplain zoning is an example of the strongest form of floodplain protection found within the eight communities within our study area.

Carlisle has a local wetlands bylaw, but its buffer zone and performance standards are the same as the state Wetlands Protection Act's. Fines and enforcement procedures are the only difference. Board of Health regulations specify that septic system leach fields must be at least 100 feet from watercourses. Additional protection is afforded by a maximum percolation rate ceiling, which protects water resources from the impacts of the too-rapid passage of leachate through highly permeable soils. The town's tough conservation regulations are well-enforced and have not been subject to legal challenges.

3) Riverfront Development Potential

There is very limited potential for additional riverfront development in Carlisle, due to topography (extensive riparian wetlands) and extensive conservation ownership. The only remaining subdividable land near the river is located along Skelton Rd., where a few new houses could be sited on hills overlooking the river. Any such structures would have to be located a minimum of several hundred feet from the river's banks due to the combined effects of the town's Flood Hazard District zone and FWS ownership. Downstream of Rte. 225, the Flood Hazard District extends a minimum of 1500 feet from the river's edge, even farther inland than the landward edge of FWS holdings.

Based on the limited potential for new construction along the river, Carlisle's frontage on the Concord River should be considered adequately protected based on existing controls.

Bedford

1) Riverfront Character

Bedford has approximately 3.1 miles (16,000 feet) of frontage on the right bank of the Concord River. Of this, all but about 550 feet are owned in fee by the federal government, as part of Great Meadows NWR. Two hundred feet of frontage is privately owned, at the foot of Riverside Ave. in West Bedford. The remaining 350 feet constitutes the Route 225 right-of-way (including the site of a previous bridge downstream of the existing one, which currently provides boating access to the river) and is owned by the Commonwealth and town. While there is an area of subdivided land near the river in West Bedford, the boundaries of all privately-owned parcels are at least 320 feet from the river's edge, beyond the vegetated buffer created by FWS ownership. Houses within the subdivisions are still farther from the river's edge, and are barely visible from the river even in winter.

Bedford's river frontage includes a floodplain of varying width, vegetated by a silver maple floodplain forest and shrub swamp wetlands. In the southern part of the town, the floodplain is approximately 300-400 feet wide. Travelling downstream along the Concord River, the floodplain widens to several thousand feet, especially where a small tributary enters the river downstream of the Rte. 225 crossing. At the northern edge of the town, the floodplain narrows where the river is bordered by a low forested hill about 40 feet high. Private holdings with houses in this area are set back 400 feet or more from the river, beyond Great Meadows NWR's property line. Many parcels are larger than the 1.5 acre minimum currently required by zoning, and the handful of houses within a few hundred feet of the river are well-screened by mature trees.

Outstanding river-related resources include archaeological and historic sites (the Two Brothers rocks), riparian and aquatic wildlife habitat, recreation, and aesthetics. These values are for the most part well-protected by FWS holdings. Intensive development of the agricultural lands along Dudley Road, especially if it resulted in the removal of mature trees, probably represents the greatest threat to Bedford's recreational and aesthetic resources.

2) Local Land Use Requirements

Zoning along the Concord River in Bedford includes three residential districts, varying from 25,000 to 60,000 square feet in density. Many of the parcels within existing development in West Bedford are smaller than the current 25,000 square feet minimum. Building heights are limited to 37 feet above grade. Cluster development is allowed by special permit, as are Planned Residential Developments. For cluster developments, 25% of the overall parcel area must be set aside as open space, while 40% of PRD developments are subject to this requirement.

Resource protection overlay zones along the river include a stringent Floodplain District, where no new construction is allowed within the 100-year floodplain. Special permits may be granted only if the proponent can show that there will be no increase in flooding as a result of the development, or that the site in question is not in fact within the 100-year floodplain.

Bedford also has a Wetlands (overlay) District along the river. While the town has informational maps which serve as guidelines to the location of this district, exact boundaries must be determined in the field, based on the presence of wetland vegetation. Both the Wetlands District (zoning bylaw) and local Wetlands Protection Bylaw (non-zoning) require the review of projects within 100 feet of the 100-year floodplain, or with 100 feet of vernal pools. Thus the town regulates a buffer zone along the river much wider than the state's WPA buffer zone. The creation of impervious surfaces (e.g. roofing and paving) within the wetlands buffer zone is limited, and performance bonds may be required to ensure that any required wetlands replications are successful.

Bedford does not allow the repair of failed septic systems, or the installation of new ones. Houses served by failed systems and all new construction must be tied in to the municipal sewer system.

While the town's subdivision regulations do not specifically mention the Concord River, they do state that development within the Floodplain/Wetlands District must "assure natural flow patterns" for runoff. In addition, developments subject to site plan review (required for private recreational facilities and some institutional uses, both of which could be accommodated near the river by special permit) are also subject to stormwater control requirements. Bedford is planning to conduct a town-wide drainage study which would identify problem areas and propose solutions, including measures to enhance aquifer protection and recharge, contingent on the availability of funding.

The town has no erosion or sedimentation control requirements or maximum slope limitations for residential construction. Sand and gravel extraction is expressly prohibited under the zoning bylaw.

3) Riverfront Development Potential

With the exception of a single lot at the end of Riverside Ave. in West Bedford, almost all of which is located within the Floodplain District, there are no undeveloped privately-owned parcels which front on the river in the town. The Riverside Ave. parcel appears to be smaller than the 30,000 square foot minimum currently required for construction of single family housing in the area. In any case its development would require permits from both the Conservation Commission and ZBA, and compensatory storage at the same elevation as that lost through any development of the lot would be required. Thus this lot should be considered undevelopable.

