# Review of Ecological Impact Analyses for U.S. Route 6 Alternative 133, 133-18/25, and 54-Manny Between Bolton Notch and Windham, Conneciticut

8 October 1996

Prepared for:

Commander, U.S. Army
Engineer Division, New England

Prepared by:

Robert H. Kennedy, Ph.D.
Michael F. Passmore, Ph.D.
James S. Wakeley, Ph.D.

Environmental Laboratory, U.S. Army Engineer
Waterways Experiment Station, Vicksburg, MS

# Table of Contents

# INTRODUCTION

The need for highway improvements along U.S. Route 6 between Bolton Notch and Windham, Connecticut, has long been recognized. Traffic usage has steadily increased during the last 30 years and is expected to increase an additional 40 percent during the next 15 years as communities to the east of Hartford grow and expand. In anticipation of this increased traffic volume, several alternative alignments for an expressway in or near the Hop River valley were considered by Connecticut Department of Transportation (CT/DOT).

A draft Environmental Impact Statement (EIS) was published by CT/DOT in 1972. The final EIS was completed in 1979 for a freeway alignment located north of the Hop River. In 1985, the Federal Highway Administration approved an Environmental Assessment (EA) and a reevaluation report, stimulating design activities and right-of-way work. A Section 404 permit application was submitted to the Corps of Engineers in 1986, and was amended in 1987. However, the permit was denied by the Corps in 1989 based on the potential for significant impacts to the aquatic environment, and the need to review and evaluate additional alternatives.

A number of new alternative alignments were proposed and a second draft EIS was produced and reviewed in April 1994. In response to public comments, three additional alignments (131, 133, and 133R) were evaluated in the Draft Supplemental EIS and Section 4(F) Evaluation, released in July 1995. Since then, two additional alternatives were developed (133-18/25 and 54-Manny), both modifications of earlier alignments.

In August 1996. the Assistant Secretary of the Army for Civil Works, through the U.S. Army Engineer New England Division, requested the assistance of the U.S. Army Engineer Waterways Experiment Station (WES) to perform an independent evaluation of three alternative freeway corridors (133, 133-18/25, and 54-Manny). This review was based on previous environmental documentation, personal interviews with appropriate state, federal, and private personnel, and a brief field visit (Appendix A). The review did not involve any additional data collection, studies, or design work.

WES was tasked to prepare a document summarizing the environmental values. impacts and technical prospects for mitigation of each of the three alternative alignments. In the report. WES was to: 1 ) Describe the ecological impacts of each alternative; 2) State and substantiate a conclusion regarding the relative environmental impacts of the alternatives; 3) Describe the feasibility of avoidance/minimization and mitigation to offset the impacts; and 4) Evaluate the adequacy of currently proposed mitigation. This report does not recommend specific regulatory permitting actions.

Review of Route 6 Alternatives

## DESCRIPTION OF ALTERNATIVES

Alternative 133: Alternative 133 involves construction of a freeway (13. l miles in length) traversing the northern portion of the town of Bolton along the alignment of the existing notch in Bolton Ridge, the western end of Coventry, the northeastern end of Andover, the northern portion of Columbia, and the southeastern end of Coventry (Figure 1). Alternative 133 traverses the Hop River headwaters, a feature common to all three alternatives considered in this report. Alternative 133 crosses the Skungamaug River to the east of the original Alternative 54 alignment, contacts the southwest edge of the Nathan Hale State Forest, and crosses the Hop River just north of the intersection of Route 6 and Andover Lake Road. The alignment continues parallel with Route 6 to a point approximately south of the intersection of Hop River Road and Route 6 where it turns northeast, crossing the Hop River and ties into the original 54 alignment at Macht Brook.

Alternative 133-18/25: This alignment, which is 12.9 miles in length, closely follows the Alternative 133 alignment until the latter turns northeast at a point south of the intersection of the Hop River Road and Route 6. Alternative 133- 18/25 continues on the south side of Route 6 and crosses the Hop River just west of the existing Route 6 river crossing on the east end of the study area.

Alternative 54-Manny: This alignment (12.2 miles in length) is similar in location to the other two routes west of the Nathan Hale State Forest, but crosses the Skungamaug River southwest of the original 54 alignment. South and east of the Nathan Hale State Forest, 54-Manny crosses Bear Swamp Brook along the edge of the Hop River floodplain, then crosses Theims Brook north of the original 54 alignment, and returns to the original Alternative 54 alignment approximately 2 miles from the eastern terminus of the study area.