Elsewhere in West Bedford, most of the houses which are closest to the river are within the 100-year floodplain. Consequently, any alteration (such as enlargement) of these structures would require both a variance from the ZBA and a permit from the Conservation Commission, creating an opportunity for these boards to require the mitigation of any impacts on the river. Since these existing buildings are largely invisible from the river, it is unlikely that any changes would be allowed that would have a significant impact on aesthetics.

The development of lands adjacent to FWS's riverfront holdings in areas farther downstream is unlikely to have an impact on views from the river, due to the landward extent of FWS's holdings and the existence of dense vegetation. Huckins Farm, a large tract of land along Dudley Road, has already been developed as a PRD, resulting in the construction of 164 housing units on portions of the site well away from the river. In accordance with PRD requirements, several hundred acres of this site have been protected as permanent open space, held by the town's Conservation Commission and the Huckins Farm residential association. Much of the remainder of privately-owned land in the vicinity of Dudley and Davis Roads in this area is used for forestry or agricultural purposes and is assessed under the provisions of Chapters 61 and 61A. This gives the town first right of refusal should the lands go up for sale. The Conservation Commission and Planning Board intend to encourage the use of cluster development as a means of preserving open space should these lands be developed.

Due to the lack of significant potential for new, intrusive development along the Concord River in Bedford, and due to the fact that the few areas of existing development are well-screened from the river and do not interrupt the naturally vegetated riparian corridor, no changes in Bedford's local land use requirements are needed in order for this segment to be considered "suitable" for designation. Minor improvements in water quality would probably result if pollutant loadings in runoff from existing subdivision roads and lawns could be reduced. Measures to achieve this might include an erosion and sedimentation control bylaw, and educational programs focussing on lawn and garden care especially with regard to fertilizer, pesticide and herbicide use and vegetative cutting.

The Town of Bedford's Open Space and Recreation Plan (1986 update) along with its Comprehensive Plan target the preservation of open space adjacent to FWS holdings along the Concord River. As the Open Space Plan points out, FWS ownership is limited to floodplain and wetland areas. Many abutting undeveloped upland tracts remain in private ownership. The implementation of the town's plans would afford additional protection to the Concord River's water quality and scenic values, and would also enhance passive riverfront recreation and the protection of riparian wildlife.

Billerica

1) Riverfront Character

Billerica has approximately 2.4 miles (or 12,500 feet) of frontage along the Concord River upstream of the Route 3 bridge—the portion of the river under study for potential designation as a national wild and scenic river. The frontage along the right bank totals about 8000 feet; that along the left bank 4500 feet. Most of the approximately 3500 feet of frontage on the right bank upstream of the Rte. 4 bridge is within Great Meadows NWR. Another 4650 feet of frontage on both banks within the study area is owned by the town Conservation Commission, the state DFWELE, SVT, and Middlesex County.

The town's frontage begins upstream along the Concord River at Mill Brook on the right bank. Frontage on the left bank commences about 3500 feet downstream, near Pages Brook. Riverfront topography varies from areas of extensive marshes, especially along the left bank just downstream of the Route 4 bridge, to areas of steep slopes such as the left bank immediately upstream of the Route 3 crossing. Elsewhere, the river's banks are characterized by low hills interspersed by floodplain.

Many of the upland areas adjacent to the river, along with portions of the floodplain, have been developed for residential purposes. The Riverside community along the left bank upstream of Rte. 4 occupies a low ridge along the river. Houses along Riveredge Road, including converted summer cottages, are largely located within the 100-year floodplain. On one riverfront parcel in this neighborhood is a building in ruins, with only the brick shell and steel girder roof supports still standing. Farther downstream a marina and restaurant front on the river. On the right bank upstream of Rte. 4, most of the riverfront is owned by FWS and is undeveloped.

Downstream of the Rte. 4 bridge, several houses are located within the broad forested wetland along the left bank, within 100 feet of the river. Two houses served by septic systems are accessed via Carter Ave., which runs north off Route 4 into this lowlying wetland area and continues downstream along the riverbank as a "paper" road. Farther downstream, the Rio Vista neighborhood extends along a steep slope and ridge running parallel to the river. Several houses are sited on the floodplain, accessible via private roads and drives running east from Rio Vista's public road network.

On the right bank, more houses and converted camps occupy riverfront slopes and floodplain areas downstream of Rte. 4. Many of these structures are within 100 feet of the river's banks. Others—two small cottages in particular—are set back from the river and surrounded by mature, dense vegetation such as cedars, hemlocks, rhododendrons and hardwood trees and shrubs. There is also a privately-owned, undeveloped beach along this portion of the river.

Most of the areas of residential development along the Billerica portion of the Concord River study segment are at least partially screened by mature hardwoods. White pine stands along ledgy slopes and at the tops of the low hills also provide screening. Lot sizes are small, however, reflecting the development history of the area as a summer community. In addition, many accessory uses—which may be technically prohibited under current zoning—are made of parcels within these residential areas. These include the storage of heavy trucking, paving, and earth-moving equipment; tire, brush and construction debris stockpiles; and large outbuildings. Such uses are particularly evident along the left bank and some parts of the right bank downstream of Rte. 4. The Riverside development, upstream of Rte. 4, is more typical of a suburban residential community, with lawns and some landscaping surrounding the houses.

Most of the marina parcel is paved or roofed over. The restaurant is separated from the river by a large paved parking lot. Informal car top boat access exists at this site; however the restaurant's owners frown on the parking of cars by non-patrons.

Outstanding river-related resources include wildlife habitat, recreation, aesthetics, and cultural sites such as Jug Island, where Thoreau spent the night during his week on the Merrimack River. The greatest vulnerability along the study segment is the potential loss of habitat and scenic value should the steep slope on the left bank just upstream of

Rte. 3 be developed or cleared. Additional development within the floodplain on either side of the river downstream of Rte. 4 would also reduce this segment's scenic and recreational value.

2) Local Land Use Requirements

Billerica's study area riverfront is zoned Rural Residential (50,000 square feet), Village Residential (30,000 square feet) and, for the marina and restaurant sites, Neighborhood and General Business respectively. Many existing lots are smaller than these current minimums. For instance, in the Riverside neighborhood, many parcels are less than a quarter of an acre (about 10,000 square feet). Structure heights are limited to 35 feet. The town permits cluster development within certain specified zoning overlay districts only, rather than townwide. There are no cluster overlay districts located directly on the river, but one such district would help to protect open space values along Dudley Road, behind the GMNWR land which fronts on the right bank of the river upstream of Rte. 4. Creation of a cluster overlay district in this location would require a 2/3rds vote in favor at Town Meeting. Alternatively, the town could vote to allow the ZBA to approve cluster development anywhere in town through the ZBA's special permit granting authority.

Billerica's floodplain zoning allows new construction with a special permit. Public safety is the major consideration the ZBA uses in deciding whether to issue this permit. Approval is also needed for new fill and paving within the 100-year floodplain. However, in 1990 the town's Board of Health promulgated a regulation prohibiting all new construction within 100 feet of the newly-mapped 100-year floodplain without a variance. (Variances are issued if it can be shown that the project will not create a threat to public safety.) This regulation strengthens Billerica's floodplain requirements, but they are still not as strong as those in towns such as Bedford and Carlisle, which basically prohibit new construction within the floodplain. An additional problem for Billerica is the fact that there are many pre-existing buildings within the 100-year floodplain, which are, of course, grandfathered.

Billerica relies on the state Wetlands Protection Act to protect its wetlands and waterways from activities that could affect natural functions. Its Board of Health regulations for on-site sewage disposal prohibit the use of "package" treatment plants within the town. The regulations also require septic system leach fields to be located a minimum of 100 feet from watercourses and wetlands, and prohibit new septic systems within the floodplain. These are strong river-protection provisions.

Billerica's zoning bylaws require that there be no increase in the rate of post-development off-site runoff, based on the rational method. This is a comparatively strong requirement, helping to minimize increases in flooding. Use of the SCS method (or other vegetation/soils-based approach, which is more appropriate for developments involving large areas of lawn, woods etc. than the rational method, which is best suited to small, mostly paved/roofed lots) would be even more conservative, especially for large tracts. There are no sedimentation or erosion control requirements, an important consideration should development along the Concord River's steep left bank ever be proposed. The town's slope development limitations apply to finished roads and rights-of-way only, not to building lots. Sand and gravel extraction, or "earth migration," requires a special permit.

There are no open space standards for conventional subdivision developments. However, the Planning Board may require the conservation of open space "in proper cases." The only form of site plan review is associated with the special permits required for residential development within the town center Historic District, which is not near the river.

3) Riverfront Development Potential

Much of Billerica's river frontage appears to have been developed for a considerable time. Exceptions are areas which were physically difficult to develop such as the wetlands along the right bank, upstream of Rte. 4, and the steep ledgy slope along the left bank, from Jug Island downstream. Most of these areas are now in public ownership. Remaining

undeveloped private holdings would be subject to new, lower density zoning requirements, septic system siting requirements, and floodplain and wetlands protection regulations. However, the right bank of the Concord River between Rtes. 3 and 4 is sewered so these provisions do not necessarily serve to prevent additional development of uplands along the riverbank in this area.

Additional construction along the left bank (e.g. along the Carter Ave. right of way) would be expensive because in order to serve this area new sewer interceptors would have to be brought in from the line that parallels Route 4. The "Hazen parcel," 29-acres on the river between the County holdings and Rio Vista, is the only large undeveloped upland tract in this area. It would be desirable to encourage the use of cluster development, with houses and roads sited away from the river, if this parcel is subdivided in the future.

Middlesex County is in the process of transferring 194 acres of land between Treble Cove Rd. and the river to the town. This tract, formerly part of the County House of Corrections holdings, was the subject of legislation enacted in late 1993 requiring the County to make the transfer. With the change in ownership comes a change in intended use: the County had expressed interest in developing the land for housing, while the town, concerned over the drain on its services such development would bring, intends to use the parcel for recreation and open space purposes.

The right to rebuild the ruined building in the Riverside neighborhood is not grandfathered because at least three years have elapsed since this building was habitable. New construction on the site would be subject to current zoning and Board of Health requirements, which may make the parcel unbuildable.

The pattern of existing and potential development along the river in Billerica, particularly downstream of Rte. 4, has created some water quality and aesthetic problems. Summer cottages built before floodplain and wetland protection laws were enacted tend to be located very close to the edge of the river, on small lots. Newer houses have also been located in the midst of the floodplain forest and on most of the higher pieces of land along the right bank. By reducing the amount of available wildlife habitat within the floodplain (e.g. vernal pools for amphibians, nesting habitat for reptiles, and roosting and cover habitat for waterfowl) and releasing untreated or poorly treated wastewater into the river and associated wetlands, this pattern of land use may be presenting a considerable threat to resources such as wildlife habitat and water quality, especially during floods.

Soils along the right bank downstream of Rte. 4 are Windsor-Hinckley soils, which, due to their coarseness and high permeability, have little filtering capacity. While this area is currently served by town sewers, any remaining on-site septic systems may be contributing to pollution of the river due to the too-rapid movement of leachate. Paxton-Woodbridge-Hollis soils are found along the left bank. These soils are severely limited in their ability to absorb septic system effluent due to slowly permeable hardpans or bedrock lying close to the surface. "Septic systems cannot function properly under these conditions." (Billerica Open Space Plan, 1986.) Even without the soils-based limitations to proper septic system functioning, the leach fields serving houses along the left bank are often underwater for days or weeks each year, allowing raw sewage to flow directly into the river.