## STUDY METHODS

Numerous documents relating to the project were reviewed and considered during the present effort. In addition, several high-quality, Geographic Information Systems (GIS) maps were provided to us by staff of De Leuw, Cather (contractor for the CT/DOT). A complete list of documents reviewed is presented in Appendix B.

A visit to the study area was conducted during the period of 12-16 August 1996. Following an overview briefing by the CT/DOT, field sites along the Route 6 alternative alignments were viewed with representatives from CT/DOT, Connecticut Department of Environmental Protection (CT/DEP), the Federal Highway Administration (FHWA), U.S. Fish and Wildlife Service (FWS). Environmental Protection Agency (EPA), U.S. Army Engineer New England Division (COE/NED), De Leuw, Cather, the Wildlife Conservation Society, and the Connecticut Office of Policy and Management (CT/OPM). The field visit served to provide (1) a view of various wetland areas that would be impacted by the proposed alignments (2) an understanding of the juxtaposition of riverine, wetland, riparian, and upland habitats in the study area; and (3) an opportunity for dialogue regarding important environmental resources in the area. potential mitigation measures, and engineering concepts and challenges.

Face-to-face or telephone interviews were conducted with representatives of CT/DOT, CT/DEP CT/OPM, FWS, EPA, COE/NED, Wildlife Conservation Society, FHWA, De Leuw, Cather, Connecticut College, and the National Biological Service. Persons interviewed were asked their opinions on a variety of issues regarding alternative alignments using a standard set of questions as a means to initiate discussions. A list of persons interviewed and the question set are presented in Appendix C.

### Review of Route 6 Alternatives

## SPECIFIC ENVIRONMENTAL ISSUES

This report broadly considers the effects of freeway development on ecological resources throughout the study area landscape, including impacts on biological associations and interrelationships within the ecosystem. This approach relies on analyses completed for the project, such as those involving unfragmented forest blocks, habitat connectivity, and wetland/riparian associations with wildlife species. However, social/economic systems and biological/ecological systems cannot be separated, particularly in environmental settings in which human activities play such an important role. To do so in assessing environmental impacts guarantees an incomplete and/or unrealistic outcome. The previous evaluation process should have acknowledged these complex linkages between and among system components.

Hop River Corridor and Associated Wetlands. Interview results indicated a general consensus among personnel of the state and federal agencies, and De Leuw, Cather that one of the most significant environmental resources in the study area is the Hop River corridor and its associated floodplain habitats. This mosaic of riparian wetland and non wetland habitats, particularly below the confluence of the Hop and Skungamaug Rivers, is known to support an unusually diverse community of reptiles and amphibians, including a healthy breeding population of wood turtles *(Clemmys insculpta)* and other regionally significant and/or declining species. As described in the EIS, the Hop River corridor supports a variety of water-dependent mammals and birds, and provides other important functions and values, including attenuation of flooding, maintenance of water quality, exports of organic carbons that supports downstream food webs, human recreation, and provision of habitat for instream fauna such as fish and aquatic invertebrates. Any project plan must strive to protect these valuable resources and functions.

Despite the relative consensus on the significance of the Hop River corridor, opinions on the probable impacts of additional river crossings, such as in Alternatives 133 and 133-18/25, were strongly divergent. There were concerns that construction of the river crossings and long-term maintenance of those sections of the road-way that drain toward the river will produce unacceptable damages, primarily due to sedimentation and other water-quality impacts, flooding problems and blockage of wildlife movements due to restriction of the floodplain.,and aesthetic degradation.

Construction of the river crossings could potentially involve building temporary crossings and haul roads in the floodplain, and perhaps the channelization of short stretches of the Hop River where it passed under the highway. However, some persons interviewed expressed the opinion that the necessary crossings could be engineered in an environmentally sensitive manner, protecting the obvious values of the Hop River corridor while at the same time avoiding the impacts of a north bank alternative east of the Nathan Hale State Forest.