Activities associated with mixed residential and commercial uses in the area along the left bank downstream of Rte. 4, including the outdoor storage of heavy construction equipment, 55 gallon drums, tires, and construction debris, serve to increase the threat of contamination. While many residents in this area obviously take pride in their homes and yards, some of their neighbors appear to be less aware of or concerned about the impacts of their activities on the river. Since Billerica residents get their water supply from the Concord River, downstream of Rte. 3, it should be particularly important to them to safeguard the river's water quality. Although the water is filtered and treated before distribution, the more pollutants the raw river water contains, the more expensive treatment becomes, and the higher the risk of contamination due to inadequate treatment. The contamination of the river by raw sewage and hazardous chemicals associated with construction and paving activities also threatens aquatic life, including the fish that draw boaters to the area each summer.

APPENDIX D: SUMMARY
WATER RESOURCES STUDY
SUDBURY, ASSABET AND CONCORD RIVERS

This summary provides an overview of the Final Water Resources Study conducted in 1993 as part of the Sudbury, Assabet and Concord (SuAsCo) Wild and Scenic Rivers Study. It includes descriptions of the various methodologies used, the results obtained, and an analysis of what the results mean. A complete description can be found in the actual Final Water Resources Study report, as prepared by GEC Inc. of Randolph MA.

I. INTRODUCTION

Purpose

The purpose of the water resources study was to provide answers to the following questions:

- What is the relationship between the quantity and quality of water in the study rivers and flow-dependent resources such as wildlife habitat, recreation, and scenery?
- What impact would possible future increases in consumptive withdrawals of water from the rivers, along with reduced flows caused by naturally-occurring droughts, have on these flow-dependent resources?
- With respect to water quality problems caused by excessive nutrient loading, what is the relative contribution of these nutrients from point source discharges and non-point source runoff? What measures could be taken to reduce the loadings?

Answers to these questions are important to the long-term management of the river. In the immediate future, they will be used to help the SuAsCo Study Committee to formulate recommendations that will serve to protect and enhance the rivers' flow-dependent resources. Acceptance of such recommendations by study area towns and state agencies would indicate their support for the goals of wild and scenic designation, namely, the long-term protection of the rivers' outstanding resources.

When reading this summary or the actual Water Resources Study report, there are several important points to keep in mind:

- **The scope of the study was limited.** With limited time and limited funding, it was necessary to focus the study on the flow-dependent "outstandingly remarkable" resources which qualify the rivers for wild and scenic designation, i.e. wildlife habitat, recreation, and scenery. As a result, characteristics such as water quality, sediment chemistry, and flushing flows could not be investigated in detail. Such issues deserve attention and should be the subject of follow-up studies whether or not the rivers are designated.
- **The water resources study report is an information document rather than a decision-making document.** It provides important new information about the relationship between river flows and water-dependent resources. This "baseline" data about the current status of outstanding resources can be used to monitor the long-term health of the river system. Study report information will also be very useful in decisions concerning future water withdrawals and many other river management issues. But the report does not create a protection policy for the rivers — it is up to the SuAsCo Study Committee, through its River Conservation Plan, to develop policies to be used in such decisions.
- **The results of the water resources study are directly dependent on a number of assumptions and simplifications that had to be made in order to create models of the rivers' hydrology and ecology.** Changing any of these assumptions would alter the results. The major assumptions are presented in the "Purpose and Methods" sections of this summary and are analyzed in the "Discussion" section.

- **The water resources study is not intended to provide predictions of the rivers' instantaneous future flows throughout the study area.** The models used in the study predicted average monthly flows at key reference points, and these predicted flows are subject to fairly large margins of error. Field work for the study was conducted over a very short period during a particularly dry summer, and longer-term gauging records come from locations outside the study area. If new consumptive withdrawals are proposed in the future, more detailed site-specific studies would be needed to predict instantaneous low flow conditions (i.e. worst-case conditions for fish and other aquatic life) downstream of the withdrawal point.

Project Administration

The Water Resources Study was made possible through a cooperative effort among the major participants in the Wild and Scenic River Study, including the SuAsCo Study Committee and its ad hoc Technical Advisory Committee (TAC). The study's direct budget of \$94,000 was funded by Congressional appropriations through the National Park Service (\$84,000) and by the Massachusetts Water Resources Authority (\$10,000). In addition, all of the interests involved in the study made substantial in-kind contributions of volunteer and staff time, and other resources.

The Massachusetts Department of Environmental Management (DEM) administered the project under a cooperative agreement with the NPS. DEM's prime consultant was Goldman Environmental Consultants (GEC), Inc. of Randolph, MA, which in turn contracted with two sub-consultants (Horsley & Witten, Inc. and a team from the University of Massachusetts at Amherst) for the hydrological and ecological portions of the study. A team of advisors, including the Water Resources Subcommittee of the SuAsCo Study Committee and outside experts who comprised the TAC, worked with DEM and the consultants to guide the study process. This team defined the scope of the study; reviewed the request for proposals; selected GEC to conduct the study; approved a work plan; resolved questions about the selection of study transects; defined hypothetical water use and wastewater discharge scenarios; and reviewed the draft study report. Without the support of the TAC, many of whom were volunteers or already over-worked agency and non-profit technical staff, the water resources study could not have been a success.

General Methodology

Following is an outline of the general methodology and approach used by the consultants:

- **Flows:** A hydrologic accounting (mass flow) model was developed and used to predict average monthly flows, elevations, and depths at several reference points, or nodes, within the study area. The model provided information both on current, or baseline, conditions, and on likely conditions under future drought and withdrawal scenarios. The predicted flows and elevations were then used to determine likely changes in wildlife habitat, recreational suitability, and scenic value under the future scenarios.
- **Wildlife Habitat:** Seven study plots along the rivers were surveyed to gather data on water levels, vegetation, macroinvertebrates, wildlife habitat, and fisheries. These plots were located along transects extending across the rivers' channel and floodplain from upland to upland. Data collected at the study plots were used to quantify the value of aquatic and wetlands fish and wildlife habitat, using "habitat suitability indices," for certain species selected by the study team. This approach measures the quantity of breeding and foraging habitat available to the species, and can be used to predict the impacts of long-term changes in water levels on species abundance and diversity.
- **Nutrient Loading:** Water quality was studied using a nutrient loading approach. The amount of nitrogen and phosphorus added to the rivers each year was calculated from wastewater treatment plant records and from information about loadings associated with various forms of land use within the study area. The effects of development and population growth within the watershed, producing increased treatment plant discharges and increased loadings from surface run-off, were then predicted. The nutrient loading information is relevant

because excessive nutrients are the major cause of accelerated eutrophication, which in turn affects the rivers' ecology and recreational value.

- **Recreation:** Recreational suitability rankings ("unacceptable" through "optimal") were defined for various segments of the study rivers based on baseline water depths and interviews with both expert users and the general public. Using the water depths predicted by the flow model, changes in these qualitative suitability rankings were calculated for each future hydrological scenario. The recreational uses studied included canoeing, kayaking, sculling, angling, and motor boating.
- **Scenery:** A visual inventory of the rivers' scenic features was conducted using photography, and river user attitudes about scenery were compiled using written surveys.

II. HYDROLOGIC MODELING

Purpose and Methods

Model

In order to determine how changes in the amount of water flowing through the rivers might affect the flow-dependent resources of concern, it was necessary to develop a model that would predict the rivers' response to a combination of drought and high water demand conditions. Specifically, we needed a model that would tell us what the surface elevation (or "stage") of the rivers would be during periods of low precipitation and high water use. Elevations were judged to be more important to the resources of concern than flows or velocities because the type of wetland vegetation that grows along these lake-like rivers is most affected by long term (\geq five years) changes in water levels. Also, with the exception of boating on the Assabet River, the type of water-borne recreation prevalent in the study area is more dependent on suitable water depths than on flow rates. Thus the model used for this study went beyond flow estimates to predict stage values.

Information used to create the hydrologic model included an eleven-year record of readings at three gauges above and below the study area; stage and discharge readings taken during the study's six-month 1993 field season; and other miscellaneous measurements that had been made by individuals and state and federal agencies. The resulting "mass flow" model takes input in the form of discharge readings in cubic feet per second (i.e. the volume of water passing a point during a given time) and produces output in the form of predicted stage and discharge measurements at eight locations within the study area.

Scenarios

The model was used to predict changes in the rivers' hydrology based on hypothetical increases in water consumption in the year 2010 combined with five-year droughts of varying severity. Five years of decreased flows are the minimum required to cause detectable changes in vegetation types within the rivers' wetlands. Each of the four scenarios combined increased water consumption — either at new withdrawal points or from increased withdrawals at existing wells — and either significant or severe droughts. The modeled results do not distinguish between flow reductions due to human use and those caused by climatic conditions.

The future water use assumptions used in the four hypothetical scenarios ranged from "most probable" to "high demand," bracketing a range of potential conditions. Scenarios 1 and 3 assumed that increased withdrawals in the year 2010 from those portions of the rivers' watershed that contribute flow to the study area would be made from either existing wells or from likely future locations, and that withdrawal amounts would be "most probable" or "high demand" respectively. Scenarios 2 and 2A assumed "most probable" 2010 water withdrawals, plus a 40 MGD

(million gallons per day) diversion from the main stem of the Sudbury River and a lesser diversion from Sudbury Reservoir respectively. The Sudbury Reservoir diversion amounts of 16.4 MGD in normal years and 8.2 MGD in drought years were based on scenarios actually examined by the MDC in the mid-1980s¹. This scenario (2A) was added to the final study report because it was felt to be more realistic than the 40 MGD direct diversion (Scenario 2) modeled in the draft report. While the engineering feasibility of a 40 MGD withdrawal was once studied by the MDC, such a diversion has never actually been proposed.

FUTURE HYDROLOGICAL SCENARIOS		
SCENARIO	5-YEAR CLIMATIC CONDITIONS	2010 A.D. WATER CONSUMPTION FACTORS
1	Significant Drought (2 drought years and 3 normal years)	Most probable in-basin increase in use.
2	ditto	Most probable in-basin use plus 40 MGD out-of-basin diversion from Sudbury River.
2A	ditto	Most probable in-basin use plus 8.2-16.4 MGD out-of-basin diversion from Sudbury Reservoir.
3	Severe Drought (3 drought years and 2 normal years)	High in-basin increase in use.

The hypothetical five-year climatic conditions ranged from a significant to a severe drought, based on combinations of dry and normal years. For Scenarios 1, 2, and 2A, a significant drought consisting of three normal years and two years during which the flow for every month is less than that actually recorded 75% of the time (i.e. the "75% exceedence value") was used. For Scenario 3, the combination was three drought years and two normal years, producing a severe drought. It is very important to note that the synthetic drought years used for the analysis, which assumed low river flows in all twelve months of the year, are highly unlikely events. They were used because the study team felt that the hydrologic and habitat models would only respond to these fairly sizable, long term reductions in flow.

Most of the water withdrawn from wells and surface waters in the SuAsCo basin returns to the rivers via sewage treatment plants or septic systems. The model assumed that 20% of the withdrawals would be "lost" from the watershed due to evaporation and transpiration associated with outdoor water use. This is a very conservative assumption, i.e. it under-estimates the actual return flow to the rivers, especially during the colder months.

The hydrologic model was tested for accuracy by running it using actual gauge measurements as input and comparing its predicted stage and discharge values to what was recorded in the field. It was found to be quite accurate in predicting stage and discharge under low flow conditions, and also under higher flow conditions when such conditions persisted long enough to saturate the rivers' wetlands. However, because of the way the wetlands absorb and store water during the first days and weeks of increased runoff (so-called "rising stage" conditions), the model tends to over-estimate stage and discharge during these periods. This idiosyncrasy, which produces what hydrologists call a "hysteresis" in the curve on a flow versus discharge graph, should be kept in mind when the model is used in the future.