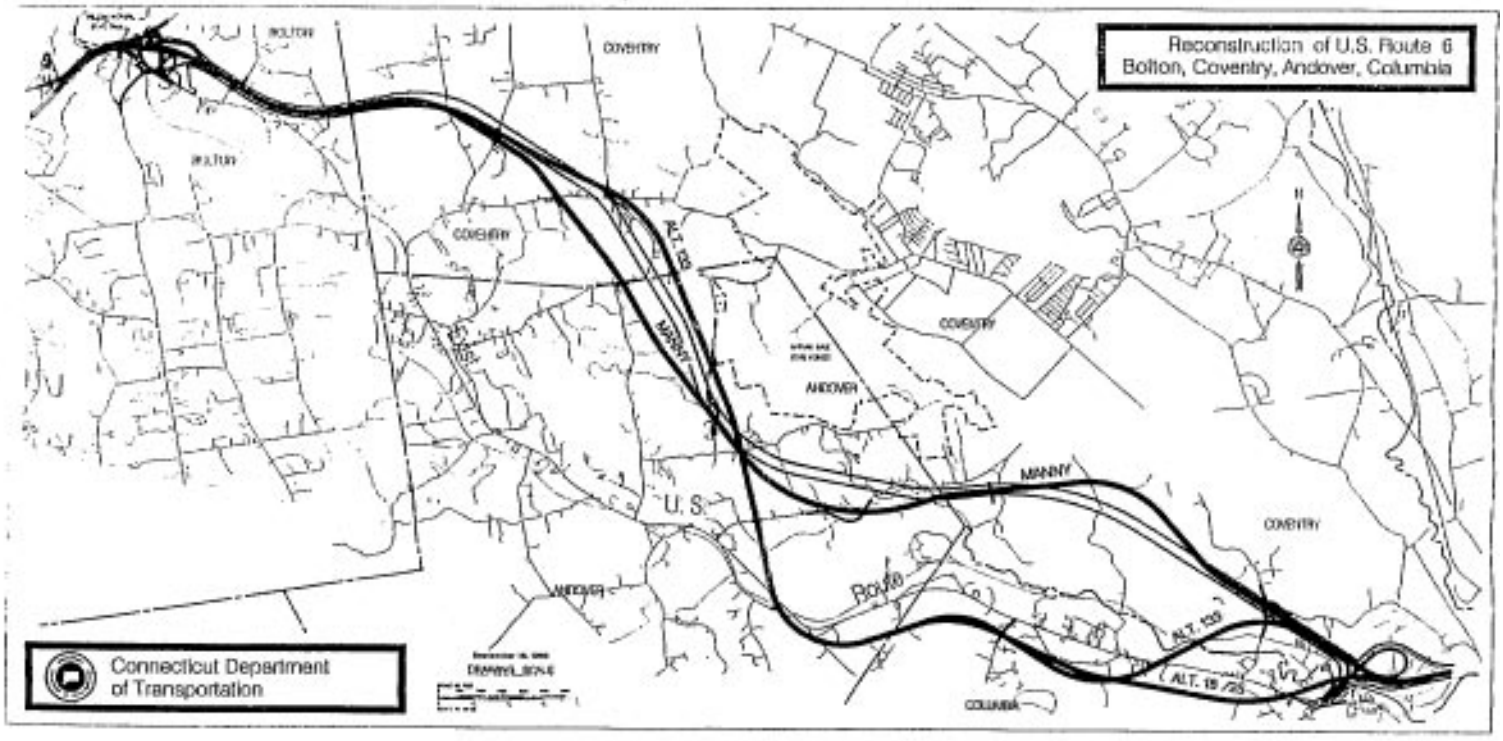


FIGURE 1. ROUTE & ALTERNATIVE ALIGNMENTS

Tributary Streams and Associated Wetlands. Several significant tributary streams and riparian wetlands, including Bear Swamp Brook, the Skungamaug River floodplain, Ash Brook, Columbia Lake Brook, and the Theims Brook complex would be impacted by one or more of the subject highway alignments. Arguably the most ecologically significant and politically contentious of these is the proposed crossing of Bear Swamp Brook by the Alternative 54-Manny alignment. Bear swamp Brook has been identified as a critical landscape feature, providing habitat continuity between the Hop River floodplain wetland complex to the south and Bear Swamp in the Nathan Hale State Forest to the north. The corridor is thought to promote gene flow and act as a movement corridor for water-dependent amphibians, reptiles, mammals and birds between the two valuable habitat areas. A similar situation was noted in California where construction of an Interstate highway fragmented wildlife habitat such that some local populations are expected to become extinct in a few generations (Steinitz et al., 1996).

Proponents of the Alternative 54-Manny alignment maintain that the crossing of Bear Swamp Brook would be simpler, cheaper, and less environmentally damaging than the Hop River crossings required by Alternatives 133 and 133-18/25. Furthermore, the important ecological connections between the Hop River and Bear Swamp would be protected through adequate bridging of Bear Swamp Brook. Opponents of Alternative 54-Manny argue that the critical link between the northern and southern habitat areas is far broader than Bear Swamp Brook itself, and consists of a broad swath of sparsely developed land and unfragmented forest blocks. Clearing of the right-of-way and operation of the highway would ecologically isolate the Nathan Hale Forest, reducing its internal wildlife habitat values and doing irreparable damage to the landscape of which it is a critical component.