¹ The MDC-defined Sudbury Reservoir scenario includes the following withdrawal constraints: no withdrawals from June 15 through September 30th of each year, no withdrawals when water elevations at Sherman's Bridge downstream fall below a cut-off threshold, and a 1.5 MGD minimum release from the reservoir to the river at all times.

Results

Scenario 2 showed the greatest reduction in flows from baseline conditions. As noted above, the 40 MGD average out-of-basin diversion associated with this scenario has never been proposed. For normal years, the flows predicted under Scenarios 1 and 3 varied little from baseline conditions, indicating that growth in water use within the study area has a relatively small impact on river flows. The hypothetical drought conditions used in the model had a much greater impact on flows. Scenario 2A, the hypothetical diversion based on the MDC's decade-old proposal, had a bigger impact on flows than Scenarios 1 and 3, but less than Scenario 2.

III. WILDLIFE HABITAT MODELING

Purpose and Methods

Model

In order to predict what would happen to aquatic wildlife if river flows were reduced, the consultants first needed to quantify the amount of existing habitat in the study area, and then to develop models that could predict changes in the amount of habitat caused by the reduced flows. The quantification technique they used is known as a "habitat evaluation procedure," or HEP, and relies on information about the physical and biological conditions found at field plots to generate a measure of how useful the area is to the species in question as breeding or foraging habitat. This measure is called the "habitat suitability index," or HSI.

Seven locations along the rivers were chosen for the study plots by study biologists in consultation with the U.S. Fish and Wildlife Service. The plots were chosen to exemplify the full range of wetland types within the study area. Thus the amount of wetlands of each type within the plots was not representative of the actual abundance of that type overall. At each transect, study staff measured elevations and recorded the type of vegetation present. They also noted physical and biological habitat characteristics, such as water temperature and percent cover, for use in calculating the HSI values. Wetland vegetation zones were identified based on a standard classification system, and referenced to elevations along the transect.

Mean HSI values for each wetland type were calculated for two species of fish (chain pickerel and largemouth bass) and nine species of wildlife: bullfrog, snapping turtle, muskrat, mink, red-winged blackbird, black duck, wood duck, American bittern, and great blue heron. These particular species were chosen by the study team, in consultation with the TAC, as representative of the range of fish and wildlife present in the study area, and because they were species for which HSI curves had already been developed.

To calculate the total amount of habitat for each species within the entire wild and scenic study area, the mean HSI value for each species and wetland type was multiplied by the total number of acres of that wetland type within the study area. These acreages had been determined based on aerial photos taken for the Massachusetts DEP's Wetlands Conservancy Program. The habitat totals established the baseline value of the study area to the eleven reference species under present-day conditions.

Scenario Analysis

Using the hydrologic model, study biologists predicted the changes in wetland vegetation types that would result from reductions in average monthly water elevations under three of the four scenarios. (The fourth scenario, 2A, was evaluated qualitatively for the final report as a result of comments on the draft report.) New habitat totals for each of the eleven reference species were then calculated and compared to the baseline totals. The result was a prediction of the percent change — gain or loss — in each species' total habitat under three future scenarios.

Results

Small to moderate reductions in total wetland area were predicted under all four scenarios. However, some wetlands vegetation types (forested swamps and buttonbush shrub swamps) were predicted to increase, while other types, such as marsh and deep marsh, were disproportionately reduced. Because wetland types of less value to wildlife would tend to replace the more valuable marsh and deep marsh habitat under all the scenarios, the model predicted a decrease in habitat for most of the species. Overall habitat loss was greatest under Scenario 3, but many of the species modeled would suffer larger negative impacts under Scenario 2.

Habitat value increased for only two of the wildlife species modeled (black duck and wood duck) under any of the scenarios, and these increases were slight. In contrast, American bittern habitat decreased by about 60% under both Scenarios 2 and 3. While no state or federally-listed rare and endangered species were modeled, due to the fact that HSI curves have not yet been developed for these species, the consultants felt that habitat for several such species of concern (including the least bittern) would be reduced significantly due to loss of marshlands. In addition, they predicted that any reduction in baseline water levels would exacerbate problems caused by several invasive plants: purple loosestrife, glossy buckthorn, water chestnut, and fanwort. These non-native species reduce habitat values by crowding out native vegetation having greater forage or cover value for wildlife. Water chestnut also interferes with recreation because it covers the rivers' surface, impeding boat passage and fishing.

IV. WATER QUALITY

Purpose and Methods

The study's budget and time constraints limited the scope of the water quality analysis to an examination of nutrient loading trends. Nutrients (phosphorus and nitrogen compounds found in sewage and overland runoff) were chosen because of their role in causing "cultural eutrophication," or the accelerated evolution of the river system into wetlands and upland. Nutrient overloads, combined with sedimentation and elevated summer runoff temperatures caused by land development activities, also cause short-term problems for aquatic organisms by robbing the water of the dissolved oxygen these organisms breathe. While several toxic contaminants, including mercury and other heavy metals, also threaten water quality in the rivers, the study team felt that since these pollutants are currently being studied by the U.S. EPA under the Nyanza Superfund program, our study should focus on nutrients alone.

The study team decided to study the trend in nutrient loadings, i.e. the total amount of nutrients coming into the river system in pounds over time, rather than nutrient concentrations. This decision was made because the concentration of nutrients in the rivers is not merely affected by inputs from runoff and sewage, but also by additional factors which are difficult to measure. For example, phosphorus binds readily to river sediments and wetland soils, so in order to calculate phosphorus concentrations within the water column, the rate of phosphorus exchange between the water and soils and sediments would have to be known. This chemical pathway is very complex, with the rate varying depending on temperature and pH among other things.