Water Quality The Hop River and its tributaries drain a relatively small (approximately 75 $mi^2$) watershed containing numerous wetlands, and permanent and ephemeral streams. While there are limited water quality data available, the river and its tributary streams have been designated as Class A (as defined by the CT/DEP), based primarily on biological characterizations. The waters are lightly stained with organic acids due, presumably, to the influence of surrounding wetlands. Hagstrom et al. (Progress Report F-66-R-7, Department of Environmental Protection, Bureau of Natural Resources, Fisheries Division, Hartford, CT, 1996) recently documented a diverse fish fauna, including both native and stocked species, in the Hop River, Skungamaug River, and Burnap Brook. A review of water quality data collected coincidently with fish surveys (limited to physicochemical variables) indicates no significant impact; dissolved oxygen concentrations were near saturation and pH values were circumneutral on all sample dates. A lack of significant water quality problems in the basin was the consensus view of those interviewed during the study. Thus, information available at the time of this study support the classification of these water bodies as Class A.

Reconnaissance of the study area identified a number of potential water quality concerns. Currently, runoff from existing Route 6 and its associated impervious surfaces (parking lots. driveways, etc.) does not appear to be adequately controlled or treated. At several locations, it appeared that large volumes of runoff water have been conveyed to the Hop River or tributary streams following storm or snow-melt events. While it is assumed that mass loads to the river would be elevated during such events, dilution due to the increases in flow would reduce ambient concentrations. However, as stated above, data describing current conditions and impacts are lacking.

Wetlands currently function as filters and adsorption sites and, thus, provide buffering against water quality changes in the Hop River and associated streams. This benefit to the system may have been undervalued during previous evaluations. At least one potential hazardous waste site exists with unknown impacts to the Hop River (vicinity of Andover Auto Parts). The storage and/or burial of abandoned vehicles and associated petroleum products close to the river stimulates questions about short- and long-term ecological impacts to aquatic communities.

Water quality impacts will clearly result from expressway development, both during and following construction. Primary construction impacts include increased turbidity due to resuspension of bottom material by temporarily modified flows or mechanical disruption. High levels of turbidity would also be expected to occur due to runoff from disturbed sites. Construction activities would also increase sedimentation associated with the transport of soils from construction sites and subsequent deposition of this material in receiving streams. While turbidity will potentially stress aquatic organisms, these impacts would be short-lived; the deposition of sediment in streams, however, could alter habitat structure and quality over relatively long periods of time and have significant deleterious effects. The impacts of sediment accumulation could be reduced if material is redistributed to downstream locations following subsequent high flow events. Other water quality impacts (e.g., those associated with nutrient or contaminant loading) would be less problematic during construction.

Post construction impacts will include increased sedimentation, the seasonal influx of road deicing materials, and increased washoff of nutrients, oils/grease and potentially hazardous materials spilled on road surfaces. Several persons interviewed indicated that the degree to which these impacts occur will be greatly influenced by planned or required mitigation activities. such as the construction of settling basins and maintenance of buffer strips. However, those persons interviewed cautioned that the maintenance of mitigation structures was critical to their long-term success.

Disagreement exists on water quality issues associated with each of the subject alternatives. Central issues included water quality impacts due to bridging of the Hop River (Alternatives 133 and 133/18-25), multiple crossings of wetland areas (Alternative 54-Manny), and loss of wetland function south of the Hop River in the eastern portion of the studs area (Alternatives 133 and 133/18-25). In evaluating the potential water quality impacts of each of the subject alternatives, it is noteworthy that water quality standards for the State of Connecticut prohibit the discharge of other than "...clean water... to Class A streams. rivers and wetlands. For non-point sources, permit approval would require implementation of Best Management Practices. Therefore. it is reasonable to assume that one or more mitigation techniques would be employed to insure that state standards and criteria are met.

Alternatives 133 and 133/18-25 require two new crossings of the Hop River. The current alternative evaluation process assumes that these crossings will involve minimal bridge development. However, discussions with study participants revealed other engineering alternatives, including extended approaches and elevated structures. Crossings of the Hop River, regardless of the type of bridging employed, will produce increased runoff due to their down-slope location and the length of the highway section approaching the crossing. This runoff must be collected and treated prior to discharge to the river. Traditional treatment systems, which could handle the volume of water and meet the requirement of removing 80% of the sediment load, would encompass several acres of the floodplain adjacent to the river. Prevention of direct inputs of water to the river from bridge surfaces would require a closed system to convey water to the treatment structure. While such systems have been developed for cold regions, discussions with several study participants indicate high potential for failure, particularly if maintenance is inadequate.

Anticipated post construction water quality impacts to the Hop River associated with Alternatives 133 and 133/18-25 include failure of the sedimentation basin and periodic overflows from a closed collection system. In both cases, impacts to the river would be episodic and potentially involve significant volumes of runoff. Such inputs to the river should be considered localized or point sources, and could greatly impact large sections of the river. However, such events would occur coincidently with high flows basin-wide (e.g., during storm events or following snow melt), possibly resulting in a lessening of potential impacts.

Review of Route 6 Alternatives

The proposed expressway sections north of the Hop River and west of Nathan Hale State Forest cross numerous streams and are located in or near several wetland areas. Advocates of Alternative 54-Manny suggest that volumes of water (and the materials transported) would be less, due to the shorter road sections drained and that impacts would be distributed. However, concerns were raised by several participants that headwater systems (free-flowing streams and wetlands) would be more vulnerable to degradation than second- or third-order streams.

Loss of the water quality protection value of wetland areas located south of the Hop River was mentioned by some participants as a potential negative impact associated with Alternatives 133 and l 133/ 8-25. However, the current alignment of Route 6 places points of highway runoff close to the Hop River and north of the upland wetland areas. Therefore, wetlands currently provide limited "treatment" of runoff from Route 6. Despite this, no documented cases of runoff-related water quality problems were presented during the interviews. However, placement of the expressway further to the south would reduce wetland acreage and reduce the potential filtering capacity below current levels.

Each of the subject alternatives will result in water quality impacts, both during and following construction. It is recommended that appropriate mitigation measures, as required to meet state water quality standards and criteria. be fully considered in evaluating alternatives. In this regard, alternatives requiring the construction and maintenance of a large treatment structure in close proximity to the Hop River or the design and operation of a closed collection system for large-span bridges seem most prone to degradation or failure, and thus, represent the greatest threat of water quality impacts.

Consideration should also be given, regardless of alternative chosen, to the design and implementation of mitigation measures along the existing Route 6 alignment. Such measures could reduce the net water quality impact of the addition of a second highway in the watershed.

Forest Fragmentation. One of the most contentious issues in the EIS, SEIS, and subsequent agency comments is the value of the existing unfragmented forest blocks in the study area and the estimation of impacts to wildlife attributable to further fragmentation of those blocks. The impacts of habitat fragmentation are potentially significant. Unfortunately, the discussion of fragmentation lacks a meaningful quantitative analysis of the impacts of different alternatives. A recent study (Steinitz et al., 1996) concluded that the greatest threats to biological diversity and ecological integrity are fragmentation and isolation of habitat.

The central issue in forest fragmentation is not reduction of habitat for individual species (although that too is an impact that should be quantified), but the *loss of sensitive species* that occurs when continuous forest cover is fragmented. Therefore, estimation of fragmentation impacts based on acreage of the footprint of each right-of-way, with or without an adjacent "buffer" area, is misleading. Here, the important quantity is not the forested acreage destroyed by an alternative but, rather, the size and configuration of forested blocks that remain after the project. Impacts of each alternative should be quantified by comparing the pre- and post-project habitat value of forested blocks.

One approach to quantification of fragmentation impacts is to identify the species at risk (e.g., forest interior breeding birds) and develop a species/area relationship that can be used to score forest blocks. This general approach was used by Richard Schroeder (1996, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, Wetlands Research Program Technical Report WRP-DE-14, in press) to develop a wildlife community Habitat Suitability Index (HSI) model for forested wetlands in Maryland. A simple application of this method to the Route 6 study area would involve available data and GIS analysis, without the need for additional field sampling. The same approach could be applied to mitigation alternatives designed to reverse the fragmentation of habitats in certain areas.

Review of Route 6 Alternatives

Any meaningful analysis of fragmentation impacts in the study area must consider the fragmentation that is presently occurring and will continue to occur due to the area's proximity to downtown Hartford (equivalent to the "future without project" conditions in most environmental impact analyses). This is particularly important since recent studies indicate that residential development may greatly exaggerate the already deleterious effects of fragmentation (e.g., Friesen et al., 1995*Conservation Biology* 9:1408-1414). Breeding Bird Atlas data and limited bird counts done as part of the EIS indicate that known area-sensitive bird species are present in the study area (e.g., ovenbirds *[Seiurus aurocapillus],* red-eyed vireos *[Vireo olivaceus],* black-and-white warblers *[Miniotilta varia])* whereas others may be absent (e.g., cerulean warblers *[Dendroica cernlea]).* Only in the context of continuing habitat fragmentation and degradation does it make sense to consider forest-block acquisition, protection, and linking as potential mitigation for project impacts.