Other water quality parameters, namely dissolved oxygen and temperature, were also studied qualitatively in order to assess the rivers' overall compliance with state and federal water quality standards.

Loading Calculations

Phosphorus and nitrogen compounds are used by aquatic plants in their growth. Too much of these nutrients cause "algal blooms," with rapid plant die-off and consequent crashes in the amount of dissolved oxygen in the water as the dead plants decay. The study team was interested in knowing how much of these nutrients is currently entering the rivers, and how much would be added by new development in the watershed. They based their calculations on

loadings associated with the two major sources of phosphorus and nitrogen: "point sources" such as discharges from sewage treatment plants, and "non-point sources" such as overland runoff.

The consultants used data from 1985 to represent baseline nutrient loading conditions, because 1985 was the most recent year for which 19 categories of land use had been mapped using aerial photos. Values for the amount of nitrogen and phosphorus found in runoff from the various land use types were found in the scientific literature. These loading rates were multiplied by the acreage of each land use category within the entire portion of the rivers' watershed that contributes to the study segments. Loadings from point sources, calculated by multiplying the concentrations in the sewage treatment plants' 1985 permit reports by the volume of water discharged, were then added to the non-point source values to produce a total.

Scenarios

While the same target year (2010) was used for the nutrient loading projections as was used for the hydrologic scenarios, the water quality scenarios were based on changes in land use rather than droughts and increases in water withdrawals. The four scenarios analyzed were A, most likely future conditions (based on land use changes predicted by MAPC, the regional planning agency); B, likely future with additional point source controls, i.e. state-of-the-art nutrient removal at all area sewage treatment plants; C, likely future with additional non-point source controls, i.e. reasonably achievable structural, regulatory or management measures to reduce sedimentation and contamination of runoff; and D, likely future with both point and non-point source controls. It is important to note that implementation of the non-point source controls in all upstream communities (not just the eight study-area towns) would require the cooperation of town governments, state agencies, and landowners.

Results

The study team found that the rivers are currently overloaded with nutrients, in particular phosphorus. In most freshwater systems, phosphorus is the limiting nutrient, i.e. increases in nitrogen will have no effect on the rate of eutrophication because aquatic plants need both nutrients in order to grow and the existing ratio between the two nutrients causes the phosphorus to be used up first. In our rivers, however, there is so much phosphorus that nitrogen is the limiting nutrient. This means that, at least until the phosphorus that is stored in the system (e.g. in sediments) is partially used up, it is more important to control nitrogen in order to limit eutrophication. Thanks to the state's new prohibition on detergents containing phosphate, however, the relative amount of phosphate entering the system is predicted to decrease in the future, which may eventually reverse this situation.

In modeling future loadings, the consultants found that under Scenario A (most likely 2010 loadings with no additional controls), both nitrogen and phosphorus loadings would increase significantly. Either additional point or non-point source controls were adequate to reduce future nitrogen loadings below current levels, and in combination (Scenario D) they reduced this nutrient by 34% over baseline. For phosphorus, however, non-point source controls alone are not adequate to reduce future loadings. Additional point-source controls would be necessary: under Scenario B, these controls alone would reduce loading by about 9%, while a combination of point and non-point source controls yields a 31% decrease. These results are consistent with what is known about the way these two nutrients travel through ground water. Phosphorus binds readily to sediment particles so relatively little of the phosphorus discharged from septic systems or dissolved in runoff reaches the rivers, while nitrogen can travel great distances in both groundwater and surface runoff.

The study team noted that while their approach compared future loadings to baseline loadings in order to determine the impact of future development on water quality, the baseline situation is already causing eutrophication problems.

V. RECREATION AND SCENERY

Purpose and Methods

To assess how potential changes in the rivers' flows would affect flow-related recreation, the consultants first estimated the value of various portions of the study area for several types of recreation, and then predicted how these values might be affected by changing water levels. The study team relied on both random user surveys and interviews with recreational experts who regularly use the rivers. In conducting these surveys and interviews, their goal was to find out how river users viewed the relationship between water quality, flow levels, and recreational enjoyment. The product of this work was a set of baseline recreational suitability rankings for eight segments within the study area. Using the changing water levels predicted under the four hydrologic scenarios, the consultants then determined how the rankings would change.

Since water levels varied little during the course of the study in the summer of 1993, the consultants could not obtain empirical information about how recreational users viewed the relationship between flow conditions and recreation. Thus their analysis relied heavily on the opinions of a few expert users, along with their own assumptions about factors that make a river segment more or less suitable for a given form of recreation.

The recreational suitability rankings for the eight segments defined by the consultants were necessarily subjective. These rankings range from "unacceptable" to "optimal." "Unacceptable" rankings were generally given when there was either too little or too much flow in the rivers. Factors contributing to an "optimal" ranking for canoeing, the most popular form of recreation on the study rivers, included unobstructed navigation (i.e. river levels low enough to allow boaters to pass under low bridges); the opportunity to use high water levels to reach parts of the system not normally boatable; and safe flow velocities for novice boaters.

To provide a basis for comparison of segment-by-segment suitability rankings for each form of recreation under baseline and future scenario conditions, the consultants gave each ranking a numerical value. The values were then tabulated by adding the ranking for each recreational type and month, producing a sum for each segment that could be compared to sums under altered flow conditions.

To assess the relationship between water levels and scenic values, the consultants included questions about this issue in the written survey administered to river users during the course of the field season. Expert users were also interviewed on the subject.

Results

The consultants determined that, although some survey respondents preferred the appearance of the rivers with fully submerged banks, and the clearer water associated with higher flows, scenic and aesthetic values were not directly affected by changing water levels for a majority of users. The Study Committee notes, however, that there were significant aesthetic problems (clogged channels and foul smells caused by decaying vegetation) when the Sudbury Reservoir was last used to supply the metropolitan area in the 1960s.