Faunal Species Impacts. Various documents and persons interviewed indicated that wood turtles *(Clemmys insculpta),* hognose snakes *(Heterodon platirhinos),* ribbon snakes *(Thamnophis sauritus),* water-dependent mammals such as mink *[Mustela vison],* and Neotropical migratory birds were of concern in selection of highway alignments. Despite these concerns, the EIS did not include a quantitative analysis of impacts to any of these species.

Several people expressed reservations concerning use of quantitative methods such as the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) to evaluate impacts. However, HEP can be tailored to the level of resolution and effort that users desire and the project warrants. Furthermore, HEP was designed specifically to answer questions about the relative impacts of competing project designs to habitats for wildlife, and to estimate mitigation requirements for unavoidable damages. There are no such estimates for the Route 6 alternatives, except those based on raw acreages. Another advantage of HEP is that it encourages users to consider the "future-without project" as the standard of comparison when estimating project damages and mitigation needs. Perhaps the most important feature of HEP is that it promotes cooperation and consensus among various interest groups from the earliest stages of a project through the formation of a "HEP Team" that jointly selects evaluation species, chooses and modifies Habitat Suitability Index models, and agrees to methods of sampling and analysis.

HEP would not resolve all of the controversy surrounding the Route 6 project. For one things HEP focuses solely on habitat impacts. Tradeoffs against other environmental and social concerns (e.g., water quality, floodway maintenance, economic and aesthetic impacts) must be based on best professional judgment and political considerations. However, use of HEP provides a sound basis for decision making concerning impacts to species of concern and potential mitigation options.

Reptiles and amphibians, especially the wood turtle, have been used as indicators of biodiversity in the Hop River study area. Wood turtles hibernate in deep pools or below undercut banks of the Hop River. From those sites, the turtles emerge in the spring to forage and breed in the adjacent fields and forests. A low reproductive rate allows little flexibility for a population to respond to an increased mortality rate. Reproduction does not occur until an individual is at least fourteen years of age and clutch sizes are small (4 eggs). Habitat loss and road mortality have been shown to cause local extinction of wood turtle populations, largely because of their very low reproductive capacity (Klemens 1993). The possibility for these impacts are of concern where proposed alignments cross or closely parallel the Hop River.

Review of Route 6 Alternatives

Mitigation. Mitigation plans described thus far in the process are insufficient to offset the expected magnitude of the project impacts. regardless of the alignment. However, the CT/DEP has been working with CT, DOT to develop a more complete set of mitigation plans for the Alternative 54-Manny alignment. Similar actions should be initiated for other alternatives. Mitigation within the setting of major new highway construction will likely include actions aimed at reducing impacts in the areas of groundwater, surface water, air quality, historic properties, noise levels, and natural resources.

Discussions of mitigation often centered around wastewater treatment, bridging to avoid wetland impacts. erosion/sedimentation protection during construction, and zoning. Some participants suggested potential mitigation may include construction of wetlands near the Hop River (however, present habitat values in mitigation areas should be quantified and considered as losses) and acquisition/protection of wetlands and associated riparian corridors. The magnitude of habitat impacts associated with any non-upgrade alignment should clearly justify the protection of critical habitat areas (such as the Bear Swamp Brook or Skungamaug River corridors), coupled with development of new wetland sites.

Some habitat losses were judged by participants to be “unmitigable”, such as forest fragmentation (partially caused by secondary or indirect impacts). However, mitigation measures such as protection of currently unprotected forest blocks may indeed result in more actual contiguous forest acreage than might exist in the future under the continuing fragmentation from residential development.

A monitoring program before, during, and following construction should be considered to determine if projected impacts were as significant as expected and whether mitigation actions were successful. Initial mitigation measures, especially during construction, may indeed be effective in controlling habitat damages to the Hop River and associated habitats (including tributaries). It may be desirable to implement a phased mitigation program with future mitigation measures contingent upon the results of monitoring. Elements of monitoring focus should include water quality parameters of the Hop River and tributaries, distribution and abundance of amphibian and reptile populations and habitats, avian diversity, direct highway mortalities, and wetland parameters.

Existing versus Future Habitat Conditions. Comparison of proposed project impacts on the landscape against the future study area habitat conditions without the project is common in federal project impact studies. This technique requires analysis of past habitat changes, an evaluation of the existing conditions, and an assessment of future habitat conditions in the study area post-project and without the project (in this case, with no new highway construction). The units of measure may be acres of wetlands of various types and qualities, biodiversity indices, habitat units, forest block acres, or other assessment measures. Indeed, this type of approach may have clarified some of the present disagreements.

During the last century, significant changes have occurred which have drastically affected the study area habitats. both positively and negatively. Reforestation is apparent throughout the area, resulting in dramatic increases in habitat for forest/riparian species. Conversely, commercial development along Route 6 and residential developments throughout the study area have degraded habitats in the Hop River corridor and surrounding uplands. Landscape-level resource planning as part of the Route 6 project could have important long-term ecological benefits to the study area.

Review of Route 6 Alternatives

Secondary and Cumulative Impacts. It was determined from document reviews and personal interviews that little difference in secondary and cumulative impacts could be expected among the alignments, except that all agreed the "Upgrade" alternatives reviewed during the early stages of this process would have much less environmental impact. The major concern regarding this issue was the potential for impacts stimulated by construction of a mid-segment interchange. Although plans for this interchange were eliminated from the design of the presently proposed alignments, there is still concern that future demographical changes may cause political pressures to again pursue the concept. The likelihood of this development and associated impacts will be dependent upon economic conditions and patterns of residential growth in the study area and the impacts would need to be considered in future environmental documents.

Because of the existing Route 6 roadway and associated commercial development, secondary and cumulative ecological impacts may be less if the new alignment was near the existing alignment. This suggests that upgrade alternatives are the "best" solution from an ecological standpoint. While a complete upgrade alternative has been eliminated from consideration for socio-economic and safety concerns, alignments that are located in part near the existing road (i.e., Alternatives 133 and 133-18/25) may have less cumulative impact. Certainly, the Alternative 54 or 54-Manny alignments constrict the Hop River corridor by creating a 4-5 mile stretch of river floodplain downstream of the Andover Auto Parts site with a heavily traveled highway within a half-mile on either bank of the river. Since this particular river reach is the most diverse and productive of the study area and requires a high level of protection, such a constriction may have significant impact. Although quantitative impact analyses are not available for comparisons, avoiding further disturbance of the Hop River corridor and associated wetlands in this reach should be a high priority.

## DISCUSSION

Discussions and negotiations concerning the development and selection of alternatives have been long and complex. Despite these efforts, however, no consensus has been reached, and participating agencies and interested parties remain polarized on a number of difficult issues. While an attempt has been made in this report to address these issues, significant limitations were imposed by the design of this review. These included: (1) specification of a restricted number of alternative designs, (2) limiting the review to relative environmental impacts and basing feasibility primarily on avoidance/minimization considerations, and (3) prohibiting collection or development of additional data or information.

This evaluation of the relative impacts of the highway alternatives was hampered by the scarcity of quantitative information in the EIS and other documents concerning impacts to important environmental resources (e.g., water quality, faunal species of concern, unfragmented habitats). Furthermore, the weighing of alternatives involved tradeoffs between potential impacts to different resources (e.g., increased impacts to water quality resulting from one alternative versus increased impacts to wildlife communities from another alternative). The EIS process and agency decision making have been hampered by the apparent lack of a procedure to weigh different impacts and reach a consensus.

### Review of Route 6 Alternatives

Because of the juxtaposition of headwater, slope, and riverine wetlands within the study area, any non-upgrade alignment will have significant impacts to the ecological setting of the study area. It was clear from documents and interviews that an upgrade of the existing roadway would cause the least ecological impact of any proposed route. However, the upgrade alternatives have been eliminated from further consideration for reasons other than ecological impacts. As they were not within our scope of study, we did not evaluate them for this report.

The three highway alternatives we considered (Alternatives 133, 133-18/25, and 54-Manny) all would have significant environmental impacts. A major impact of all three alignments is the crossing of the Hop River headwater area, a very high quality wetland and riparian site. Significant construction impacts to this area could have potentially long-lasting impacts to aquatic and associated habitats in the Hop River. Stringent controls on construction activities should be required in this specific area, along with other water course crossings.

In the western portion of the study area, the Alternative 133 and 54-Manny alignments appear to have similar impacts on wetlands and associated habitats, including the Hop River headwaters and Ash Brook, except where they cross the Skungamaug River. The Alternative 133 alignment is likely to reduce impacts on both the Skungamaug River habitats and on two “unfragmented” forest blocks (blocks 5 and 7). However, impacts from Alternative 133 may be lessened if the alignment was moved slightly west near the border of the Nathan Hale State Forest to avoid vernal-pool wetlands in the forest.