Not surprisingly, the study team found that the shallower parts of the rivers (e.g. the upper Sudbury) are less suitable for water-borne recreation than other segments during mid-to-late summer, due to low flows. The drought years defined by the modeled scenarios exacerbated this condition (while making areas with spring bridge clearance problems more suitable), but increased water demand had less of an effect. The diversions associated with Scenarios 2 and 2A likewise had less of an impact than the low flows caused by drought, mainly because of the assumptions under these scenarios that no withdrawals would take place when the river was already below a critical elevation at Sherman's bridge.

According to the consultant, spring high water levels make parts of the Sudbury's floodplain accessible and thus optimal for canoeing and kayaking. However, the same high flows in the Assabet, they felt, make the river minimally acceptable or unacceptable due to turbulence. The Concord River, which changes less with fluctuating flow conditions, is never optimal according to the study team because even though the river is never too shallow for boating, or too high for bridge clearance, the opportunity to paddle up tributaries or elsewhere within the floodplain during periods of high flow is absent.

Everyone who relies on the information in this report should understand that the suitability rankings are extremely subjective. Extreme caution must be used in comparing the baseline "combined average monthly suitability" rankings to future scenario conditions. The combined rankings accord equal weight to August canoeing and November sculling, taking no account of the relative popularity of each recreational type or unequal use of the rivers at different times of year. For example, the model's combined suitability rankings might appear to favor a proposed withdrawal that would improve November sculling conditions at the expense of August canoeing, even though the consultant's survey showed that canoeing is by far the most popular form of water-borne recreation on the study rivers.

In short, the recreational model used is very sensitive to the assumptions made about factors contributing to the relative suitability of the various segments. It assumes lack of bridge clearance is an impediment to recreation on reaches of the rivers that can be accessed without boating under bridges; that the more challenging flow conditions found along the 4.4 mile Assabet segment in some seasons are less preferable than the flatwater conditions available year round within the remaining 25 miles of the study area, even though not all users are novices; and that the Concord's less frequent flooding beyond its banks makes it less suitable than the Sudbury for canoeing. While the study provides useful descriptive information about the recreational and scenic values of the river, the tabulated suitability ranking information it contains should be viewed with caution.

VI. DISCUSSION

Study Limitations

A number of significant assumptions have been identified in this summary. The scope of the study was limited due to funding and timing constraints. It relied heavily on a modeling approach to predict future hydrological, ecological, water quality, and recreational conditions. Future users of these models must fully understand the assumptions upon which they are based. All users of the report's information should resist the urge to treat its numerical results as hard facts rather than indications of general trends.

Even with sufficient funding, only an intensive multi-year field investigation can yield detailed information about characteristics like hydrology and water quality, which vary significantly in time and space. It would be a mistake to rely on the "snap shot" of information about worst-case low flow events or water quality problems observed during this study, or as a result of previous single-day monitoring efforts, to predict the actual likelihood and duration of worst-case events in the future. In addition, the general results produced by the hydrological scenario models do not obviate the need for site specific investigations of the likely impacts of any significant new withdrawal, diversion or discharge in the future.

Modeling Approach

The hydrologic model was not sensitive enough to respond to minor, short term changes in flow conditions, so it was necessary to create scenarios which included major diversions and significant, multi-year droughts. The decision to select these scenarios for analysis should not be misinterpreted. Of the conditions used to construct the scenarios, only the "most probable" increased 2010 water demand is likely to occur. Drought years consisting of twelve months in a row of flows that are on average exceeded 75% of the time are highly unlikely, and five year periods that include

two or three such years are rarer still. The diversion amounts and locations under Scenario 2A were chosen because they had once been proposed for consideration, not because there is any certainty this water will ever be needed, such a diversion would make economic sense, or would be permitted by state regulatory agencies. Scenario 2 does not represent any diversion proposal, past or present, but was chosen as beyond the worst-case situation. Assumptions relevant to the study's investigation of water supply withdrawals included the following: there would be constant withdrawals for in-basin water supply; major new diversions would vary based on flows at Sherman's bridge and on seasonal constraints; and there is no storage within the watershed that could be used to augment low flows.

Recommendations for Future Technical Studies

The assessment of the impacts of increased demand focused on low flows rather than altered hydrology during the spring freshet. The impacts on flushing flows of both current consumptive withdrawals and any diversion proposed in the future have not been examined. In order to determine how high flow events affect sediment dynamics, which in turn affects floodplain ecology, sediment chemistry, and navigability, state and federal agencies along with any coordinating entity which might be established pursuant to wild and scenic designation should work together to conduct additional studies of this issue.

To improve the relevance of the biological models, it would be helpful if habitat suitability indices could be developed for species of special concern, such as state-listed rare and endangered wildlife.

Conclusion

The water resources study is an unusual example of cooperation among many diverse interests to generate new, objective information on subjects which have been the focus of many past debates. The study would not have been successful without the substantial commitment made by all participants.

The study provides important new information for decision-makers about the flows needed to protect the study rivers' wildlife habitat, recreation, and scenic values; and about the compatibility between future growth and new withdrawals on the one hand, and the protection of these values on the other. This information is essential to the development of a management plan for the river and the resolution of several river protection policy issues.

The reader should remember that the hypothetical water use scenarios evaluated in this study were defined for discussion purposes only, and do not reflect actual proposed withdrawals or conditions. If major new consumptive withdrawals (including either a single large withdrawal such as the reactivation of Sudbury Reservoir or multiple smaller withdrawals) are proposed in the future, the applicant would have to satisfy multiple state and federal permit requirements. Such requirements would likely include site-specific studies of the proposed withdrawal's impacts on the rivers' resources.