Although there was general agreement among the participants as to the high quality of the Hop River corridor habitats and adjoining wetland/riparian areas to the north of the river, there was some disagreement as to the quality and significance of impacts to wetland/riparian areas south of the river. Of specific concern south of the existing highway were wetlands in the Bailey Road, Burnap Brook, and Columbia Lake Brook watersheds. Of these. the Bailey Road and Burnap Brook wetlands would be avoided by the three alternatives in our review, all of which run north of the Hop River in that reach. The Columbia Lake Brook watershed does contain substantial high quality wetlands, although it has been impacted by a darn that controls flows to the Hop River.

From an ecological perspective, it is difficult to weigh alternatives without simultaneous consideration of potential mitigation options. For example, any crossing of the Hop River that involved extensive fills within the floodplain or lacked runoff controls could not be recommended. Environmentally sensitive design features are an important part of the initial selection among these alternative alignments.

Review of Route 6 Alternatives

Comparative analysis of the alternatives indicated:

(l) The impacts of Alternatives 133 and 133-18/25, although potentially severe, are more likely to be mitigated successfully than those of Alternative 54-Manny. The important connectivity of instream and riparian habitats along the Hop River can likely be protected with maximal bridging of the floodplain. Water-quality impacts due to construction are likely to be short-lived, and the deleterious long-term effects of sediment and contaminants in runoff from the completed roadway should be mitigated sufficiently with well designed and maintained control measures.

(2) Unlike Alternative 54-Manny, Alternatives 133 and 133-18/25 avoid severing the important habitat connections between the Nathan Hale State Forest and the Hop River floodplain. The broad corridor of sparsely developed land and unfragmented forest blocks on each side of Bear Swamp Brook is an important factor helping to maintain biodiversity of both areas, and bisecting the corridor with a major highway will do long-lasting damage to both habitats. For the majority of water-dependent mammals, birds, amphibians. and reptiles, this wetland/riparian connection could be partially protected with expanded bridging of the brook and its riparian zone as part of the 54-Manny alignment. However, a major highway in close proximity to and along the entire length of the eastern Hop River wetland/riparian complex would restrict the movements of some species (e.g., wood turtles) and would be an important source of added mortality due to road kills and other hazards. Construction of a freeway (Alternative 54-Manny) along the north bank of the Hop River floodplain in an area where a major secondary highway (Route 6) already exists on the opposite bank is an added concern. The greater distance of the expressway alignments from the Hop River west of the Nathan Hale State Forest is not of similar concern. However, if the Alternative 54-Manny alignment is ultimately pursued, the original Alternative 54 crossing of Bear Swamp Brook may be preferable to the 54-Manny crossing location because of 54-Manny's proximity to the Hop River floodplain.

(3) The Nathan Hale State Forest/Bear Swamp Brook/Hop River corridor is an obvious location for mitigation (compensation) measures aimed at reducing the overall environmental impacts of the project. Project impacts are of such magnitude that mitigation likely will require a combination of techniques (see discussion starting on page 4-91 of the Supplemental Draft Environmental Impact Statement, and the Section 4(F) Evaluation). In addition to direct actions such as maximum bridging of brooks and rivers. development of new wetlands, and enhancing wildlife habitats, the acquisition, development, and management of wetland areas and associated upland habitats will likely be necessary to compensate for direct and indirect habitat losses. A primary consideration in selection of mitigation sites should be the enlarging of existing unfragmented forest blocks. The most valuable forested block in the study area is the Nathan Hale State Forest because of its large size, public ownership, and connection to the Hop River along Bear Swamp Brook. Thus, wetlands and adjacent forested habitats between the Nathan Hale State Forest and the Hop River floodplain should be a priority location for acquisition, zoning restriction and management. Based on breeding bird species/area relationships in the literature and discussions with forest fragmentation experts, enlarging the effective area of the unfragmented Nathan Hale State Forest by improving connections with other habitat blocks would provide more significant biodiversity benefits than protecting or consolidating some of the smaller, privately owned forest blocks in the study area.

(4) Alternative 133-18/25 is ecologically preferable to Alternative 133, based on (a) the preference for construction of a second new Hop River crossing at or near the site of the current Route 6 crossing rather than at a new location, (b) avoidance of highway construction on the north side of the Hop River in this reach, and (c) environmental resources on the south side of the river, in the existing Route 6 corridor, are already affected by high levels of human disturbance.

Review of Route 6 Alternatives

# CONCLUSION

Assuming proper mitigation and careful highway design and maintenance, the least environmentally damaging alignment would be Alternative 133-18/25, although Alternative 133 would have only slightly greater impact. From a landscape perspective, the most ecologically damaging alternative would be 54-Manny.